ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES

REGIONAL AND LOCAL DEVELOPMENT STUDIES

THE IMPACT OF AGRICULTURAL BIO-CHEMICAL TECHNOLOGIES ON RURAL HOUSEHOLD FOOD SECURITY: THE CASE STUDY OF TWO WEREDAS IN OROMIA REGION

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MoA	Ministry of Agriculture
MoFSS	Months of Food self-sufficiency
MNRDP	Ministry of Natural Resources Development and Protection
MoPED	Ministry of Planning and Economic Development
MPP	Minimum Package Program
NFSS	National Food Security Strategy
NGOs	Non-Governmental Organization(s)
OADB	Oromia Agriculture Development Bureau
OFSSDPA	Oromia Region Food Security Strategy for Drought Prone Areas
ONCCP	Office of the National Committee for Central Planning
OPEDB	Oromia Planning and Economic Development Bureau
OPHCC	Office of Population and Housing Census Commission
PADEP	Peasant Agricultural Development and Extension Program
PADETES	Participatory Agricultural Demonstration, and Training Extension System
SEADZ	South Eastern Agricultural Development Zone
TFSSDPA	Tigray Region Food Security Strategy for Drought Prone Areas
TAHDU	Tahtai Adiabo and Hadigiti Agricultural Development Unit
Timad	Local unit of measurement for farmland which is equal to 0.25 ha
TLU	Tropical Livestock Unit
UNDP	United Nations Development Program
UNECA	United Nations Economic Commission for Africa
USAID	United States Agency for International Development
WADU	Wolaita Agricultural Development Unit
Wereda	Administrative unit next to zone
ZADD	Zonal Agricultural Development Department
ZPEDD	Zonal Planning and Economic Development Department

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ABSTRACT

The Ethiopian agricultural sector, as well documented in many literatures, is characterized by poor technology adoption and as a result low productivity per unit area. The food supply and demand gap is so high with its resultant outcome of high prevalence of temporary and chronic food insecurity. The dependence on rainfall, severe environmental degradation and high man land ratio are some of the major problems of the sector with their consequent results of persistent crop failures, drought and famine.

To curb the problem of food shortages and food insecurity, the country has adopted various strategies in which use of agricultural bio-chemical technologies (fertilizer, improved seeds and chemicals), in one way or another, has been the centerpiece of these strategies.

The contribution of these agricultural bio-chemical inputs, undoubtedly, is positive for food self-sufficiency rather than for food security. This is also true for areas where there is abundant and reliable rainfall. In lowland areas where moisture is critical for crop production, their impact on increased grain production could be marginal.

Thus the hypothesis of this research is that the use agricultural biochemical inputs alone cannot be a means to achieve reasonable level of household food security due to variations in resource endowments at household level, ecological variations, income gap and unique characteristics of the households themselves. To prove this hypothesis an intensive review of literatures and data was made. Primary data were also collected from two weredas (Hetosa and Dodota-Sire) of Arsi zone Oromia Region consisting of ten peasant associations (kebeles) and 142 households.

The hypothesis of this research is proved to be true, that fertilizer, improved seeds and chemicals by themselves have insignificant contribution and they only explained 21.1 per cent of the variations in household food security (the food self-sufficiency scenario) or thirty three per cent in the case of food availability scenario. Only fertilizer has a significant impact on food security among the three. The variations in food security level is more explained by a combined effect of many socioeconomic variables. Taking into consideration eleven variables they explained 81 per cent of the variations in the level of household food security.

Thus, the policy implication is that household food security is multidimensional, complex and driven by factors ranging from economic, social, political and socio-cultural as well as environmental. To alleviate this problem a single production oriented strategies, mainly focussed on use of modern agricultural inputs, which may not be affordable and suitable for resource poor and various agro-ecologies cannot be an appropriate measure. The strategy should, rather, aims at the inherent condition of the socio-economic and socio-cultural as well as environmental settings of that particular locality and community.

CHAPTER ONE
INTRODUCTION

1.1. Statement of the Problem

It is evident that food security in Ethiopia has deteriorated mainly due to low performance of agriculture, repeated occurrence of droughts and rapid population growth and inability to reach the most needy small scale poor farmers. With considerable agricultural potential, Ethiopia has been self-sufficient in staple foods and net exporter of food grains until the 1950s (Alemayehu, 1988). However, since the early 1960s, the domestic supply has failed even to meet the basic minimum requirement of the people.

The trend in growth of production matched that of the population only in the 1960s and early 1970s when the population was growing at about two per cent. Since then, however, the gap between growth in food production and demand for food has dramatically increased (Getachew, 1995 as quoted by Markos, 1997). During the last two decades both food production and per capita availability have exhibited a downward trend. Total domestic production on average decreased by 1.1 per cent per annum while the level of per capita food production dropped by 4.3 per cent. The per capita performance never again reached the level achieved at the beginning of the year 1960 (Getachew, 1995).

The World Bank Development report (1992) also indicated that the per capita daily energy supply declined from 1953 calories in 1965 to 1667 calories in 1989. The deficit in the past five years was also estimated to be about sixty per cent or 85 kg/person/annum. In general terms, domestic production was unable to meet the national requirement in almost all years and food aid and commercial imports have partially filled the gap. The annual volume of cereal food aid has fluctuated between 54100 tons in 1975 to about 334000 tons in 1996. At the same time food aid accounted for about 9.8 per cent and 3.9 per cent of domestic cereal production. In a normal year the volume of cereal aid could account for twenty five per cent or more of the total market cereal supply. Even in drought years food aid may account for up to fifty per cent or more of the total market supply (Debebe, 1994).

The population growth rate is also alarmingly high. Trend lines show that by year 2010 Ethiopia's population, which is about 58.1 million, is projected to reach 83.5 million. Looking ahead to 2020, the CSA projected a median population of almost 106 million (CSA, 1998). Such trend of population growth represents a formidable challenge to Ethiopia's ability to feed itself. First the rapidly increasing population (currently 2.73 per cent) requires a rapidly growing food production to maintain even the current low consumption pattern; second, a major effort is required to gradually eliminate the structural deficit. In all cases it is difficult for a country to feed its population if the current technological status of the agriculture remain to continue in the future.

Various sources indicate different size of food insecure population in Ethiopia. However, the consensus is that there is alarmingly high number of food insecure people in the country. IFAD (1992) estimated that nearly forty three per cent of the population is below a poverty line. The Intergovernmental Authority on Drought and Development (IGADD, 1990), on the other hand, claimed that the food insecure people were about seventy eight per cent, of whom sixty seven per cent were resource poor households in rural areas. The World Bank (1992) with the inclusion of farm settlers estimated 41.3 per cent of the population of the country to be food insecure. Recently, MEDaC estimated that twenty seven million people out of which the very poor accounted for slightly more than fifty per cent of the rural and sixty five per cent of the urban population (Debebe, 1994).

In the last two decades, debilitating food shortages and tragic famines have been among the major problems facing many Sub-Saharan countries of which Ethiopia is one of the most severely affected. The famines of the 1970s and 1980s hit the country very severely. The drought of the 1970s and 1980s and civil war along with bad development policy left the country as one of the countries that depend on food aid for substantial proportion of its food supplies (Markos, 1997).

The decline of Ethiopian agriculture may be attributed to recurrent natural disasters such as drought, floods, pest infestation, epidemics and animal diseases and environmental degradation especially in densely populated part of the country. According to one study of the total country's land resources about fourteen million hectares are severely degraded and of which two million hectares of farmland have reached a point of no return. Annually about 1900 million tons of fertile topsoil is being eroded (EHRS, 1986; Tegegn, 1995:27; Mulat, 1995:229). As a result crop production and productivity is progressively declining from year to year. Besides, due to general environmental degradation and fluctuation of climatic conditions as well as pure dependence of the agricultural sector on rainfall, feeding the ever-growing population on sustainable basis become hardly possible. Irrigated agriculture only constituted one per cent of the total cultivated land in the country; use of traditional soil fertility amendment measures such as use of manure and organic fertilizer, fallowing, crop rotation and multiple cropping are quickly declining, mainly attributed to high population to land ratio, deforestation, decline in grazing land and subsequently resulted in declining livestock numbers, general rural poverty and declining rural institutional support systems.

EFAP study (1994) pointed out the quantitative and monetary impact of land degradation in Ethiopia as follows.

> *"1. In 1990 reduced soil depth caused by erosion, resulted in a loss in grain production estimated at between 57000 and 128000 tons, depending on whether the loss of soil depth has amounted to 3.5 or 8 mm. This loss also reflects the impact of 1000 to 2500 km^2 of cropland going out of cultivation because the soil depth fell below a minimum critical level. The foregone production in the livestock sector resulting from soil erosion was estimated to be between 35000 and 78000 TLU. Together these losses represent financial losses of Birr 18 million to Birr 40 million; equivalent to 0.5 to 1.1 per cent of the 1990 agricultural GDP;*
> *2. In addition to agricultural production losses as a result of soil loss, the burning of dung and crop residues caused physical production losses estimated to be four to eight times greater than the production lost on account of soil erosion. In financial terms these losses amounted to four to seven percent of the 1990 agricultural GDP.*
> *3. The combined impact of production losses from soil erosion and the burning of dung and crop residues is alarming. The total cereal production foregone in 1990 was equal to about one-fifth of an average year's harvest of five million tons of grain. The grain production lost would have been sufficient to feed 4.4 million people, based on an annual per capita cereal requirement of 220 kgs. To the average farmer, the financial cost of the grain and livestock production foregone (in 1990) represented about 12 per cent of his income. In aggregate, the financial costs of foregone grain and livestock production over the period 1985-1990 would have meant on average annual decline of between 0.33 and 0.41 per cent of the agricultural GDP in 1985"(MNRDP, 1994:39).*

Such production losses and their financial consequences are expected to increase as more and more cultivated land reaches the critical minimum soil depth at which point productivity drops dramatically and production is no longer worthwhile (MNRDP, 1994).

Various policy options were also adopted and implemented in the last three or four decades. Most of these policies especially starting from the early 1970 were based on food self sufficiency, which in one way or another, emphasize the use of improved bio-chemical technologies which are assumed to increase agricultural productivity. Due to the above indicated factors and associated problems related to unfair rural land holding and tenure system, weak agricultural and rural development policies and lack of capital and shortage of foreign exchange, even the use of these technologies and their contribution remain to be insufficient to impact on the growth of the food sector.

Inspite of the policy changes in the past decades, Ethiopia has remained with limited alternative to curb the problem associated with declining agricultural productivity and food insecurity. The widely adopted strategy, and which is still playing an important role in increasing agricultural production is expansion of the cultivated land. It is estimated that forty five percent of the reduction in crop production, in Ethiopia, is due to reduced crop land and fifty five per cent is due to reduced yield (Tegegn, 1995:29). However, the available land for expansion remain only in the west and south west part of the country, and these on the other hand, are areas with low infrastructure development, high prevalence of diseases such as malaria and sleeping sickness and areas of biodiversity. Thus, at least in the short run, it is evident that these potential areas could not be effectively utilized for peasant agriculture as they require high investment in terms of social and economic infrastructure development (Dejene, 1996; Mulat, 1995 and Tegegn, 1995). The other alternative is the intensification of the existing production system. This alternative seems important for Ethiopia since almost all the highlands of the country are densely populated and man land ratio is so high that further land expansion is impossible; and land degradation is severe to constrain the continuation of low input-output traditional form of production.

Intensification entails the use of multiple cropping, improved farm management and practices, irrigation, and the use of agricultural technologies that generate higher yields per unit area such as commercial fertilizer, improved crop varieties and pest control chemicals.

The use of production boosting technologies, however, are determined by the ability of the country to produce or import the related inputs, the purchasing power of the peasants, the dissemination strategies adopted, the efficiency of pricing, marketing and distribution systems, the suitability of the inputs to diversified ecological systems of the country and the availability of other complimentary inputs. The contribution of these technologies to national/regional food self-sufficiency is immense as documented by the experiences of different countries. Regarding their impact on household food security, however, there are insufficient studies and the existing ones mostly equated their contribution to productivity. Food security at household level is rather a function of various factors and its causes are ranging from physical to political and socio-economic. Though modern agricultural biochemical inputs are important factors they are not a sufficient condition to alleviate household food insecurity. Studies made on this issue generalized the same idea.

The food security strategy of the FDRE (1996) has indicated that the causes of food insecurity are inadequate and variable rainfall, environmental degradation, military and political conflict, weak transport and infrastructure, land tenure, geographical diversity of production; poor storage, poor nutrition and health, heavy work loads for women and the peculiar problems of pastoralists (NFSS, 1996; Wolday, 1998).

The findings of the study made by Aceves et al (1997), on the other hand, puts variability of rainfall as a prime constraint to increased agricultural production. Getachew (1995) has also made an in-depth investigation on the causative factors of household food insecurity and identified some fourteen causes of famine and food insecurity in Ethiopia which include poor governance and political conflict, land tenure, population growth, environmental degradation, poverty and other socioeconomic conditions (Getachew, 1995; Wolday, 1998).

Other government documents and authors have also indicated the same causative factors for household food insecurity in Ethiopia (TFSSDPA, 1997; AFSSDPA, 1997; OFSSDPA, 1997; Wolday, 1998; ESC, 1990; Debebe, 1994; Maxwell, 1990; IFPRI, 1997; FAO, 1996). In general, causes of food insecurity in Ethiopia are mostly related to variability of rainfall, environmental degradation, population pressure, and inefficiencies in rural institutions, poverty, weak infrastructure and marketing system. Thus the impact of biochemical agricultural technologies on household food security is only positive where the above mentioned factors have been favorable.

1.2. Objectives of the Research

Improved agricultural inputs have played substantial role in improving agricultural productivity and have also taken as major strategies for fulfilling the food self-sufficiency objectives since the emergence of the green revolution in many developing countries. In the same manner, in Ethiopia, agricultural policies and strategies adopted for the past three decades have put bio-chemical inputs as their central concern to improve the performance of agricultural sector. Yet the agricultural sector productivity did not show significant change over years, and rather characterized either by stagnation, decline or high fluctuations. The food demand and supply gap is widening and fulfilled mostly by imports and foreign aid. The food insecurity problem especially at household level is serious. The strategies main goal of achieving food self-sufficiency heavily depended on modern inputs without taking major complementary measures that have a central role for small holder peasant agriculture. Thus, the efficiency of the food sector has not been improved significantly despite there has been significant changes in the use of agricultural bio-chemical inputs such as fertilizer, improved seeds, pesticides and herbicides. Thus one can hypothesize that in traditional agriculture where the use of modern agricultural inputs is low and not supported by irrigation, appropriate land tenure, efficient rural institutions and other off farm employment opportunities, the contribution of these inputs to household food security is minimal.

Thus the objective of this research is, in general, to find out the impact of these inputs particularly fertilizers and improved seeds, on household food security and the magnitude of their contribution as compared to other factors determining the level of household food insecurity.

Particularly, this research tries to answer the following questions:

1) Are the packages of agricultural technologies adopted in Ethiopia at different times improved the problems of rural areas and household food insecurity?

2) What is the level of food security and food insecurity between different households with varying resource endowments and between various ecologies? Does the use of improved agricultural inputs have any significant contribution to household food security between

households and varying ecologies or what is the contribution of these inputs as related to other determinant factors of food security?

3) Does the strategy of high utilization of agricultural inputs sustainable without other complementary inputs to alleviate the food security situation at household level?

4) Are the so-called surplus producing areas having long experience in using these inputs really food secured?

To answer these research questions an in depth analysis of the socio-economic, agricultural policies adopted in Ethiopia since the 1960s and the implications these policies have in the research areas are shortly reviewed using detailed time series and cross sectional data.

1.3. Significance of the Study

In Ethiopian economy, as well documented in various literatures, the agricultural sector remain to be one of the important sectors dominating the economic, social and political life of the Country. Various policies and strategies have been adopted to improve the performance of the sector since the 1960s.

One of the common characteristics of these policies is, however, that the top priority given to integrated rural development approach which emphasizes, in the Ethiopian context, on the intensive use of modern agricultural technologies such as fertilizer, improved seeds, pesticides and herbicides. The emphasis given to irrigation which could have played in boosting agricultural production and crop intensity has got negligible priority. Yet the major problem of the country's agricultural production and systems is moisture stress both in most of the highlands and the lowlands.

Despite the high priority given to intensive use of agricultural inputs, the agricultural sector output could not cope up with the ever-increasing population. The vagaries of nature and man made calamities have progressively devastated the agricultural resource base, so that it becomes hardly possible to produce the maximum output from a particular plot of land as it had been four or five decades ago.

As a result drought and famine almost rules over the rural Ethiopia every three years with minor famines and every decade with major drought episode that can have a serious implication on the overall socio-economic conditions of the country.

The current government has also adopted the agricultural strategy that emphasizes the same strategy as in the past. This strategy varies with other agricultural strategies that have been pursued since the 1960s in that it encompasses intensive use of improved cultural practices and higher rate of fertilizer application together with other manmade inputs.

Even though the program has already passed some five years since its inception, its impact is not that much higher to bring about fundamental change on the over all development of the economy. This is because those adopters are still few in number and the sector is still affected by the variability of rainfall. It was found out that the program success has been encouraging on the highlands where rainfall pattern is relatively stable and reliable.

Though many and varying agricultural and rural development strategies have been adopted in Ethiopia the problem of food shortages and food insecurity is persisting and worsening from time to time. The problem of the agricultural sector is complex. Some of these problems are related to economic conditions, others to social, natural and socio-cultural. Natural and economic conditions are believed to have major impact and dominate most of the literatures on agriculture in Ethiopia. These problems include rainfall variability, land degradation, deforestation, overgrazing, shortage of both grazing and cropland, population pressure on the highlands, inaccessibility of the fertile lowlands, shortage of technology. Lack of infrastructure, illiteracy, and general poverty of the overwhelming majority of the farming community are other important factors that attributed to the weak performance of the agricultural sector.

Thus, where the agricultural sector is constrained with enormous number and deep rooted problems, a single strategic measure cannot improve the performance of the agricultural sector in general and the crop sector in particular. Thus the assumption and the practical applications of these green revolution strategies has proved to have insignificant contribution except in few areas.

This study has major significance in many respects. It tries to identify the most important factors that contribute to the productivity and production of major crops as well as determinants of food security at household level. It also tries to justify that the application of agricultural inputs (commercial fertilizer, improved seeds and chemicals) by themselves could not be a sustainable means towards household food security in all ecologies, in all household's with varying characteristics and resource endowments. Food insecurity, which is the most chronic problem in Ethiopia, could not be tackled at least with these factors and the food self-sufficiency strategies as well.

It has also significant contribution to various government, non government, community based organizations and private institutions who are involved in the development of agricultural sector and improving household food security, distribution and marketing of fertilizer and improved seeds, investors in the sectors, and humanitarian and aid agencies. Particularly, decision-making and policy bodies, the agricultural extension system, academic and research institutions, the NGOs and CBOs, political institutions, and the like could benefit from this research.

1.4. Research Methodology

1.4.1. Method of Data Collection and Sample Design

In this research at least two methods of data collection are used.

1. Secondary data were collected from various institutional reports, research documents, literature and related sources. These data include the general socio-economic condition of the research area, population, rainfall, adoption and utilization of improved agricultural technologies since the 1960s, a time series data of agricultural production and area under crops and investigation of various agricultural development policies adopted in Ethiopia at different times.

Specifically secondary data were collected from UNECA, MEDaC, IDR, RLDS, BPEDO, ZPEDD, ZADD, the concerned *weredas*' Agricultural Development Offices, Addis Ababa University and ECA libraries, Kulumsa Research Station, MOA, OADB and National Meteorological Authority.

2. Primary data were collected using both purposive and multistage simple random sampling methods using standardized questionnaire. The contents of this questionnaire comprise household characteristics, farming systems and agro-ecological setting, agricultural production, extension services, agricultural input utilization, livestock holding and production, household food security conditions, off-farm employment opportunities and income and expenditure of the households. To administer these questionnaires two *weredas* in Oromia region were selected purposively based on the following criteria:

a. Since the purpose of this research is to find out whether agricultural bio-chemical technologies have major impact on household food security or not, it is the assumption of this research that these *weredas* best represent this objective. This is because the *weredas* have a long period experience in the use of these biochemical technologies at least since the late 1960s and are the first CADU rural development strategy target areas.

b. As a result of 'A' they are high utilizers of the improved agricultural technologies than most parts of the country, so that the issue of adoption or non adoption of these technologies is insignificant;

c. Except in one *wereda*, the agro-ecological setting and the rainfall pattern is favorable for agricultural production, and hence this may evens out the vagaries of nature as the determinant factor for household food security. In other words, since rainfall pattern is not as such a major problem in the specified *wereda*, it could be taken as a control variable in comparing the differences and similarities of the level of food security in different agroecology. However, one *wereda*, which is located in the semi arid lowland agro-ecological zone also selected to carryout comparative analysis of the impact of improved agricultural inputs in rain abundant and rain deficit areas in the mid highland and semi lowland areas. However, both weredas have relatively same characteristics with respect to population setting, level of development, adoption of technology, farming systems and etc.;

d. Both *weredas* are relatively accessible and have well-developed infrastructure. Thus, adoption of technologies and level of household food security are not constrained by this factor. Based on these criteria two *weredas* (Hetosa and Dodota-Sire) were selected as representative areas for high level of bio-chemical technology adoption.

The second sampling stage was the selection of representative *kebeles*. To select these *kebeles* simple random sampling technique is used. Before carrying out sampling of the *kebeles* list of each kebeles in the sample *weredas* was taken from the respective *wereda's* Agricultural Development Offices.

Depending on the total number of *kebeles* in each *wereda* the ratio of the number of *kebeles* in the sample *wereda* to the total number of *kebeles* in the two sample *weredas* are taken and multiplied by the predetermined number of *kebeles*. The sampling procedure, in short, is as follows:

$SSW_i = NKW_i/(NKW_i+NKW_j) * 10$ (predetermined sample size of the kebeles); and similarly for *wereda* 'j'

$SSW_j = NKW_j/(NKW_i+NKW_j)*10$ (predetermined sample size of the *kebeles* in *wereda'j'*),

Where, SSW_i and SSW_j are sample size of the *kebeles* in wereda 'i' and 'j' respectively;

NKW_i and NKW_j = the total number of *kebeles* in *wereda* 'i' and 'j' respectively.

After the number of *kebeles* to be sampled from each *wereda* known the sampling interval method is used to locate each of the sample *kebeles*. Based on this procedure five *kebeles* from Hetosa wereda and five *kebeles* from Dodota-Sire *wereda* were selected using the sampling interval of seven for Hetosa and six for Dodota-sire.

In the third stage, households were randomly selected from sample *kebeles* from an exhaustive list of households living in each *kebele*. This list was obtained from each *kebele's* administration. The procedure is almost the same to that of the second stage sampling procedure used for selection of the *kebeles*. First, total number of households in each sampled kebele and *wereda* was taken; second, using the ratio as indicated in stage two, the number of sampled households in each *kebele* was determined; third, the sample interval was set and based on this interval the required number of sample households was selected. In short, the procedure is as follows:

$SSHK_iW_i = TNHK_iW_i/(TNHAKW_i) * PTHW_{ij}$

Where, $SSHK_iW_i$ = sample size of households in *kebele* 'i' in wereda 'i'

$TNHK_iW_i$ = total number of households in *kebele* 'i' in *wereda* 'i';

$TNHAKW_i$ = total number of households in all sampled *kebeles* in *wereda* 'i';

$PTHW_{ij}$ = predetermined total household sample size in wereda 'i' and 'j' respectively.

Based on this, out of the total number of predetermined sample size of 150 households 65 per cent or 98 households were selected from Hetosa *wereda* and 52 households from 'Dodota-Sire' *wereda*. After the survey was already started, however, due to inefficiency of enumerator, the researcher is forced to change one sample *kebele* from Hetosa to Dodota-Sire wereda. Hence, the actual sample size was adjusted accordingly. The number of households selected for the purpose of this research seems small as compared to the total households living in each *wereda*. However, since the farming systems, socio-cultural and economic characteristics of households as well as other variables related to food security and adoption of technologies are almost the same across the households this number is significantly adequate to be taken as a representative sample size. In short the variance between households is smaller than the variance between *kebeles*. Using the Sheskin methodology the sample size is significant at eight percent confidence interval and ninety five per cent confidence level (Sheskin, 1950:65).

However, out of the target households only 142 (76 from Hetosa and 66 from Dodota-Sire) were found to be relevant and the remaining eight households were rejected because the data on these households were found to be undependable. Since the characteristics and the physical, social and economic environment in which the households are set is homogenous the reduction of the number of households does not affect the reliability of the final outcome of this research.

In the collection of the primary data ten enumerators were employed, who are development agents in the respective *kebeles*. They are well versed with the subject matter of the questionnaires, acquaintance with the sample households and have access to primary data, and therefore it was assumed that the cost of collecting primary data is so low than it has to be. In order to keep the quality of data to be collected an intensive orientation was given to the enumerators. A continuous monitoring was carried out during sampling and actual data collection by the field supervisor.

1.4.2. Data Analysis

The analytical tools used in this research are both descriptive and quantitative data analysis methods. In the descriptive analysis ratios, percentages, cross-tabulations and frequency distributions are widely used. To test the impact and relationships of various variables including bio-chemical inputs to household food security the multiple linear regression model is used. In the analysis of the relationships of variables two different scenarios were taken into consideration- the agricultural inputs only and multiple variables scenarios.

The model is described as follows:

MOFSS= f (LANHOLD, FAMSIZ, LABFRCE, ECO, NOX, OFFRMIN, LIVSTCK, FRT, IMSD, CHEM, PROD) and the equation would be

$$FOSS/FAV = \alpha + \beta_1 LANHOLD + \beta_2 FAMSIZ + \beta_3 ECO + \beta_4 NOX + \beta_5 OFFRMIN + \beta_6 LIVSTCK + \beta_7 FRT + \beta_8 IMSD + \beta_9 CHEM + \beta_{10} LABFRCE + \beta_{11} PROD + \varepsilon$$

Where MOFSS is a proxy to household food security (dependent variable) i.e., food self-sufficiency period in which a family can feed itself from what it produced (measured in months). It is directly taken from household responses through administered questionnaires. FAV is food availability at household level from major crops in grain equivalent and measured in quintals. Food Availability is calculated as Total production of major crops at household level plus purchases for consumption less post harvest loss less requirement for seed less sales for different purposes all converted into grain equivalents.

LANHOLD = size of land holding. It is assumed that the size of land holding (crop land) irrespective of the tenure system determine the level of food security of the household, i.e., the size of the land holding is directly related to the volume of production in traditional agriculture and so to the level of food security;

FAMSIZ/LABFRCE = Household family size. Family size in the agrarian economy is a major indicator for labor availability for agricultural production and also a source of demand for more food. A family with a large number of economically active members has more opportunity to farm large area, and to adopt improved farm practices and so opportunity for higher production and income. Conversely, family size in poor community is a constraint for further development especially where the resource endowment is poor and the proportion of economically inactive members of the family is high.

ECO = ecology in which a particular household resides in, determine the level of household food security and the adoption of agricultural technologies. In traditional agriculture where production is not supported by irrigation the variability of rainfall determine the volume of production each year. Thus it is assumed that household food security and adoption of technologies are better in the highlands than in the lowlands;

NOX = number of oxen owned by the household. Since oxen are the major traction powers in traditional agriculture their availability determine the amount of cultivated land, volume of production obtained and consequently the level of income and food security;

OFFRMIN = Other income obtained by the household. It is explained by off-farm employment opportunities. The more the household has access to off-farm employment, the better it is food secured;

LIVSTCK = Number of livestock owned. In rural areas livestock, apart from being as source of food, income and traction power, are hedges against any risks arising from natural and man made calamities. The larger the number of livestock owned by the household, the better the coping ability of the household to food insecurity. The number of livestock is changed into tropical livestock unit to arrive at common units of measurement. Eventhough the production obtained from this resource in terms of meat, milk and meat best measure the availability of food stock at household level data on this variable are scanty and unreliable;

FRT, IMSD, CHEM are use of fertilizer, improved seeds and chemicals (pesticides and herbicides) respectively. The assumption is that the more the household uses these inputs the more it has the capacity to produce more and consequently the better access to food. However, it is not always true that the level of input use determine the level of food security. It is mostly determined by the agro-ecological setting and rainfall variability. However, these variables are the central concern of this research.

PROD = production. This variable is a function of various variables included above. However, it is taken as a contributing factor for household food security as far as the supply side of food security is concerned.

The procedure in using the model, two steps were taken into consideration as indicated above.

a. The dependent variable being the number of months in which the household become food self-sufficient or the net available food at household level measured in quintals after converting it into grain equivalent and the independent variable being fertilizer, improved seeds and chemicals used. These data are obtained from household survey.

b. The impact of other variables including agricultural inputs, land holding, oxen and livestock holding, family and labor force (active population), off-farm income and related variables are treated using data obtained from the survey. The dependent variable is here, also months of food self-sufficiency and the amount of food stock available from major crops produced at farm level.

1.5. Scope and Limitation of the Research

This research has an in depth analysis of the factors that influence the agricultural production and the contribution and impact of these factors on household food security by classifying different categories of the study targets into varying classes of resource endowment, access to knowledge and experience to extension and agricultural input usage, and agro-ecological setting. It has also a brief review of the Ethiopian agriculture performance and rural development strategies since the 1960s and analysis of the contributing factors to (commercial fertilizer, improved crop seeds and chemicals) food security and self-sufficiency.

However, the study has many limitations. The methodological tools to carryout the analysis of the household food security, as an effect of variable factors with a wide range of both negative and positive implications so far has not been available. What are already existing and in use are more of descriptive and qualitative. Again the quantitative measure of the impact of agricultural biochemical technologies (modern agricultural inputs in this case) are based on measuring their impact on productivity and production of specific crops, and profitability of these inputs. In some latest literatures one can find such quantitative analysis, but they still have limitations in that they only focus on one or two variables to measure their impacts on household food security. In this study, however, efforts were made to utilize as many variables as possible by applying econometric model considering that the model can show the cause and effect relationship between the variables. It was also tried to prove their reliability as a best measurement of the impact of the variables on food security. However, though it is a belief of the researcher that the model can fit to analyze the case, it could have its own limitation.

Household survey by its own is complex and to get reliable data especially on household farm cash income and expenditure, volume of production and number of livestock holding as well as other variables which have close economic and social implications on a particular farm family are not always free from errors. Thus caution were made as much as possible to prove the authenticity of these data.

Transport facilities and other necessary research inputs are other major constraints in this research. This research could not be exhaustive by itself. However, the ideas and issues raised and some of the findings are believed to initiate other researchers for further investigation.

1.6. Organization of the Paper

This paper is organized under seven major chapters and twenty-five sub chapters. Chapter one of the paper is an introduction where the methodological tools used in the research are incorporated including statement of the problem, the objectives and, significance and limitations of the research are included.

Chapter two of the thesis briefly reviews literatures related to the issue of food security, agricultural technology adoption and constraints.

Chapter three of this thesis deals with a brief analysis of the performance of agricultural sector strategies, production, food self-sufficiency, major problems attached to each of these issues and the quantitative analysis of the impact of modern agricultural inputs based on data since the 1960s.

The general physiography, social, economic conditions of the survey area was discussed, in brief, in Chapter four of the paper. In Chapter five of the paper an in depth discussion and descriptive analysis of the household survey results is made including the demographic, land tenure and holding systems, farming and crop production system, household resource endowments, farm income and expenditure, household food security, agricultural extension and etc. In this chapter efforts were made to analyze each of the survey variables' data as related to each other in a manner that the impact of one variable on the other could be clearly measured. Particularly those variables, which have a strong relationship with household food security, have given due consideration in the analysis.

Chapter six of the thesis focuses on the econometric analysis of the impact of various variables on household food security. In the chapter two steps were taken into consideration to analyze and measure the impact of the variables. In the first step only modern agricultural inputs as causes for improved household food security are taken (household food self-sufficiency period and daily calorie availability as dependent variables). In step two about 11 variables are taken as independent variables (including modern agricultural inputs) so that one can accurately identify and compare the impact of these variables with the results obtained in the first step. The final part of the thesis is conclusion and recommendations.

CHAPTER TWO
LITERATURE REVIEW

2.1. The Role and Factors Affecting Agricultural Technology

Sub-Saharan African agriculture is mainly rainfed, with irrigated agriculture accounting for only three per cent of the total cultivated land in the 1950s and 1960s. Today, however, the situation is changing dramatically in most areas. In many countries expanding local food production horizontally to keep pace with population growth is becoming increasingly difficult. In these areas, increases in population density has necessitated a shortening of the fallow period, resulting in incomplete natural regeneration of soils previously under cultivation and a consequent decrease in soil fertility (Conway and Barbier, 1990:122). Consequently, the decline in food production and food security becomes serious in these countries. To tackle the problem of general decline in production they have tried to use widely production boosting modern agricultural inputs together with varying agricultural and rural development strategies.

The growth in crop production in general and crop productivity (yield increases) in particular are dependent on two factors, namely technology and policy. Technology creates the physical potential for increasing crop production within ecological constraints by shifting the production function upward and by raising the yield ceilings. The realization of that potential depends on the existence of a conducive and stable policy environment. To quote the Pearson commission (1969), "the green revolution has been a matter of both new technology and new policy". Technology creation requires continuous research, and agricultural research, being a public good, cannot be sustained without adequate funding and policy support.

Without a sound and stable policy environment, technology adoption will be slow and may not have a significant impact on food production and food security; technologies may remain on the shelf rather than reaching the farms, where they belong. Policies such as macro economic, pricing, credit, marketing and distribution, research and extension and environment tend to have a major impact (Bumb 1991; Bumb *et al* 1994). Although the following discussion focuses on the role of the policy environment in promoting fertilizer use, the analysis will have general applicability to other components of existing crop technologies (such as seeds, irrigation, and plant protection materials) because fertilizer use is highly complementary to these inputs.

Macro-economic policies should ensure that foreign exchange shortages, exchange rate depreciation and tariffs do not constrain the supply of fertilizers and other inputs needed for technology adoption. Wide fluctuations in crop and fertilizer prices can discourage farmers from adopting even highly productive technologies. The incentive prices must be supported by adequate supply of credit for farmers and fertilizer dealers so that lack of finance does not become a constraint on supply and use of improved inputs. In several developing countries, credit has been identified as a major constraint on technology adoption, especially when subsidies were drastically reduced and fertilizer prices increased rapidly because of currency devaluation (Conway and Barbier, 1990:196).

Inefficiencies in marketing, distribution, and transportation of inputs result in low crop yield in many countries because fertilizers are not available at the right time and at the lowest cost.

The role of fertilizers in promoting crop yields through the adoption of improved crop varieties and other related measures is well-documented (Bockman *et al* 1990). Fertilizers play an important role in replenishing the nutrients removed by harvested crops. The mining of nutrients has become a serious problem in many developing countries, especially in sub Saharan Africa. A recent study estimated that many countries in sub Saharan Africa have negative balances in their nutrient balance sheets (Stoorvogel and Smaling 1990). On average, harvested crops and other factors remove more than 10 million tons of nutrients from the soils annually.

Traditionally, fallow systems and shifting cultivation practices were used to replenish most of the nutrients removed by crops. However, because of increasing population pressures and food requirements, the length of fallow periods has been reduced from ten to fifteen years to two to three years in many areas. In some countries continuous cultivation has fully replaced shifting cultivation, and many resource poor farmers are pushed to cultivate fragile land and use forestlands to produce food. As soils in these areas are fragile in structure and poor in nutrients, they cannot support continuous cultivation unless nutrients are supplied from external sources. Furthermore, because of competing demands for fuel, fodder, and construction materials very little crop residue is currently plowed back. Hence fertilizer application appear to be essential to replenishing the removed nutrients and to intensify cultivation in high potential areas, and thus to reduce the pressure on marginal lands and forestlands. Reducing this pressure would help in preserving resources, protecting the environment, and maintaining bio-diversity (Conway and Barbier, 1990).

Fertilizer alone will not create a sustainable system of agriculture. It should form an integral part of an integrated nutrient management system that uses nutrients from all sources, including crop residues, animal wastes, green manuring, and biological nitrogen fixation. Experiments in many countries (Japan, USA and India) have shown that productivity is higher and sustainable over a longer period of time if fertilizers are used in combination with farmyard manure, crop residues, soil amendments and crop rotations (Tandon, 1993). Despite their important role, fertilizers cannot be efficiently used in all agro-ecological and socio economic conditions.

Factors that will determine the kinds of technologies that will be needed include (1) the need for greater efficiency of resource use in agriculture, both to prolong supplies of finite resources and to reduce possible pollution effects; (2) the fact that agriculture in the future will be even more management and knowledge intensive than it is today; (3) a greater need for understanding the fundamental physical, biological and socioeconomic processes (such as soils, genetics and crop protection) that affect agriculture in particular ways; and (4) a greater need for genetic materials and agronomic practices that are specific to production locations (Conway and Barbier, 1990:207)

There are three basic strategies for increasing world food production: bringing new lands into production (expansion of the area cultivated), increasing the productivity of existing lands (i.e., raising yields) and increasing cropping intensity through double or triple cropping or by reducing fallow periods. For most of human history, production increases came largely as a result of expansion of the area cultivated while such expansion is still going on, it has slowed considerably, and for areas with large populations and limited land, such as Asia, expanding the area cultivated is essentially no longer possible. This necessitated the need to increase productivity of existing lands by raising yields, or by increasing the number of crops per year or both. Increased cropping intensity may not be a realistic option in many resource-limited situations.

In the rainfed farming systems where fallow periods are no longer adequate to maintain soil fertility, the key requirement for increased food production will involve providing adequate soil nutrients combined with improved seed technologies and complimentary practices to increase weed control, good plant population and other cultural practices. However, it has been suggested that given the present knowledge and the rapidity with which food production must increase and given Africa's severe problem of soil degradation, there is little choice but to depend heavily on external sources of nutrients in the foreseeable future (Desai 1990; Conway and Barbier, 1990:122).

Past yield trends suggest a simple annual rate of increase of about 0.7 per cent as a result of the application of improved techniques on agricultural land in sub Saharan Africa. However, recent evidence from a number of USAID missions also suggests a rapid uptake of new seeds and fertilizer in response to better economic environments in the region (Seckler, 1993; Conway and Barbier, 1990).

The transformation of the agricultural sector will result in the production of sufficient food to feed the agricultural and non-agricultural population. The sector also releases labor and capital to the non-farm sectors. The increased agricultural production and employment opportunities would generate increased income to both farm and non farm families (Oehmke and Crawford, 1993). The role of technology in achieving a sustained increase in food production in sub-Saharan Africa is dominated by Herdt (1988), Delgado *et al* (1987), Eicher (1990) and Eicher and Rukuni (1994).

Because, technological change expands the production possibility frontier, it is central to increasing agricultural production. Agricultural technology includes one or more of the following aspects: mechanical, biological, chemical and management methods. The technology may consist of a package of several components which may be adopted simultaneously or independently depending up on whether the specific practice is complementary or not. The technologies can be considered divisible (e.g., hybrid seeds, fertilizer, pesticides, etc) and non-divisible or lumpy (e.g., tractors, mechanical harvesters, etc).

Most countries have attempted to encourage the adoption of new technologies in order to increase factor productivity in their agricultural sector assuming that increase in the productivity of scarce resources such as land and labor will increase aggregate output. At the conceptual level, the adoption of technology is represented as an upward shift in the production function. A shift in the production function will increase both the marginal and average product of the variable input. It is, hence, evident that the development of the agricultural sector can reduce food insecurity and subsequently poverty and hunger in the Ethiopian context (Mulugeta, 1994: 109).

Given the rapidly growing population in Africa and continued degradation of the natural resources, the opportunity to increase production through area expansion is very limited. Yields can be increased through more intensive application of labor, more intensive application of existing technologies or adoption of new technologies. Farmers can adopt new inputs and new management practices in their production.

The experience of the agriculturally developed countries has amply demonstrated that application of modern technology brings structural improvements in agricultural production by enhancing the productivity level per unit of cropped area. Among the ingredients of modern technology, the high yielding varieties spearheaded the rapid growth in crop yields.

It may be stated that an improved technology may not mean reduction in cost. A technology is an improved technology because it enables larger volume of food grains to be produced out of the same area of land; because it converts something which was not available for human consumption into something that is now available. It will be perfectly legitimate to accept an improved technology because it makes possible a higher production, though at higher unit cost, simply because there is no other method of securing a higher production (Batra, 1978:11). The rate at which producers who have settled into traditional agriculture accept a new factor of production may depend upon its profit, with due allowance for risk and uncertainty. The concept of traditional agriculture implies long established routines with respect to all production activities. Introduction of a new factor of production would mean not only breaking with the past but coping with a problem, because the production possibilities of the new factor of production will be subject to risk and uncertainties yet unknown. It is, therefore, not sufficient merely to adopt the new factors and reap the larger return; learning from experience what new risks and uncertainties are inherent in these factors is also entailed (Schultz, 1965:24-35).

Preliminary observations show that farmers in Ethiopia have been very reluctant to adopt simple recommendations such as high yielding varieties and fertilizers. The yield gap between research stations, on farm trials and farmers' fields are very high. The possible explanations for the slow adoption of improved technology by farmers include lack of credit, lack of location specific research recommendations, poor extension services and rural infrastructure and repressive pricing policies. This large and diverse list of constraints has to be examined to identify the most limiting ones and to determine their relative importance (Mulugeta, 1995:114-115).

A wide range of economic, social, physical and technical aspects of farming influence adoption of agricultural production technologies in developing countries. Recent adoption studies in Asia (Duraisamy, 1989; Lin, 1991; Janset *et al* 1990) and Africa (Polson and Spencer, 1991; Kebede et al, 1990, Adesina and Zinah, 1993; Green and N'Ogolata, 1993 and Hassan and Faki, 1993) have identified farmer and farm specific, technology specific, institutional and policy variable and environmental factors to explain the patterns and intensity of adoption. The literature also reveals that technology adoption is a function of various social and economic characteristics. Most studies have viewed adoption of a technological practice in isolation from other related practices, ignoring the interdependence of different technological practices. Other studies have viewed adoption as a discrete choice, which assumes that farmers will eventually adopt a full range of technologies. Finally most studies have considered few explanatory variables and hence the models are under specified (Mulugeta, 1994:115).

The growth in inequality in rural areas stems in large from the fact that small poor peasants who have restricted access to credit, technical knowledge and the material means of production are unable to innovate as easily or as quickly as those who are landed, liquid and literate. Those farmers who already possess resources in the form of land, capital and knowledge are able to grasp the opportunities created by the "green revolution" and further improve their position. But those who are land less and illiterate will tend to lag behind and perhaps become further impoverished. It is the largest and most prosperous farmers who innovate and the middle sized farmers who imitate (Griffins, 1973:248).

Small peasant land owners who are excluded from the green revolution may be forced to sell their land to the larger farmers and this will lead to greater inequality in the distribution of land and increase in the land less rural workforce. This is well documented by many authors in case of Ethiopia (Cohen, 1989; Betru, 1975; Tesfay, 1975).

Eventhough the contribution of improved agricultural technologies to improved productivity is positive, the process of their adoption increases capital costs to the greatest extent and at the end of the process they dominate other types of cost. Finding means by which small farmers can finance purchased inputs is thus likely to be a key factor influencing overall adoption rates. In addition, while the new technologies are capital intensive, they are also labor demanding particularly for maize and sorghum. This also presents challenges for adoption, since the increased labor demand stemming from adoption tends to come during critical periods (weeding and harvesting). However, it also presents an opportunity for increased employment if markets for hired labor supply are adequate in adopting areas. Such labor supply often originates in other climatic zones which tend to be highly populated, with low wages and slack agricultural periods during the periods of high demand at lower altitudes (USAID, 1995:64).

Despite the land reform, socio-economic differences do exist in rural areas of Ethiopia, one example being the differences in land and oxen holding. Significant number of farming households has small land holdings. In some administrative zones, close to fifty five per cent of farming households have holdings of 0.5 hectare or less. These and other socio-economic factors may limit the ability of some farmers to adopt. If small farm size is associated with low income, farmers with small-holdings will face special difficulties in financing the purchased inputs required by improved packages due to lack of oxen and other assets. Farm size is thus hypothesized to have an effect on the overall rate of adoption; areas with a large proportion of very small farms are expected to have lower adoption rate (Mulugeta, 1995).

According to the same source, it is assumed that, in Ethiopia, farmers with less than 0.5 ha are unable to adopt the packages due to severe resource shortages and the high risk associated with adoption. Implementation of a financially sustainable credit approach for these farmers will also be difficult since the probability of default and the administrative cost of reaching many small poor farmers is higher. It is assumed that farm households with holdings larger than 0.5

ha are able to fully adopt, although many will not be able to do so without a credit package (USAID, 1995:52).

The adoption of agricultural technologies would increase production approximately by 1.4 million tons of grains. The proportionate production increase is seventy two per cent in high potential areas and the increase in production in all areas is twenty five per cent. Calculation of the structural deficit under intensification shows that technical change can only reduce the deficit under the most favorable conditions that is when adoption is very widespread. This poses an important challenge for the government's extension package program. It also highlights the need to consider complimentary long-term measures, along with intensification, to increase food production. These may include investment expansion to lower altitude areas expansion of irrigated area, increased double cropping, and related measures (USAID, 1995:91).

A number of literatures have discussed about the merits of agricultural biochemical technologies in boosting agricultural production, since the 1960s in Ethiopia. The introduction of the green revolution in many south east Asian countries, especially experiences gained from India and other south east Asian countries have led to the expansion of same technologies in different parts of sub Saharan Africa. The substantial increase in grain production and the subsequent improvement of food self sufficiency as well as food security especially in countries that integrate these technologies with irrigation and favorable marketing and distribution systems had enjoyed substantial economic and social benefits. Though much is said and documented about these inputs their contribution to household food security has not been much emphasized. In countries with large population below the poverty line, highly variable rainfall, high man land ratio and weak distribution and marketing network and total dependence on imported inputs, the contribution of these inputs to household food security could, undoubtedly, be negligible.

In Ethiopia, for example, the utilization of fertilizer and improved seeds has been increased from year to year. Between 1970 and 1980, and 1980 and 1990 fertilizer distribution and utilization have increased at a rate of five folds and 9.3 per cent per annum respectively. Yet, in these two decades, the country has experienced three major drought and famine years and more than five minor droughts in which the magnitude of crop failure is significant. Even if rainfall is still favorable a number of farmers lack adequate cultivable land to support an average family and enough oxen to cultivate the available land. Some studies have shown that about fifty five percent of the farmers owned land below 0.5 ha (with majority of farmers living in densely populated areas of the central and northern highlands) and nearly fifty per cent of them have no ox. Rural population below poverty line is estimated at about fifty to sixty per cent (MEDac, 1998; EEA, 1999/2000). Even in good years when rainfall is conducive for crop production it is usual to meet over a million tons of food grain deficit and find nearly some five million people on relief list. The extent of temporary food insecurity is obviously estimated to be over these figures. Various studies put different figures regarding the number of food insecure population in Ethiopia. World Bank and IGADD estimated the food insecure population to about 41.3 and seventy eight per cent (World Bank, 1992; IGADD, 1990) respectively. The 1994 MEDaC's study, on the other hand, estimated this figure to over twenty seven million people. Hence, despite a substantial increase in fertilizer and improved seeds from year to year, it is customary for a country to face food shortages every year. As a result, the country depends on food aid and imports. Available sources showed that between 1985 and 1996 alone the country has got an average of 0.8 million tons of food aid per annum, though domestic grain production grew from 4.9 million to 10.3 million metric tons. The demand and supply gap in these years has been increasing and to fill this gap the country has to import an additional food grains each year. Yet fertilizer and improved seeds as well as chemicals (herbicides and pesticides) distribution and their use have grown by sharp rates while yield increment in major crops ranged between 8.8 and 12.1 quintals per hectare. Furthermore, fluctuation of yields from year to year is significant and in the same years there are three years of recorded yield declines from the average national yield (1100 kg/ha). Thus it can be hypothesized that, where there is a critical shortage of agricultural resources and the vagaries of climate are serious as well as where most of the farmers are risk averters due to serious absolute poverty use of fertilizers and other improved agricultural bio-chemical technology could not be sustainable means to achieve reasonable food self-sufficiency level let alone household food security.

2.2. Concepts and Definitions of Terms

A. Food Security

Food security has different definitions and applications to different socioeconomic groups, institutions and organizations. The widely accepted definitions are the following.

Maxwell (1990) defines food security as a household's ability to establish access to productive resources such as land, livestock, agricultural inputs and family labor combined to produce food or cash. These are linked with the household's ability to generate cash income through various employment and trading opportunities. This is further mediated by favorable policy that encourage effective use of resources and labor, as well as the ability of a household to take part in a market to ensure access to food by all members of a household at all times, while maintaining or improving their asset position. Food insecurity, on the other hand, is defined as a temporary, complete lack of and/ or decline in access to productive resources; deterioration of the household asset position over time; declining resource productivity as a result of environmental degradation and lack of alternative technologies to meet rapidly growing food needs; and associated with lack of employment opportunities (both in the formal and informal sectors). These are mediated by unfavorable policies that discourage effective use of resources and labor; as well as poor market functions such as non-operation of markets or market fragmentation (with the subsequent impact on food prices). All these put together systematically obstruct access to enough food by all members of a household for three or more months of a year (Getachew, 1995).

Scott, argues that "for those peasants with very low income, little land, large families, high variable yields, and few outside opportunities, the pattern of safety first holds consistently" (Scott, 1976:24). Since peasants do not have identical pattern of ownership of assets, there is a variable degree of reluctance to invest in areas such as irrigation, improved seeds and better farm practices, particularly by small producers and tenant farmers. For poor and marginal peasants, the decision for cash crop production, for example, depends on a number of rational considerations. The peasant could opt to grow a cash crop provided there is a reasonable chance of maintaining a minimum level of food security by so doing. Because of the diversity of economic structures, there is also diversity of economic opportunities arising from farming systems, the level of techniques used and the decision to risk some form of investment (Getachew, 1995).

FAO, on the other hand, defined the objectives of food security as assuring to all human beings the physical and economic access to the basic foods they need. This implies three different aspects: availability, stability and access. This definition is clearly stated in terms of food security for each individual, and it can be argued that this is the most meaningful definition of food security accepted by the committee on world Food security and refined this definition as "physical and economic access to adequate food for all household members, without undue risk of losing such "access". This definition introduces the concept of vulnerability.

B. Levels of Food Security

For the national economic policy options it is usually better to define food insecurity at different levels: national/regional, and household level.

Food security at national level is perhaps best described as a satisfactory balance between food demand and food supply at reasonable prices. They may seem a rather vague definition, but it is intended to indicate a situation where there have been no major upheavals in food markets in them in recent past, where adequate food is available and where most of the population have access to that food. In the definition changes in food security can be identified over time by rising prices. Rises in prices of food first affect the poorest as they spend a higher proportion of their income on food. The absence of an imbalance between food demand and food supply does not mean that all households in the nation are food secure. It means that if they suffer from food insecurity it is because they lack entitlement to food or effective demand.

The household level food security is the most important in so far as the household is the basic economic unit which determines the level of consumption by the individual. In most analysis there is a presumption that income comes to the household as a whole, resource allocation decisions are made at the household level and household consumption is divided amongst its members in some relation to the needs of the individuals.

At the individual level, an individual is food secure if his or her food consumption is always greater than need. Consumption is determined by the claim the individual has on the household food resources. This may be affected by individual has on household food resources. This may be affected by individual earnings and assets, or by the individual's position in the household. It is clear that food security at one level does not imply food security at a lower level of aggregation. A country which is food insecure will almost certainly contain groups of the population which are food secure, and many countries which are food secure at a national level will contain groups of the population who suffer from severe food insecurity (Getachew, 1995; FAO, 1996).

C. Food Self-sufficiency

The concept of food self-sufficiency is generally taken to mean the extent to which a country can satisfy its food needs from its own domestic production. According to FAO (1996), there are two fundamental differences between these two concepts: food self-sufficiency looks only at national production as the sole source of supply, while food security takes into account commercial imports and food aid as possible sources of commodity supply; food self sufficiency refers only to domestically produced food availability at the national level, food security brings in elements of stability of supply and access to food by the population. In other words, food self-sufficiency is linked to an overall perspective on development which emphasizes the need for self-reliance, an auto-centric approach, whereas food security is consistent with a view of development which incorporates international specialization and comparative advantage (FAO, 1996; Getachew, 1995).

D. Issues in Food security

There are many arguments among economists and nutritionists on the issue of the measurement of food security. The most common measure of "food insecurity" in the country is the number of people, whose food consumption falls below a predetermined minimum level of, which is deemed necessary for good health. In most cases, the energy requirement is focussed and on the calorie intake of the population. A person is considered undernourished if his daily calorie intake falls below an established minimum, which is deemed necessary for maintaining an adequate body weight and permitting an adequate level of activity. There are many objections to the application of this measure as an aggregate measure of food insecurity. Nutritionists raise questions about the notion that the energy requirements per person which have been determined by prevailing inequalities in the income distribution are, indeed, well defined and constant. They argue that a single standard of calorie requirement fail to take into account interpersonal differences due to differences in age, sex, body composition and level of activity. They also argue that an inadequate intake of calories is not the only cause of undernutrition.

Economists on the other hand argue that food deficiencies in a country cannot be evaluated on the basis of the average per capita calorie intake since this average ignores the large interpersonal differences in food consumption due to large inequalities in the distribution of income and wealth and thus in the entitlement to food. This measure does not provide any information on the extent of the food deficiency of the undernourished people, i.e., the depth of the gap between their actual consumption and the minimum required level. This measure evens out and, therefore, ignores the effects of temporary shortages in food supply that both increase the size of the undernourished population and deepen their food deficiencies.(Berck and Bigman, 1993:241-242). However, in general, the calorie consumption is universally used as the measure of the level of food security.

The issue of food security must embrace simultaneously supply and demand for food. This is done through the notion of a household food system. The supply side of household food security includes access to productive resources that ensure production of food crops, while the demand side of household food security consists of the ability to generate cash income through sale of labor, livestock, cash crops and others. A joint supply and demand-led household food security can be defined as a system that ensure target consumption levels on a year to year basis. The components of the household food system are as follows: the household itself and its productive resources (using principally its own labor and land based resources); access to cash income earning opportunities; exchange through markets, and institutional cooperation to mobilize social network and resources.

technological change. The technological state of any given production process is a description of the composition and combination of inputs and technologies that exist at a given time. Thus, technological change describes a movement from one technological state to another. Adoption of technology must be preceded by technology diffusion where the later terms refer to the act of making technology available to potential adopters. Diffusion, then, is the link between research and extension and adoption. Thus, effective diffusion is an essential but not sufficient condition for adoption.

F. Bio-Chemical Technology

Biochemical technology is a broader term and incorporates the genetic modification of plants and animal species through scientific research to conventional fertilizer, improved seeds, herbicides and pesticides technologies. In this thesis bio-chemical technologies is used to describe commercial fertilizers, herbicides and pesticides (for chemical technology) and improved seeds (for biological technology).

CHAPTER THREE

PERFORMANCE OF THE AGRICULTURAL SECTOR AND SITUATION OF FOOD SECURITY, STRATEGIES AND TECHNOLOGY ADOPTION

The agricultural sector and particularly peasant agriculture is the prime engine of growth and development in Ethiopia. Improved agricultural performance is critical not only to raise effective demand, but also to meet food security objectives, foreign exchange requirements, and basic needs, and to increase employment opportunities. The agricultural sector mainly dominated by traditional farming system with low input output level manipulated by small holder peasants. Commercial agriculture is at its infant stage though efforts were made to develop them in the late 1970s up to the 1990s in the form of private commercial and state farms. Large private sector investment in the sector is also very small. The production system almost totally depends on rainfall and in most cases affected by variability of climate. Use of modern and improved agricultural technologies, which can improve productivity per unit area, is in the order of 30.7 kg of fertilizer (in 1997/98) and 1.04 kg of improved seeds (in 1995/96) per hectare. As a result, on the average, yield of major crops is only 1220 kg per hectare. The major staple food crops of Ethiopia-*teff*, wheat, barley, sorghum and maize occupy about 69 percent of the annually cultivated land. Yet the yield per hectare remain to be as low as 885, 1221, 1188 and 1667 kg (EEA, 1999/2000; CSA, 1998). The over all impact of this backward production system and low productivity is manifested in low overall gross production and the widening gap between food demand and supply.

It is evident that the situation is worsening from time to time. On average it is not unusual to find a food deficit of over a million tons of grain in a particular year. During odd years when the drought occurs (usually every three to four years) this gap can increase more than four to five folds. On the other hand, the population of Ethiopia is growing by almost three per cent per year and expected to reach 83.5 million in the next ten years (CSA/OPHC, 1998). Undoubtedly the country adds every year a number of people to feed without sufficient improvement in agricultural production.

In view of this, the country has adopted different strategies in the past thirty years, but what is achieved so far remains to be unsatisfactory. As discussed in the previous chapters, the central concern of these strategies has been the intensive use of agricultural technologies (commercial fertilizer, improved seeds, herbicides and pesticides). In many of these decades due to unfavorable rural land and socio-economic policies the contribution of these technologies to improved agricultural productivity and food security remained low. The concern is also on food self-sufficiency than food security until recently.

The situation is worsening on the densely populated highlands and lowland areas where pastoral and agro pastoral production systems predominate. Land degradation, deforestation, overgrazing, high man land ratio and dwindling physical and economic resources of the population are main causes for declining agricultural production and worsening food insecurity.

In this chapter the condition of agricultural production, food security and technology adoption and the interrelationships between them are briefly examined by dividing it into three brief periods.

3.1. The Performance of Agricultural Sector (1960-1974)

Agricultural production in Ethiopia has been remained low due to factors related to natural, social and economic conditions prevailing in different times. Particularly, the crop sub sector, which may comprise about eighty five per cent of the staple food in Ethiopia, is characterized by extremely low yield and fluctuating aggregate production.

To improve the productivity of this sub sector, the government adopted various policies and different rural development strategies at different times with almost all focussing on the use of commercial fertilizers and improved seeds, of course together with varying agricultural extension services and approaches.

Whether, the impact of these policies are positive or have any significant contribution to increased production and food security is the concern of this chapter.
In Ethiopia, agricultural and rural development strategy adoption (since the 1960) experience can be categorized into three major distinct periods. These are the period 1960-1974 (characterized by feudal land tenure system); 1975-1991 period (rural land reform,

cooperativization, villagization programs) and the post 1991 period with distinct agricultural strategy based on the intensive agricultural package program.

The agricultural and rural development strategy, in Ethiopia, has started to get attention on the development agenda in the first five-year plan. The first type of intervention was the community development approach, which was adopted between 1958-1962 (Solomon, 1986, IGE, 1973). It aimed at stimulating popular endeavors to identify and tackle the problems of local communities through small self-help projects. It covered all aspects of rural development with particular emphasis on agriculture, rural artesian, social infrastructure and welfare activities.

Though the objectives of the community development program seem directed to promoting agricultural production, it failed to fulfill its target. According to Solomon (1986) this was due to poor local cooperation, weak coordination and organizational structure of the program, lack of finance, trained field personnel and embezzlement.

The second rural development approach adopted in the period 1960-1974 was the package program. Its aim was developing peasant agriculture through the diffusion of appropriate package technologies. Thus programs such as CADU, WADU were established with the cooperation of bilateral and multilateral assistance. Each component of the program were linked to each other including crop research, livestock production, agricultural extension, input distribution (fertilizer, improved seeds, chemicals), credit provision, etc. The package program was also failed because of absence of land reform, targeting the richest farmers and land lords (consequently lead the poor to further poverty and eviction), unbalanced growth and concentration in few areas, etc (Dejene, 1996; Solomon, 1986; Cohen, 1987).

The agricultural production in this period was relatively better than in 1970s and 1980s. Especially in the 1960s Ethiopia was food self-sufficient in major staple crops. Between 1960 and 1974, on the average, production had been 6.2 million metric tons and average yield 770 kg per hectare. In the reference years cultivated area had declined and production grew by 2.9 percent per annum (Table 1).

Wolaita Agricultural Development Unit data on the distribution and utilization of agricultural inputs are not available in the 1960s. Of course, the strategy of agriculture and rural development had given major emphasis on commercial agriculture and thus whatever agricultural inputs available were diverted to these farms. Thus the relatively better agricultural production and per capita availability of that time has not been due to the adoption of extension services and modern agricultural inputs, but may be due to relatively reliable rainfall, the stable physical environment (with low degradation rate), low growth rate of the population, geographic concentration of production and better policy that favor the private sector as well as low man land ratio.

The food security at national level (here food self-sufficiency) had also been better as compared to the 1970s and 1980s and the early 1990s. Using the bench mark of eighty four per cent from major crops out of estimated 2100 KCl per day/person, the food demand and supply gap (domestic production) in wheat equivalent was only in deficit of 1.4 million tons during the reference period. However, along the years variation exists. For example 1972, 1973 and 1974 were years of deficit ranging from 1.1 million to 1.3 million metric tons. These were drought years that hit the northern part of Ethiopia and be the cause of the downfall of the feudal regime. Other years remain to be surplus, with surplus availability ranging from 2.9 million to seven million metric tons. In general the gross domestic supply is greater than the consumption requirement by about two per cent over the fourteen reference years (Figure 1 and Table 2).

Table 2 Domestic food Production and Consumption Requirement in Ethiopia (1960-1974)in '000 quintals of grain equivalent

Year	Total Availability	Total consumption requirement	Gap	Availability/head (kg/head)
1960	47095.3	43567.5	3527.8	200
1961	47910.7	44415.0	3495.7	200
1962	48736.0	45505.6	3230.4	198
1963	49735.9	46506.8	3229.1	198
1964	50449.7	47529.8	2919.9	196
1965	52053.4	48621.3	3432.1	198
1966	55112.5	49740.4	5372.1	205
1967	57019.4	50883.7	6135.7	207
1968	58495.0	52054.0	6441.0	208
1969	60235.2	53251.1	6984.1	209
1970	57917.5	54553.2	3364.3	196
1971	59888.0	55807.8	4080.2	199
1972	45858.4	57091.6	-11233.2	149
1973	45903.3	58404.5	-12501.2	145
1974	44657.4	57898.0	-13240.6	143

Source: Calculated from Table

Notes: Total Availability = Gross domestic major crop production – [post harvest loss(10%) + seed requirement (5.5%)] (in grain equivalent)

Consumption requirement = total population * 185 kg/person/year (in grain equivalent)

Figure 1 shows the trend of food grain availability and consumption in Ethiopia.

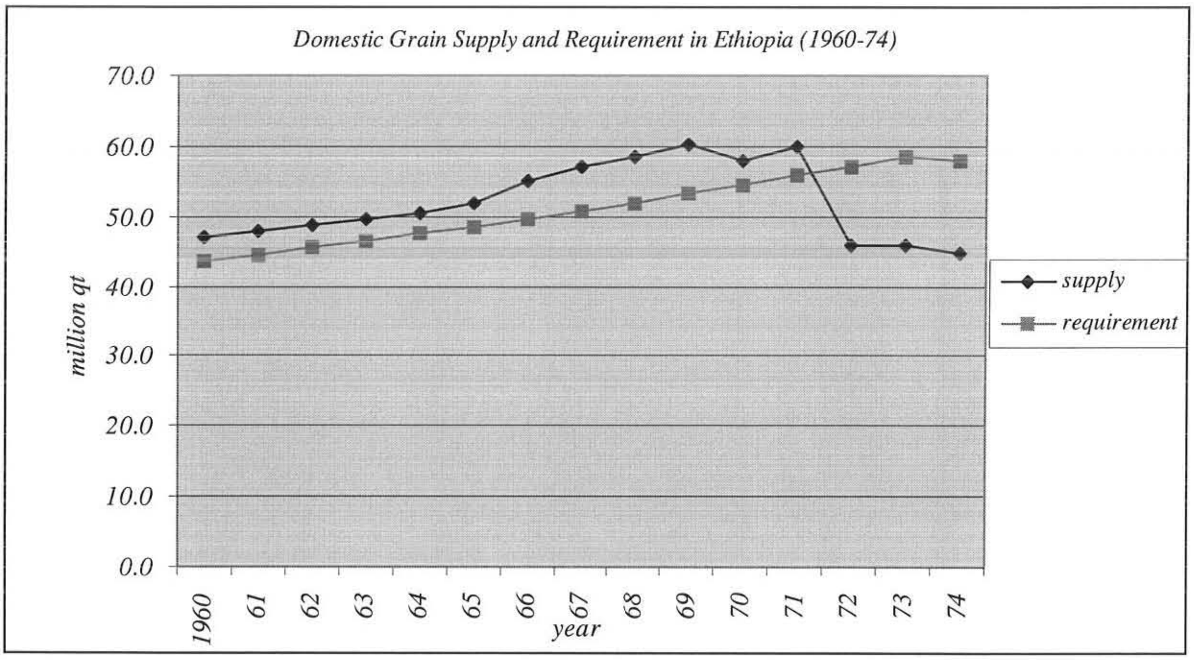

Figure 1. Domestic Grain Supply and Requirement in Ethiopia (1960-1974).

3.2. The Performance of Agricultural Sector (1975-1991)

A radical change in socio-political and economic structure of the country in general and the rural sector in particular, have characterized the 1975-1991 period. Radical changes have taken place immediately after the revolution of the 1974. Among the radical changes that have been taken place in the agricultural sector were the land tenure policy that enabled the peasantry to own the land, development of rural institutions (Cooperatives, settlements and villagization programs, state farms and peasant associations).

Getachew (1995) has identified four distinct periods of rural and agricultural development in post revolution period; 1974-1978, 1978/79-1983/84; 1984/85-1990. In the first period introduction of radical social, economic and political measures have taken place particularly the rural land reform, restructuring of rural and urban economic organizations. This, on the one hand, relieved the rural peasantry who for a long period of time deprived from the basic means of production and left them for grave poverty, and, on the other, led to political instability throughout the country. Thus as such except for the land reform there was no planned economic development endeavor in this period.

Period two (1978/79-1983/84) was a period of recovery and one of its features was socio-economic development was carried out through a one year development campaigns. The main objective of these plans was to rehabilitate the war ravaged economy and directed to alleviate the immediate social and economic problems prevailing in the country. Since these plans were short term (usually one year) and lack long and medium term vision as well as operated through hierarchies of committees its impact remained marginal. It also disrupted by war and climatic fluctuations especially in 1983/84.

Period three (1984/85-1990) was a period of planned economic development with long term perspective and formation of regional planning and agricultural development zones. The Ten year perspective plan was designed to alleviate most of the country's socio-economic problems, but failed due to various constraints; lack of fund to effectively finance the planned programs (as the plan was formulated mostly based on foreign aid and loans), civil war, recurrent droughts, ill designed policies and etc.

Regarding the agricultural sector in the first period of the revolution there was no clear direction of rural development strategies. The MPPI (minimum package program 1) was the only rural development program in the period and it could not be effective as the major focus was on national unity and political stability. The MPPI (1972/73-1976/77) from the beginning had its own constraints such as limited geographical coverage, land tenure problem, the model farmers approach to extension services and limited financial and technical support.

The major agricultural development strategy which was geared towards increasing production and improving peasant extension services were limited to MPP and PADEP (peasant agricultural development and extension program) which covered the period 1977-1983/84 period. The MPPII was phased out in 1984 and replaced by the PADEP program. PADEP was not as such different from MPP programs except with its wider coverage and its special emphasis on surplus producing areas. The major objective of the program is same to the broad goals of the agricultural sector; i.e., improving food self-sufficiency, generate foreign exchange and employment opportunities. The program relied heavily on foreign finance and due to the prevailing conditions and disagreement between the donors and the government the program has been under financed. Thus its impact on production and food security was not satisfactory. The approach of prioritizing surplus producing areas as a development strategy and consequently concentrating investment, extension services and inputs on these areas have little contribution to improve household food security. According to Getachew (1995) ninety per cent of the annual expenditure on fertilizer and seed was given to these areas, and the ratio of extension officer to farmers had been 1300. While in non-surplus producing areas it was only 1:2500 (Getachew, 1995). According to the same source the failure of the surplus producing areas was attributed to the following;

(a) the so called surplus producing areas themselves were food deficit, and their contribution to food security has been minimal.

(b) Though the objective of the policy is to improve food security and attain food self-sufficiency, the focus has been on the highlands than in the lowlands where food insecurity is chronic; and at the same time there was no measure taken into effect to improve the purchasing power of the food insecure areas;

(c) It was not possible to improve the production and food security conditions in the country, as the then policy environment has not been favorable for improving the small holder agriculture.

The condition of agricultural production especially that of the major crops, in general, was declining and with marked fluctuations. During the 1975 to 1991 period cultivated area and production of major crops, on average, declined by 0.7 per cent per annum. Per capita production of these crops was also declined from the 1975 level by 3.1 per cent by the end of 1991. The situation of life in the rural areas was worsening despite certain changes in some favorable years when production to a certain level showed an upward trend.

The food security situation has also been at its gravest condition. The long period environmental degradation, civil war and policy failures have their own contribution to the failure of rural coping abilities and resilience. Thus the 1983-85 drought and subsequent production failures have put most of the rural population at worst condition.

Table 3: Estimates of Area, Production and Yield of major crops and per capita production(1975-91)

Year	Area ('000ha)	Production ('000qt)	Yield (kg)	Prod/capita (kg)
1975	5555.0	62446.0	1124	189
1976	5226.0	50335.0	963	148
1977	5435.5	47249.0	869	136
1978	5418.5	45996.0	849	129
1979	5810.7	72123.1	1241	197
1980	5408.9	62548.5	1156	166
1981	5341.2	59321.1	1111	153
1982	5801.8	74559.4	1285	187
1983	5390.5	60095.5	1115	147
1984	5557.2	45237.0	814	107
1985	5612.4	49631.8	884	114
1986	5504.0	61862.0	1124	139
1987	5846.7	69612.0	1191	152
1988	5613.0	62700.0	1117	133
1989	5725.3	67559.0	1180	139
1990	5154.4	67621.7	1312	143
1991	5114.2	55907.0	1093	115

SOURCE: CSA Annual Crop Sample Survey (1974/75-1990/91)

Thus domestic production of major crops in 1984 was only seventy two percent as compared to the 1974 level. According to some sources the population at risk was estimated at ten per cent of the population at that time. In general domestic production has covered not more than sixty seven percent of the total consumption requirement of the population. At the same time to fill the gap the country has imported and got 1.3 million metric tons of grains particularly in 1985. Imports both commercial and food aid, remain to be as major means to cover the food deficit through out the decades (MEDaC, 1996; Getachew, 1995). Commercial imports contributed less than 20 kilograms per capita until 1985, when the imports of wheat and rice rose in response to the food crisis. In 1985, roughly 322000 tons were imported and by 1987, this had dropped to 140,000 tons. Food aid, on the other hand, has increased since 1984 and remains at a high level. In overall terms, food aid had almost been twenty kilograms per capita in those years.

Table 4: Food Supply, Demand and Per Capita Supply of Food Crops from Domestic Major Crop Production

Year	Net Supply ('000qt)	Consumption requirement('000qt)	Supply/head (kg)	Gap ('000 qt)
1975	53629.7	61208.7	160	-7579.0
1976	43018.5	62800.1	130	-19781.6
1977	40385.2	64432.9	120	-24047.7
1978	39283.3	66108.3	110	-26825.0
1979	61752.2	67835.2	170	-6083.0
1980	53618.4	69716.7	140	-16098.3
1981	50817.7	71667.7	130	-20850.0
1982	63915.7	73675.5	160	-9759.8
1983	51477.9	75738.4	130	-24260.5
1984	38837.7	77859.1	90	-39021.4
1985	42520.9	80197.3	100	-37676.4
1986	52810.3	82523.0	120	-29712.6
1987	59471.5	84916.3	130	-25444.8
1988	53477.1	87378.8	110	-33901.7
1989	57665.7	90000.3	120	-32334.6
1990	58640.7	92700.4	120	-34059.6
1991	47822.2	95481.3	90	-47659.0

SOURCE: CSA, Annual Crop Sample Survey (1974/75-1990/91)

Thus taking the average of the pre revolution period and the period covering 1975-1991, the situation of food availability declined by less than one per cent per year. According to some sources between 1981 and 1991, on average, between 2.82 to 7.2 million people or 8.8 to 14.2 per cent of the total population of Ethiopia has been at risk with varying degree across the country. The failure of *belg* rains and the after math of this rain as well as the 1983/85 droughts were the most striking famine years in the reference period (MEDac, 1996).

The proximate causes of the per capita production decline are many. The population growth rate of almost three per cent per year plays a role, as do the erosion-induced losses of soil fertility and output potential. But the three most commonly invoked explanations center on military conflict, drought, and economic policy (Getachew, 1995:62).

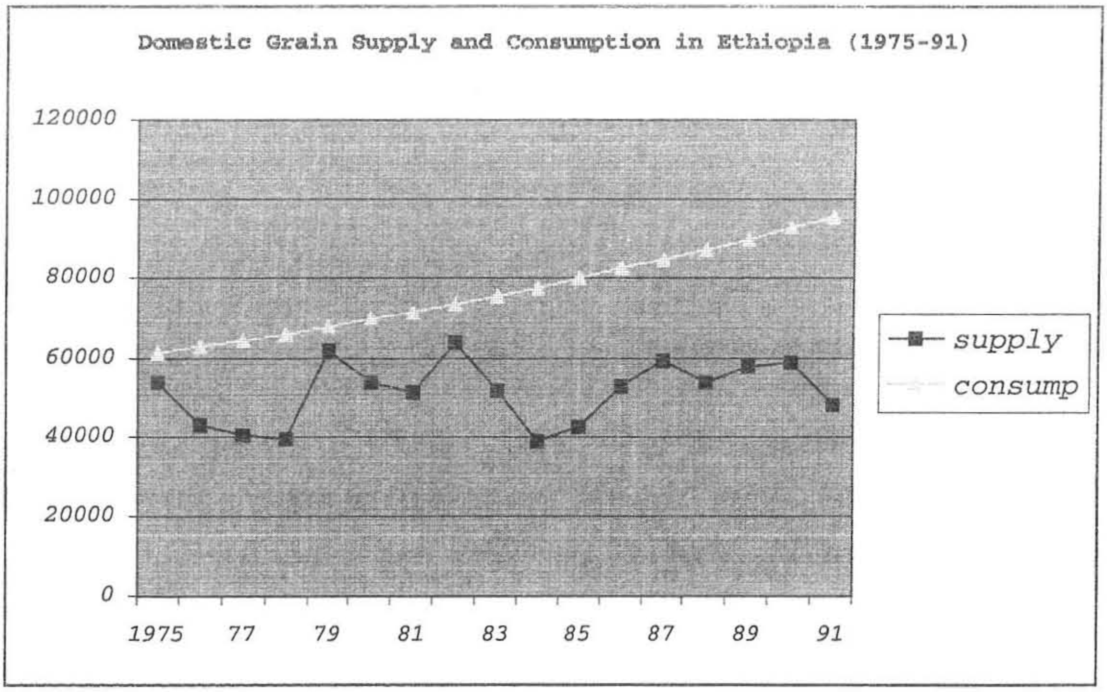

Figure 2. Domestic Grain Availability and Requirement in Ethiopia (1975-91).

3.3. The Performance of Agricultural Sector (1992-1998)

After the collapse of the *derg* regime and the establishment of new socioeconomic condition in the country, the agricultural sector has got top priority in the sense that the sector's contribution to the overall development of the macro economy is crucial. The policy of Agricultural Led Industrialization (ADLI) which aims at the development of the agricultural sector (the rural economy) has been formulated recognizing that the sector is the prime engine for the development of other sectors. The strategies of the agricultural sector specifically the agricultural extension system focuses on intensive use of agricultural inputs, cultural practices and intensive advisory services. This extension system known as Participatory Demonstration and Training Extension System tries to incorporate the training and visit system adopted since the early 1980s and the SG-2000 experience (EEA, 1999/2000).

Together with the adoption of this extension system and rural based economic strategy, the liberalization of market prices, relatively free access to land and mobility, the dismantling of the producers' cooperatives have been undertaken successively to support the ADLI strategy.

As a result the Ethiopian agricultural sector performance has improved than in the 1980s at least in terms of the volume of production. But, still, one of the most serious problems of the agricultural sector has not been (low productivity and susceptibility to variability of rainfall) unabated.

The past seven years time series data of the agricultural production, especially the crop sector, show that production has increased by about 5.7 percent per year, which is more than eight folds than the growth rate achieved in the 1975 to 1991 period. Cultivated land also increased by 9.1 percent annually. The productivity of major crops, however, did not show significant change than in the 1985–1991 period. Thus in the last eight years the largest volume of production was achieved not from increased labor and land productivity but from the expansion of cultivated land especially in regions such as Oromia and other parts of the country where there is relatively abundant and suitable cultivable land.

The impact of the extension system (PADETES), though, proved to be positive, its coverage is limited to very little area and the peasantry. Thus its impact in terms of the volume of production, area and contribution to household food security is meager.

According to some studies in areas where the program has been carried out yield per hectare especially for maize, *teff*, sorghum has increased from two to three folds. Yet this increased yield is only attained on the highlands where there is relatively reliable rainfall throughout the year. In the lowlands the impact of the program is insignificant as rainfall pattern and distribution dictate the production system in the areas. The program by itself is too costly for the majority of the farmers in Ethiopia who are poor and hardly able to fulfill their basic necessity. However, there is tremendous potential for the program if supplemented with other inputs such as traditional farm practices, irrigation, and rural credit targeting the poor farmers.

The food security situation did not show significant improvement over the reference period, despite there has been major agricultural strategy changes in the country. Famine and drought still continue to undermine the coping ability of the rural population to environmental and man made hazards.

The per capita production except in some favorable years, on average, remained at the level of 118 kilograms. This is 5.3 per cent greater than the level in the 1980s. Yet the food demand of the population has increased at the rate of three per cent and the domestic supply for consumption remained to be only 118 kilograms per capita. The per capita calorie deficit, average of the last seven years, has been 625 calories per day. Thus Ethiopia cannot fulfil its population's food demand (from major crops) during the period 1992-1998. As a consequence the gap is fulfilled through relief aid and food imports.

Table 5: Estimates of Area, Production and Yield of Major Crops in Ethiopia (1992-1998)

Year	Area ('000 qt)	Production ('000 qt)	Yield (kg)	Population ('000)	Prod/Capita (kg)	Supply/Capita (kg)
1992	4856.8	57949.6	1193	50186.0	115	99
1993	7157.6	56997.4	796	51651.6	110	94
1994	7680.7	67428.1	878	53132.3	127	109
1995	9026.1	102758.0	1138	54649.0	188	161
1996	7524.6	91152.1	1211	56372.0	162	138
1997	6849.5	73626.7	1075	58117.0	127	109
1998	8186.9	80662.2	985	59882.0	135	115
Rate (%)	9.1	5.7	(3.1)	(3.0)	2.7	2.5

SOURCE: CSA: Crop Sample Survey (1991/92-1998/99)

3.4. Technology Adoption

One of the Ethiopian agricultural sector constraints to increased production and contribution to the development of the overall economy has been its low-level of technological advancement. The agricultural sector performed under traditional system of production unable to feed the ever-increasing population. Technology, here, defined as land productivity ameliorating inputs including commercial fertilizer, improved seeds, pesticides and herbicides.

As discussed in parts of this paper, the Ethiopian agricultural strategies adopted for the last four decades mainly focused on wide use of these inputs. The volume of these inputs supplied to the agricultural sector, as a result, has been increasing from year to year since the early 1980s. Yet application of these inputs remains at the lowest level than any sub-Saharan Africa averages, and their contribution to increased production and productivity remain low. This is because these inputs, particularly fertilizer and chemicals, are imported which require substantial amount of foreign exchange earnings; the impact of these inputs can also be at lowest stage as the distribution and marketing network necessary to avail the existing inputs to the needy farmers are poorly developed; in the 1980s and the 1990s emphasis was given to cooperative farming and state farms by marginalizing the overwhelming majority of the small-holder peasant farming which by that time contribute to over ninety per cent of the total agricultural production; and the existence of many poor peasants who cannot afford to buy these inputs.

The inputs are one of the important soil fertility ameliorating mechanisms and remain to play a decisive role in view of progressive environmental degradation, particularly on the highlands, increasing population pressure and consequently increasing food demand as well as continuously declining soil and land productivity the importance of these inputs will remain to be the centerpiece of the Ethiopian agricultural strategy in the future.

According to various literatures, agricultural inputs particularly adoption of fertilizer has its origin in the late 1950s with demonstration plots conducted by MOA and point four agreement. The emergence of the CADU, WADU and other rural development projects in the late 1960s gave an impetus to the increased use of these inputs in Ethiopia (Mulat, 1996).

Data on fertilizer, improved crop seeds and chemicals are available and reliable only since 1971. According to these data the volume of fertilizer supplied to the agricultural sector increased from 947 metric tons in the 1971 to 43287 in 1980 (Mulat, 1996).

Due to change in economic strategy and top priority given to the agricultural sector the volume of inputs delivered to the peasants has increased by more than 33 folds in the period 1980 to 1991 with average annual growth rate of 200 percent; and between 1975 to 1991 fertilizer utilization per hectare, on the other hand, increased from 2.5 kg to 28.7 kg; and improved seeds from 0.3 kg to 2.1 kg. Table 6 shows average production of major crops and inputs used by the peasant sector. The utilization of the inputs, though higher than in the 1970s by substantial amount, it has been lower to bring significant impact on the overall production. The low emphasis given to the small holder agriculture and the high profile given to producer's cooperatives and state farms deprived the contribution of the small holder's agriculture to improved production and productivity. However, producers cooperatives and state farms contributed only 5.5 and 4.5 per cent of the total agricultural production (IFPRI, 1989). The unequal distribution of land and unremunarative tenure system as well as low price for agricultural produces (forced AMC procurement and low prices than parallel markets) have been other major hindrance to improve the agricultural sector and the use of agricultural inputs.

and shortage of supply. New technology is frequently capable of increasing the efficiency of the traditional resources (land, labor and capital). Use of fertilizers on traditional crop varieties may result in very little yield increase. Similarly, introduction of improved varieties without fertilizer application may result in little or no yield increase. If both are introduced the resulting yield increase may be large. In Ethiopia due to incapacity of research institutions to develop and supply adequate improved seeds the area cultivated by the combination of adequate modern agricultural inputs is low. Such a package may consist of improved varieties, fertilizer, pesticides and relevant advice on how best utilize the package. However, it may be difficult to get such a package accepted among low income farmers (even if available) because the required changes in the production system and the decision making may be more than such farmers are willing to accept at a given time.

Beyond the problems of technology supply and adoption the Ethiopian agricultural sector is more constrained by other factors at the macro level than the availability and use of agricultural inputs. These factors may include, as documented in many studies are rainfall variability, decline in soil fertility and environmental degradation, high population pressure in agriculturally potential areas of the highlands, technological backwardness, policies and other socio-economic factors. Thus, due to the combined effects of these factors the agricultural sector performance has been weak and as a result annual production of the sector could not even fulfill the basic necessity of the increasing population since the 1970s.

CHAPTER FOUR

GENERAL BACKGROUND TO THE STUDY AREA

The study *weredas* selected for the purpose of this research are located in Arsi zone of Oromia region. They lie within the central highlands and the rift system of Ethiopia. Under this chapter the physiographic, demographic and socio-economic conditions of the two *weredas* are briefly discussed.

4.1. Physiographic Features

The two sample *weredas* are located in the central highlands and the rift system of Arsi zone of oromia. Hetosa *wereda* is found in the gridline of $8^0$17'N-$7^0$55'S longitude and $39^0$27'E-$39^0$6'W latitude; while Dodota-Sire is found within the gridline of $8^0$33'N to $8^0$7'S longitude and $39^0$34'E to $39^0$11'W latitude. Hetosa is bounded in the North and Northeast by Dodota Sire and East Shewa administrative zone and in the East by Tena wereda and East shewa; in the South by Digelu and Tijo *weredas*, in the West by Tiyo and Zeway Dugda *wereda*. While Dodota Sire *Wereda* is bounded in North, Northwest and north east by Adama Boset, in North west by Zeway dugda; East Jeju; Southeast Sude, in the south and southwest by Tena and Hetosa *weredas* Maps 1 and 2 show the geographic location of the study areas.

Both *weredas* account for 9.6 per cent of the landmass of the zone (937.49 km^2 for Hetosa and 1342.78.27 km^2 for Dodota-Sire). Agro-ecologically, they comprise three distinct climatic features. About ninety eight per cent of the area of Hetosa is characterized by the highland and mid altitude agro ecological zones while 62.2 per cent of Dodota-Sire is lowland.

Most of the *weredas* topography is flat plain with the exception of the eastern portion of Hetosa *wereda* with undulating terrain adjacent to the Chilalo mountain. Due to favorable topography, the *weredas* are suitable for mechanized agriculture. Mechanization is widely practiced in the peasant sector especially in Hetosa since the mid 1980s. The prospect for mechanization is enormous not only due to their topography but also due to the rich agricultural potential and long experience these *weredas* has with improved agricultural technologies.

The rainfall pattern of these *weredas* is bimodal, with the main rainy season extending from June to September, and the small rains from February to April. The average annual rainfall is about 400-1600 mm for Hetosa and 800 mm for Dodota-Sire. Over eighty per cent of the rainfall is obtained in the months of July and August. The distribution of the rain in Hetosa is more or less regular but with decreasing trend from time to time. In Dodota-Sire rainfall is erratic and characterized by late onset and early cessation and is a main constraint to crop production. Distinct drought years with marked shortfall of rain are also observed with increasing trend since the 1984. In the highland (Hetosa) though the pattern is regular torrential and heavy rains, in some years, are becoming main cause for crop damage and irregularities in the lowlands.

The *weredas* have varying soil types with distinct potentials for agricultural production. In the highlands and mid altitude zones black clay soils predominate. These soil types dominate the plains of Hetosa and the highland part of Dodota-Sire. In the lowlands silty and sandy clay soils are the dominant form of soils, with highly fertile properties but with low moisture retention capacity. The soils of the highlands are very eroded and its fertility is becoming low from time to time. In the lowlands both wind and water erosion are the major problems in dry and wet seasons. According to available sources the vertisols and andosols are the two major types of soils in Hetosa (fourty five and thirty five Per cent respectively) while in Dodota-Sire fourty five per cent are cambisols, twenty per cent andosols and thirty five per cent lithosols.

Table 8: Physiographic Conditions of the Sample Weredas

Description	Hetosa	Dodota-Sire	Both
Total Area(km^2)	937.49	1342.78	2280.27
Altitudinal range(masl)	2000-4030	1400-2500	1400 - 4030
Average Rainfall(mm)	400-1600	800	400 - 1600
Rainy seasons			
Main	June-Sept.	June-Sept.	June-Sept.
Small	Feb-April	Feb-April	Feb-April
Ecology(%)			
Dega	32	14.5	23.3
Woina dega	48	24.5	36.3
Kolla	20	61	40.5
Soils			
Cambisols		45	22.5
Andosols	35	20	27.5
Lithosols		35	17.5
Vertisols	45		22.5
Others	20		10.0

SOURCE: AZPEDD, 1998: Socio-economic Profile of The Weredas

The dominant vegetation cover is open grassland and Savannah land interspersed with acacia trees in the lowlands. On the highlands and mid altitude zones vegetation cover is limited to grass and intensively cultivated land.

The landuse pattern of the weredas is dominated by cultivated land. Due to high population pressure and available potentialities in the *weredas* about 48.2 per cent of the land is currently cultivated followed by communal pastureland. Of the total landmass of the *weredas* about 77.8 percent can be classified as an agricultural land. Due to rapid expansion of crop cultivation, over grazing, deforestation and the like available forest and bushland is rapidly declining (about 16.2 per cent). Currently, barren and degraded land dominates the land use system in most part of the *weredas* with rapid progress on the highlands. Trees were cut for domestic fuel and sale. Most of the communities adjacent to the highland of Chilalo make their living by selling wood throughout the year. In this area fuel wood selling comprises a substantial sum of household income. The land use pattern of the *weredas* is shown in Table 9.

Table 9: Percentage Distribution of Land Use Types in the Weredas

Landuse Types	Wereda		
	Hetosa	Dodota-Sire	Both
Cultivated land	52.9	43.5	48.2
Pastureland	16.4	10.4	13.4
Forest and Shrubland	28.2	4.2	16.2
Swamp and Marshes	-	-	-
Barren and Degraded land	-	3.3	1.7
Others	2.6	38.5**	20.6
Total	100.0	100.0	100.0

***this figure seems exaggerated and care should be taken in using it*

SOURCE: AZPEDD,1998

The vegetation cover is rapidly dwindling because of general environmental degradation, deforestation, and expansion of cropland. Natural forests have already diminished to the negligible level (0.5 per cent). Heavy pressure on land, increasing demand for fuelwood and rapid expansion of crop cultivation are major causes for complete deforestation. The grazing land is also over stocked and currently overstocking rate is 6.7 TLU per hectare. On the highlands communal grazing areas are almost diminished to insignificant level. In the lowlands though pressure on grazing land is relatively better than that on the highland shortage of grazing areas are becoming serious particularly during the rainy seasons. In almost all areas straw and crop residues are the most important types of animal feeds.

4.2. Socio-economic Condition

According to available sources the population of the *weredas* in year 2000 is estimated at 324419 people. Of this about 84.3 percent resides in rural areas and the remaining 15.7 per cent in urban areas; and 50.1 per cent are male and 49.9 per cent female. The population is growing at rapid rate than other *weredas* in the zone. In 1969 the population number was estimated at 118885 with 23450 households (Cohen, 1987). Accordingly within the past three decades the population has increased by almost three folds with the annual rate of 3.3 per cent. Given the dwindling natural resources and declining agricultural potentialities, the rate at which the population is growing is alarmingly high. For example, in 1969 population density had been fifty two persons/km^2 and currently this has been increased by 173 per cent and reach 142.2 persons/km^2; farmland holding also reduced from 3.86 ha per household in 1980 to 1.83 ha per head in 1997.

The dominant economic activity in both *weredas* is mixed farming. Crop production dominates the farming system of the area with significant production of livestock (though this is insignificant in the highlands). Traditional farming practices are the most important in most areas, eventhough mechanization is currently expanding on the highlands.

Both *weredas* are the first CADU pilot project areas and well accustomed to using agricultural technologies such as commercial fertilizer and improved seeds and modern agricultural extension services. On the highlands and mid altitude zones mechanization became important during ploughing and harvesting. In these areas, as a result of high use of modern inputs productivity of major crops is relatively high as compared to other areas. In the lowlands, however, it is dictated by pattern of rainfall and yield of crops is widely fluctuating. But in good rainy seasons the yield of crops is also significantly higher in the highlands.

The major crops, which are widely grown in the area, are cereals, pulses and oil seeds with limited vegetables in garden areas and irrigation along the major rivers. Among the cereals wheat is the most important both in area and volume of production. According to some sources, on average, wheat comprises over fifty four percent of the area and sixty one per cent of annual production between 1995 and 1997. In Hetosa wheat accounts for over seventy per cent of annual production, and now it is replacing most of the crops in the *wereda* due to its high response to fertilizers, availability of improved seeds, relatively stable prices on the market, mechanization, and favorable natural conditions. In the lowlands maize and pulses are the dominant crops. Thus the production system and cropping pattern of both *weredas* are mostly dictated by the physical and technical conditions. The cropping pattern of the broad categories of crops remains unchanged. In 1980, for example, the share of cereals in total cultivated area in these *weredas* had been 91.1 per cent and in 1997 this share remain unchanged (ninety per cent). While, the share of individual crops within the farming system, such as wheat has increased significantly over the past two decades.

Fallowing and manuring as means for fertility ameliorating mechanism are virtually non-existent owing to small landholdings per head and the use of dung as fuel. According to SEADZ (1989) area under fallow in 1984 was 7.3 per cent and now almost declined to a margin of insignificant percentage. Instead chemical fertilizers are widely used. These *weredas* (specifically Hetosa) are considered to be one of the areas with high utilization of commercial fertilizers and improved seeds in the zone. Between 1996 and 1997 alone these *weredas* have used, on average, 51925 quintals of fertilizer per annum (AZPEDD, 1998). Out of the total cultivated land in both *weredas* about 25.4 per cent (assuming a rate of 200 kg/ha) has been under fertilizer, where this percentage rose to 33.4 per cent in Hetosa *wereda*. Fertilizer application is about fifty one kg per hectare and this is significantly higher than the national and zonal average. Except the landless, and resource poor farmers fertilizer is more or less used by all farmers. Significant volume of fertilizer used each year is applied for wheat followed by maize and pulses. However, improved seed utilization is very small (on average 0.54 kg per hectare) due to shortage of supply and high prices and for farmers retain their own seeds from previous harvest. In the case of improved seeds, however, critical shortages of supply and high prices are major constraints. Thus farmers replace their seeds once in four years.

Except for some years (1994/95) the production trend of these *weredas* showed positive slope, but with wide fluctuations in the lowland areas of Dodota-Sire *wereda*. Table 10 below shows area, yield and production of major crops, and level of input use of the *weredas* under consideration. Based on the 1995/96 and 1996/97 data, production of major crops has decreased by 22.1 per cent, mainly attributed to shortage of rainfall in the lowlands. Per capita program and the consequent use of modern agricultural inputs have contributed to the growth of aggregate production. In the lowlands, however, both aggregate production and per capita availability was highly fluctuating from year to year. For example, in 1995/96 per capita production remained to be less than 381.4 kg per person.

Table 10: Average Area and Production of Major Crops and Level of Input use (1996-1997)

Description	Wereda			% distribution	
	Hetosa	Dodota-Sire	Both	Hetosa	Dodota-Sire
Area	51022	51206	102228	100.0	100.0
Cereals	44172	48551	92723	86.6	94.8
Pulses	5527	1985	7512	12.5	4.1
Oil seeds	1323	670	1993	23.9	33.8
Production	858829	422080	1237209	100	100
Cereals	762030	358744	1120774	88.7	85.0
Pulses	39011	9512	4823	5.1	2.7
Oil seeds	6766	2618	9384	17.3	27.5
Input use					
Fertilizer	34128	17797	51925	65.7	34.3
Improved seed	606	502	1108	54.7	45.3

SOURCE: Wereda Agricultural Development Offices and own calculations.

Though there is irrigation potential along various rivers in the *weredas*, the area of land that has been irrigated is very small. Most of the irrigated land is concentrated around the Awash and other smaller rivers. Irrigation is mainly used during the dry season except in the lowland areas of Dodota Sire where evapotranspiration is high both in the dry and wet seasons. Production is limited to vegetables such as potatoes, cabbage and onions. However, this is a potential area to be taped to alleviate the meager production and severe food security in the areas.

Livestock plays an important role in the household economy of the area. It is a source of draught power, hedge against natural and manmade calamities and means of capital accumulation. The *weredas* have high potential of livestock. According to the information obtained from the *weredas* (AZPEDD, 1998), there are 205266 TLU of livestock resources, which consists of 227418 cattle, 135125 shoats, 39347 equines and 108212 poultry. In the lowlands this resource is relatively high owing to the availability of grazing land and climatic conditions that favor livestock production than cropping. However, since grazing lands are sharply declining from time to time traditional livestock production system become limited than it has been two decades ago. Thus livestock density per available grazing land is as high as 6.7 TLU per ha, which is almost six folds above the recommended stocking rate for this ecology (assumed to be two hectare per TLU). Table 11 shows the total livestock resource, per capita holding and distribution between the *weredas*.

Table 11 Total livestock resources in the wereda (1997)

Type of livestock	Total		Wereda		%species
	No.	TLU	Hetosa	D.sire	
Cattle	227418	159193	88543	70650	44.6
Shoats	135125	13513	6521	6992	26.5
Equines	39347	31478	18162	13316	7.7
Poultry	108212	1082	512	570	21.2
Total	510102	205266	113738	91528	100.0
Density/ha(TLU)		6.7	6.1	7.7	
Holding/head		0.75	0.65	0.91	

SOURCE: Own calculations, Wereda Agricultural Offices (1998)

Note: 1 TLU equal 1 cow or cow, 0.8 horse, 1.1 camel, 10 sheep and goat
Density equals number of TLU per natural grazing land; holding per head is calculated by using rural population.

Lack of grazing land and drinking water is the major constraint to livestock production in both *weredas*, with high degree of water shortage in the lowlands.

Due to high population pressure land holding per household is very small. According to OPEDB (1998), the average land holding is as small as 1.78 hectare and its distribution is uneven. The same source indicated that about 23.4 per cent of the households own only 1 ha and less, 59.5 per cent between one and two hectares (Table 12). As a result of past land tenure system and the growing number of farming population, most of the new entrants especially the young people have no opportunity to own land and remain to depend on their family. This is one of the major agricultural problems of the area.

Table 12 Percentage Distribution of Land Holding (ha)

Holding size	Wereda			Cumm.%
	Hetosa	D.Sire	Both	
0	10.8	0.0	7.0	7.0
1	14.5	20.0	16.4	23.4
2	23.3	60.0	36.1	59.5
3	20.7	10.0	17.0	76.5
4 and above	30.7	10.0	23.5	100.0

SOURCE: AZPEDD, 1998

Oxen holding is also not adequate for most of the farming community. An average ox holding is about 1.6, with significant variation between the two *weredas*. Distribution is also skewed. About 11.1 per cent of the families have no ox; 31.3 per cent own only one oxen, averaging to 42.4 percent of the households who have no adequate draught power necessary to plow the land in traditional agriculture (Table 13). Oxen hiring, sharing and traditional cooperation are the major means of alleviating this problem. For farmers in a better off position mechanization is one of the alternative means in cultivation and harvesting. For resource poor farmers, however, this option is hardly possible.

Table 13: Oxen Holding per Household by the Weredas

Oxen Holding	Wereda		Both	Cumm.%
	Hetosa	D.Sire		
No oxen	13.4	6.9	11.1	11.1
One	18.1	55.5	31.3	42.4
Two	35.1	24.7	31.4	73.8
Three	21.1	6.9	16.1	89.9
Four and above	12.3	5.9	10.0	100.0

SOURCE: AZPEDD, 1998

As indicated repeatedly in the sections above these *weredas* have a long experience with various agricultural and rural development policies adopted in Ethiopia since the CADU period. This may favor the adoption of modern technology particularly commercial fertilizers and improved seeds in these *weredas*. The knowledge and application of modern technologies and other improved farming practices are no more new to these areas. However, the extension services density in terms of extension personnel, number of stations and farmers to agent ratio is high. The main package of services in terms of knowledge transfer and materials is totally focussed on the propagating the advantages attached to the new extension package program. However, this is no more new to these farmers and hence the service is not orientated to the immediate problem of the farming community such as off-farm employment opportunities, adequate supply of improved seeds, appropriate land tenure, etc. Apart from general shortage of farmland, oxen and supply of improved seeds; crop pests and diseases such as army.worms, stalk borer, cut worms, termite, shoot fly, aphids; and diseases such as rust, smut, leaf blotch and blight are serious problems in crop production. Birds (*Quelea quelea*) are also other pests which cause heavy seasonal damage in the lowlands.

The social and economic infrastructure of the *weredas* is relatively better. These *weredas* have 210 kms of all weather roads (19.5 per cent asphalt and 80.5 per cent gravel roads), with average road density of 0.64 km/ 1000 population or 9.21 km/ 1000 km^2. However, accessible roads that connect most of the remote rural villages are still lacking and remain to be one of the problems in input distribution and marketing in the wet season.

There are fifty primary and ten junior and two senior high schools with 932 teachers and 21466 students in 1997 (AZPEDD, 1998). The literacy rate of the *weredas* is estimated at 35.8 per cent (CSA, 1996). The health infrastructure is however poor in the lowlands. There are only one health center and sixteen clinics serving 324419 people in both *weredas* in 1997. Owing to the typical ecological condition of the lowland areas, favoring the malarial epidemics, water born and other communicable diseases, the number and efficiency of the health service infrastructure is not adequate. The ratio of clinics to total population in 1997 was 1:20276 (health coverage of 49.3 per cent).

4.3. Food Security Situation

The food security situation varies widely from *wereda* to *wereda*. At the aggregate level, Hetosa *wereda* has been food self-sufficient in almost all years, owing to favorable rainfall, adoption of technologies and extension services. In the lowland, however, the rainfall pattern and its timing is widely fluctuating and the production level from season to season varies. Depending on the condition and pattern of rainfall food security situation also varies from time to time.

Based on the two years production averages, and the 186 kg grain equivalent, standard used in Ethiopia (for major crops), on average the two *wereda* were food self sufficient with minor deficit in 1996/97. Disaggregating these data to each *wereda*, the situation of food insecurity is worse in Dodota-Sire than Hetosa. In the past seven years Dodota-Sire has suffered almost three years of food deficit period. In Hetosa, however, food self sufficiency and surplus periods predominate through out the reference period; the surplus ranging from 246000 quintals to 317000 quintals. Table14 show the food self-sufficiency condition of the *weredas*.

Table 14. Food Crop Production, Availability and Supply at Wereda Level

SN	Description	Weredas		
		Hetosa	Dodota-Sire	Both
1	Total production (qt)	807807	370874	1178681
2	Domestic use(qt)			
	Seed	44429	20398	64827
	Post harvest loss	80781	37087	117868
3	Net Availability(qt)	682587	313389	1309374
4	Net available (Grain equivalent, qt)	692927	317737	1010664
5	Population (Number)	200441	123978	324419
6	Per capita availability(kg)	372820	230599	603419
7	Total Consumption demand(qt)	346	256	311
8	Food deficit/surplus(qt)	320107	87138	407245

SOURCE: own calculation from Table 10

The location and long history of modern agricultural input use put these *weredas* at a better position considering the food security situation. According to the interviews made on the field level, the only known drought year has been 1984 (especially for Dodota-Sire *wereda*). Many reasons can be cited, among which, the land tenure system, the introduction of cooperative forms of production, demobilization of the peasants into new villages (often unsuitable in traditional agricultural society in Ethiopia), the exploitative marketing policy, fluctuation of the rainfall, the overall effect of the natural and unwise policies adopted since the 1974. The issue of environmental degradation as a causal factor for food insecurity is, however, a recent phenomenon.

Even though it is difficult to measure food insecurity at household level from aggregate data, it is, however, easier to predict the magnitude and existence of problem based on proxy indicators.

a. The production of the major staple foods which is on average at the level of 381.4 kg per capita, roughly over sixty nine per cent above an annual food requirement of a person. However, if the need for basic household expenditure, social obligations, purchase of agricultural inputs and contribution in the form of tax and seeds, post harvest losses etc, are included in food demand and supply analysis the situation could be so different in that most of the households could be at the margin of food insecurity. The inter-household variation in production capacity clearly indicate the wide existence of food insecurity situations especially in the lowland parts of these *weredas*.

b. Food security is a function of many variables among which the number of oxen holding, land ownership, other employment opportunities, and cash incomes, etc. As mentioned above the average land and oxen holding was 1.78 ha and 1.6 oxen in 1998. Of the total households, only 46.5 per cent have two and more than two oxen to plough the land necessary in traditional agriculture; and 30.4 per cent of the land holding is less than or equal to 1 ha. The employment opportunity and off farm activities are virtually absent except during the peak agricultural periods (planting and harvesting);

c. Data from zonal DPPD also showed that annually significant number of people were in need of emergency food in the lowland *wereda,* which is one of the indications of the existence of both transitory and chronic food insecurity in the areas.

d. On the highlands, due to severe soil erosion and land shortage, most of the people earn their living by selling fuel wood and in the lowlands both fuel wood and charcoal selling are important sources of household income;

e. The prevalence of crop pests and diseases and large pre harvest losses in the areas can substantially reduce the volume of household food production. The critical shortage of grazing land the declining number of livestock per head can also indicate the existence of food insecurity at household level of varying degrees.

CHAPTER FIVE.

DISCUSSIONS OF THE SAMPLE HOUSEHOLDS SURVEY RESULTS

5.1. Family Size and Labor Availability

The average family size in the sampled households is about 6.4 persons per household.. About 14.1 per cent of the household members' age ranges between ten and fourteen years. About 14.8 per cent and 3.2 per cent of the population is children below five years and people with age range of above 64 respectively. The average age being 47.5 with median age of forty-four. The family size ranges between two and fourteen persons. The total population of the sample households is about 909 people of which 68.9 percent live in the high and mid altitude areas and the rest in the lowlands. The economically active population (those within the age group of 15 and 64) is estimated to be 65.2 percent of the total population. However, since in rural areas, children above the age of 10 and those people above the age of 64 equally participate in economic activities the potential economically active population in the sample areas rises to 82.7 per cent.

Of the total sample population about 48 per cent are female and the remaining 52 per cent are males. It is also estimated that most of the sample population is illiterate. The survey data shows that about 53.4 per cent of the population (46 for males and 61.4 per cent for females) are illiterate and only twenty nine per cent have primary education. As indicated in Table 15 the ethnic composition of the population also shows that 81.6 per cent are Oromos and the remaining 18.4 per cent are Amaharas. 72.5 per cent of the samples are christians and 27.5 per cent are muslims. Almost all Amaharas and the majority of the Oromos are christians.

The number of family size has a strong correlation with other household resource endowment. For example, the family size has direct relation to the land size, oxen holding and income of the family though this is not always true in all cases and areas.

There is wide variation in the family size between the two sample *weredas* and between the high and lowlands. Family size, in the lowlands is, on average, about 6.5 (1.6 percent above that of the highland areas).

Table 15: Demographic Characteristics of Sample Households

	Description	Ecology			Wereda		
		Highlands	Lowlands	Total	Hetosa	D/Sire	Total
1	Total population by age	625	284	909	504	405	909
	less than 10	179	113	292	148	144	292
	10 to 15	92	37	129	75	54	129
	15 and above	354	134	488	281	207	488
2	Household heads	98	44	142	76	66	142
	Male	89	39	128	69	59	128
	Female	9	5	14	7	7	14
3	Population (sex)	625	284	909	504	405	909
	Male	318	156	474	260	214	474
	Female	307	128	435	244	191	435
3	% of potential labor force	25.8	34.8	28.6	26.1	31.7	28.6
4	Education	625	284	909	504	405	909
	Illiterate	330	156	486	265	221	486
	Basic education	17	11	28	13	15	28
	1 –3	96	53	149	75	74	149
	4-6	74	40	114	55	59	114
	7-8	58	14	72	51	21	72
	9-12	49	10	59	44	15	59
	12^{+}	1	0	1	1	0	1
5	Ethnicity (%)						
	Oromo				85.5	76.8	81.6
	Amhara				14.5	23.2	18.4
6	Religion (%)						
	Christian				75.2	69.3	72.5
	Muslim				24.8	30.7	27.5

SOURCE: Household Survey, 2000

Family labor, in traditional agriculture, is the most important factor of production both for increased income and production as well as for food security. According to the sample survey the average family has a labor force of about 5.3, which is about eighty two per cent of the total family members (includes children within the age group of 10-14). In rural farm economy, child labor is mostly used for cattle rearing and in some areas children within the age group have high participation in agricultural activities especially weeding and cultivation of maize and sorghum. However, most of the children pass at least half of the workday at school and their contribution to agricultural production is not that much significant. Compared to the average farmland a household owned, (7.7 *timad* or 1.9 hectare) shortage of labor could not be a serious problem at household level. In cases where labor is a shortage especially during peak seasons, mechanization and hired labor are widely used in the highlands and mid altitude zones, owing to suitable topography, relatively high productivity of the land and income of the farmers and favorable weather condition and high adoption of agricultural inputs and extension services than in the lowlands. Over thirty two percent of the farm households in the high and mid altitude *kebeles* use mechanization mostly during harvesting and planting time. Another thirty six per cent of the households use hired labor. This enabled most of the family labor to be released for other activities though this is very limited in the areas.

The labor force has also a strong correlation with household food security, level of income (off-farm income), productivity and land holding. This implies that as family labor supply increases, the more the households are food secured, the more productive and have opportunity to participate in off-farm activities.

The result of the survey also shows that those families with average labor force of greater than five owned forty four per cent of the farmland and earn about 94.4 per cent of the off-farm income and fifty two per cent of the total farm income. The contribution to household food security (food self-sufficiency), however, is not significant than the average months for the whole sample households. Production per head is also higher and on average production per family labor force is about 398 kilograms.

However, in the lowlands where rainfall pattern and distribution play major role in determining the level of food security and agricultural production, the contribution of labor force for food security and increased family welfare (as measured by farm income) is weak. Existing Labor force, here, has no opportunity for off-farm job and thus it is more of a burden to the family. In this area, production per labor force is as low as 323 kilograms, and only 31.8 per cent have off-farm income (mostly sale of fuel wood and charcoal), whereas they constitute over twenty eight per cent of the total labor force in the sample areas. Thus, the contribution of labor force to food security depends on the ecology the household resides in and the availability of off-farm employment generation activities.

In general, labor force in the family is strong contributing factor for food security. The survey result shows that as labor supply in the family increases the level of food security is improved. On the average, those families having a labor force of 10 and above in most cases feed themselves adequately throughout the year with strong variation between ecology and land holding size (Table 16). This may be attributed to the fact that, in traditional agriculture, the level of production depends, among other factors, on family labor and this determines the amount of land cultivated, the level of farm management and type of farm practices to be adopted, the type of crops to be grown and the ability of a household to participate in non-farm activities and opportunity to earn additional income from these activities. Taking the food self-sufficiency period of a particular family to be 12 months, households with labor force of five and below feed themselves for only 9.2 months, while those with labor force of 6 and 10 can feed themselves for nine months in the year, which is two per cent below the average sufficiency period of 9.2 over the whole sample households. These families, however, contribute over 78 per cent of the total labor force supply in the sample areas and earn 94.4 per cent of total off farm income and 51.8 per cent of total farm income. Thus one can conclude that labor force availability is a determinant factor for improved household income and though not to agricultural production unless it is supplemented with other resource endowments such as land, oxen, and etc. According to the survey results, labor supply is strongly correlated with land holding, livestock ownership and amount of agricultural inputs used, income, off-farm employment opportunities and volume of production.

Table 16: Contribution of Family Labor to Food Security

SN	Description	Labor Force Size			
		2-3	4-5	6-12	Total
1	Number of Families	30	54	58	142
2	Total number of labor force	89	74	586	749
3	Total farmland (timad)	223.88	388.62	482	1094.5
4	Off-farm Income per labor force (Birr)	5.28	18.95	53.57	44.41
5	Total farm income/labor force (Birr)	614.42	1024.28	239.10	361.27
6	% share of labor	11.9	9.9	78.2	100.0
7	%share of farmland	20.5	35.5	44.0	100.0
8	%share of off-farm income	1.4	4.2	94.4	100.0
9	% share of total income	20.2	28.0	51.8	100.0
10	% having off-farm Job	13.3	11.1	44.0	14.8
11	Food self-sufficiency Period	9.2		9.0	9.2

SOURCE: Calculated from Household Survey Data, 2000.

Labor mobility is mostly restricted in the areas owing to the similarity of production system in the area, absence of other employment opportunities, and low urbanization and commercial activities that can open up wide job opportunities for the existing labor force. Employment opportunities are limited to fewer areas only during planting and harvesting period. This is also limited to short duration not exceeding a month or two. Hence, income from off-farm employment is limited to daily labor, brewing local drinks (for women) and an average family income from these sources is only Birr 155 per year (Birr 44.4 per labor force). This is, however, compensated by the sale of fuelwood and other forest products and small scale petty trading. Thus the productivity of the rural labor force is very small due to lack of opportunities. The quantitative analysis of this factor as a contributory element to household food security showed that it has a correlation of 16 per cent which is next to area under fertilizer, improved seeds and level of agricultural production. Thus, in this survey, it is possible to conclude that labor is a strong and necessary factor to determine the level of household food security, of course, where there are opportunities for further participation in non-farm activities.

5.2. Land Tenure and Holding Size

Three major land tenure systems predominate the study area: own holding, share cropping and land renting.

Own holding tenure system widely varies by patterns and distribution owing to the ill-designed land distribution policies. Almost all households in the *kebeles* who are legally registered as members own the land either through government allotment or inheritance from their parents. According to the survey, only below one per cent (0.7%) of the sample households did not own land. These are the soldiers and migrants that have relatives from the survey area and emigrated from other areas for different reasons. Since once land is distributed to each household in the *kebeles* there is no further opportunities to redistribute for the new members. Absence of additional suitable land for cultivation in the highlands further exacerbated the problem of land redistribution for newly established households who mostly depend on their families for subsistence. These constitute the overwhelming majority of the landless households in the area and mostly earn their living from petty trading, land renting and share cropping.

Land renting is the second dominant form of tenure system widely practiced in the highlands and mid altitude zones. Of the total sample sizes some 23.2 per cent of the households rent out their land and 22.5 per cent cultivated rented land. On the highlands this percentage raises to 27.6 and 23.5 per cent respectively. Those families who rent out their land were the aged, the sick, female headed households, families with insufficient labor and farm oxen, poor farmers who cannot afford to buy agricultural inputs (seeds and fertilizer). Rented land accounts for about 14.5 per cent of the total farmland in the areas. Land renters are usually the well to do farmers with sufficient labor and farm income. Mechanization also contributed to the expansion of land renting and widely used by small-scale local investors and urban dwellers on contractual basis for one cropping season. Land cost varies from place to place and depend on fertility of the land and the ecology as determined by the reliability of rainfall. Usually it varies between Birr fifty and 300 per *timad* (200 to 1500 per hectare). In the lowlands, however, land renting is not widely practiced due to low land productivity and availability of rainfall.

Table 17: Percent of Households involved in Land Renting Arrangements and Mechanization

Description	Wereda		Ecology		
	Hetosa	D/Sire	Highland	Lowland	Total
% of farmers renting their land	28.9	16.7	27.6	13.6	23.2
% cultivating rented land	23.7	21.2	23.5	20.5	22.5
% involved in rental arrangement	52.6	37.9	51.1	34.1	45.7
% using mechanization	42.1	0.0	32.7	0.0	22.5
% experiencing both land renting and mechanization	19.7	0.0	15.3	0.0	10.6

SOURCE: Calculated from Household Survey Data

Though, share cropping is also other form of tenure practiced in the area it is mostly used by the households who lack draught oxen, labor, land and agricultural inputs. This constitutes 2.1 per cent of the total farmland in the area and practiced by 2.8 per cent of the sample households.

The implication of these forms of land tenure (renting and share cropping) on household food security is multidimensional especially for small-scale resource poor farmers. First, it is a means for increased purchasing power, to some extent. Second, it is a strategy for alleviating constraints to factors of production, and for the second party it is a source of employment, increased income and at macro level it is a strategy for increased supply of food grains. However, with the absence of additional employment opportunities for resource poor farmers the long-term impact of such land tenure system could be negative both in economic and social terms.

1. it could lead small scale farmers to landlessness and migration to the urban areas;
2. with the absence of other employment opportunities land renting could also lead to high rural open and disguised unemployment;
3. the food insecurity condition persists and worsen as income earned from land renting is insignificant to subsist a farm family even for two to three months. For example the income earned from land renting is only Birr 800 (five quintals of wheat at current farm gate prices) which is only enough to fulfil below fifty percent of the average family food needs. This also contributed to declining coping ability to food shortages and household entitlement to food.

Thus, though land renting and share cropping have contributions to improved food security they are not sufficient condition to enable a poor household to achieve reasonable and sustainable level of access and entitlement to food. They should be supplemented by adequate and efficient credit system for oxen and purchase of farm inputs, off-farm employment opportunities and have to get adequate training.

Land holding is highly skewed from place to place having weak correlation with the ecology, family size, land productivity, resource endowment of the family and other necessary conditions important in land distribution.

The average farm size per household is only 7.7 *timad* (1.9 hectare) consisting of 86.7 per cent of own land, 13.5 per cent of share cropping and renting. Though, the size of holdings seem relatively better as compared to other parts of the country, land holding per active labor force and per head is very small owing to high population pressure, shortage of additional cultivable land, lack of opportunity for further expansion and weak inter-sectoral linkages especially under developed industry and service sectors that can potentially pull out the excess labor force from the rural economy. On the highlands holding size is as low as 1.7 hectares which is not enough to feed sufficiently an average family of 6.4 persons under low input low output agriculture. In the lowlands, holding size is relatively better due to relatively low population density, low emphasis given to crop production as compared to the highlands. Here, the average holding size (own holding) is about 2.1 hectare. In these areas there is also a possibility for land expansion if irrigation is used.

As shown in Table 18 holdings less than or equal to 0.5 hectare constitute about 1.3 per cent of the total farm size and owned by 5.6 per cent of the households and 8.5 per cent of existing holdings are below one hectare. Likewise, households who owned below one hectare and those who owned farmland between one and two hectares constitute only 71.8 per cent of the household. Inequality in land holding is significant in all ecologies. On the highlands about 23.4 percent of the households owned about eleven percent of existing farmlands, which is below one hectare. In the lowlands this percentage declines to 11.4 per cent and four per cent respectively. The result shows that there is high land holding inequality on the highlands than in the lowlands and family size and holding sizes were weakly and negatively correlated. As land is fundamental factor of production and basic livelihood in agriculture and for rural community it determines the level of household income, production, adoption of technology and food security. Thus the descriptive analysis of the survey shows that farm size has a strong relationship with these variables. And by implication the smaller the farm size and the lower other employment opportunities the lesser is the food security status and household income. Thus, the size of farm as a measure of food security is well fit to the established assumptions irrespective of the tenure system in these areas. The result of this study also show that, those who have relatively larger farm size have also a self-sufficiency period of more than the average; use relatively higher amount of improved seeds and fertilizer than those who owned small holdings. However, even though in the lowlands holding sizes are larger, the relationship it has with these variables is insignificant. This is because the pattern and distribution of rainfall determines the level of production and family income. In this ecology farm size strongly related to the number of livestock ownership.

5.3. Farming System and Agricultural Production

Farming system in the study area is mainly dominated by sole cropping and mixed agriculture. Sole cropping is the dominant form of farming system and widely practiced in the highlands and mid altitude zones. This is dominated by wheat and barley production and livestock production play a minor role with the exception of its role in the provision of draught power. Farmers in these areas own less than two (1.8) oxen and on average 4.15 TLU of other animals per family. Use of mechanization services during planting and harvesting time is a common practice for about 22.5 per cent of the households (thirty three per cent on the high and mid altitude zones). In the lowlands, however, mixed farming is dominant where households carryout crop production and livestock rearing side by side together with some petty trading and sale of charcoal and fuelwood.

Thus, in general, of the total households sixty five per cent are sole croppers and thirty five per cent are practicing mixed farming. In the lowlands maize, sorghum and lowland pulses are major crops produced.

Owing to the favorable physical and environmental conditions, high responses to fertilizer and better demand on the market, wheat is produced widely. This crop constitutes about fifty two per cent of cultivated land and seventy per cent of production. Its share raises to sixty per cent and seventy three per cent of cultivated land and volume of production both in the highlands and mid altitude zones, in some sample *kebeles* this percentage raises to over eighty per cent. In these areas barley and pulses are second widely cultivated crops. Apart from ecological suitability and responses to agricultural inputs, and the impact of long experiences farmers have with extension services have played major role for its wide production. Wheat is both staple and cash crop in these areas. The crop constitutes over seventy two per cent of total annual crop sales and 28.8 per cent of its total production is marketed. It is estimated that the crop fulfills about fifty nine per cent of the household's food consumption, and thus it has a strong contribution to household food security than any other crop cultivated in the area. Thus the failure or success of this crop at any particular year determines the status of food security at household level. The crop is highly commercialized especially on the highlands and cultivated relatively under modern production system and consumes most of the family labor, land, capital and other agricultural inputs. Over fifty seven per cent and eighty six per cent of the total improved seeds used in that locality goes to wheat and almost 31.9 per cent of the area under this crop is cultivated using improved seeds and fertilizers.

The productivity of the crop is also high and in 1999/2000 cropping season yield per hectare is, on average, 1852 kilograms with wide variations between *kebeles*, which resulted from variations in soil productivity, level of input use and the pattern of rainfall. In the highlands and mid altitude zones, the yield of the crop is, on average, 2253 kilograms (twenty three per cent above the average for the whole sample) and this reaches 2340 kilograms in Hetosa *wereda*. However, in the lowlands due to moisture stress the yield has been only 793 kilograms, which was 64.8 per cent below that in the highlands. Furthermore, almost over ninety three per cent of the sample households produce this crop owing to the above mentioned reasons. The crop plays a determinant role in improving household food security though it is not the intention of this research to quantitatively prove the magnitude of its contribution to the food security.

Maize, barley and *teff*, on the other hand, constitute 24.1 per cent of cultivated area and 15.4 per cent of total production in the highlands and 50.2 and 37.4 per cent in the lowlands, respectively. They have significant share in marketed surplus and about nine per cent of these crops were supplied to the market in the highlands and 8.1 per cent in the lowlands. Their contribution to household food consumption is also high. *Teff* is the second most important cash crop in the highlands and about 51.1 per cent of its total production is marketed by the sample households.

Pulses are the second important crops though they are insignificant both in area coverage and volume of production. Pulses are widely cultivated on the highlands where horse beans and field peas dominate the production system. They are used totally for home consumption with insignificant supply to the market (only 3.2 per cent). Their contribution for crop rotation and as a means of fertility ameliorating mechanism is also insignificant as they only occupy 8.8 per cent of the total cultivated area (9.5 per cent in the highlands and 7.6 per cent in the lowlands). It has also insignificant contribution to household food security, as its share in the total food supply is as low as 6.5 per cent. Their productivity is as low as 807 kilogram, which is lower than the *wereda* and zonal average.

Oil crops, especially linseeds and niger seeds (noug) constitute only 0.8 per cent of cultivated area; 0.4 per cent of production and produced by about fifty five per cent of the households. They dominate the highlands and mid altitude areas with wide variation in productivity. They are totally used as cash crops, and used by most of the households as another source of cash income. They are cultivated on lands with exhausted fertility as well as on newly developed lands. They are totally used as cash crops and their contribution to household food security is indirect and insignificant (only 0.7 per cent).

Table 19: Percentage Share of Area under Major Crops, Production, Yield and Number of Farmers Cultivating them

Crop	Highlands				Lowlands			
	Area	Product	Yield (kg)	% farmers	Area	Product	Yield (kg)	% farmers
Wheat	59.6	72.5	2253	92.9	39.5	45.9	793	93.2
Barley	13.2	10.9	1539	66.3	17.4	17.7	693	75.7
Maize	6.1	2.3	691	34.7	16.7	16.1	656	86.4
Teff	8.0	3.8	872	32.7	18.6	13.4	492	84.1
Sorghum	0.3	0.0	0	6.1	0.0	0.0	0.0	0.0
Other cereals	0.8	0.6	1440	4.1	0.0	0.0	0.0	0.0
Pulses	9.4	5.0	996	54.8	7.6	4.7	421	45.5
Oil Crops	1.3	0.5	743	5.1	0.0	0.0	0.0	0.0
Vegetables	1.4	4.4	5733		0.2	2.2	6000	
Total	100.0	100.0	1851		100.0	100.0	681	

Note: % of farmers= % of farmers cultivating/producing that particular crop

Source: Calculated from Household Survey Data, 2000.

In general, due to the long experience of adoption of technology geared towards production of major food crop in the country and in the areas, in particular monocropping is going to replace multiple cropping. In the early 1980s wheat only occupied below fifty per cent of the cultivated land, and now dominated around fifty two per cent of the area. This has a great implication on the farming system, the ecology and food security system of the areas unless it is regularly supplemented by continuous research outputs and extension services. The predominance of weeds, pests and crop diseases can be major failures to increased production policies when monocropping is rapidly replacing multiple cropping which are insurance against crop failure and the vagaries of climate. Diseases such as rusts and leaf blotches are serious constraints to wheat production as most of the seeds used for longer time were not replaced. Frequent replacement of seed, on the other hand, needs strong and efficient research centers and multiplication sites that can develop, test and disseminate the new varieties within shorter possible time. These require large investment in agricultural research, marketing, distribution networks as well as on human resources (research personnel). The capacity of the research system in the country is not only inefficient in terms of investment but also in generating low cost, disease resistant, drought tolerant as well as early maturing crop varieties. What are currently developed by the research centers are mostly dominated by highland wheat, barley and few highland pulses, maize and sorghum for the lowland areas. Thus the majority of the research outputs currently available and disseminated to farmers were highland oriented, and as a result the lowland part of the country has not been benefited from what is already existing meager research works. Whereas, the lowlands are major drought sensitive areas, in which the majority of food insecure population resides in, but have high potential for development.

It is obvious that the level of production at household level also determines access and entitlement to food of the household. This implies that increased agricultural production especially that of staple food crops (in traditional subsistence agrarian economy) is a precondition to access to food. The survey results also show that level of production is directly related to availability of food and the level of food self-sufficiency period with correlation coefficient of 36.3 per cent. The food security status is more explained by this factor. The level of production at household level is also related to the favorable condition of rainfall, availability and use of agricultural inputs, amount and fertility of the land and ownership of sufficient draught oxen as well as other supporting extension services.

The impact of the extension services especially that of the newly adopted package program is significant. The level of crop productivity, mostly that of wheat is very high than the conventional way of production system. Currently, about fifty seven per cent of the sample households were participants of the program, and 35.1 per cent of wheat area was covered by the program in 1999/2000 cropping season. About fifty six per cent of wheat crop production is attributed to this program with an average yield of 2922 kilograms. But the success of this program varies from ecology to ecology with positive impact on the highlands and mid altitude zones.

On the highlands wheat is the dominant crop in the extension system. According to the survey, in this ecology, fifty one per cent of the households were participants and 94.6 per cent of the area under the program and 98.8 per cent of production of same was the share of wheat with insignificant proportion goes to *teff*, maize and pulses. The productivity of the crops covered by the program, as a whole was about 3480 kilograms and 3633 for wheat. In this ecology, the program has been successful both in boosting production and productivity as well as improving household income, food security and wellbeing.

However, there are still serious shortcomings related to the expansion of the program at wider scale such as limitation of the program only to one crop and consequently leading to monocropping, unavailability of /shortage of new varieties of seeds, high costs of agricultural inputs particularly for resource poor farmers. The package program is also too costly in terms of inputs and labor especially for those farmers who cannot afford to pay down payment for purchase of inputs (fertilizer, improved seeds, chemicals), lack adequate oxen and other resources necessary for agricultural production. It is also important to note that lack of sufficient supply of improved seeds and timely delivery of fertilizer, variable rainfall (i.e., in the lowlands) are also constraints for resource rich farmers as well.

Table 20: The Impact of the New Agricultural Package Program on the overall production and the share of Target Crops

		Wereda							
		Hetosa				Dodota sire			
SN	Description	Wheat	*Teff*	Pulse	Total	Wheat	*Teff*	pulse	Total
1	No. of participants	50	1	3	50	28	7	0	31
2	Area (*timad*)	123	2	5	130	72.5	16	0	88.5
3	Production (qt)	1117	2	12	1131	311	34.5	0	345.5
4	Yield (kg/ha)	3633	400	960	3480	1716	863	0	1562
5	Fertilizer (qt)	43.0	1.0	6.0	50.0	38.50	15.73	3.0	57.23
6	improved seed (qt)	38.75	0.05	1.13	39.93	14.15	0.30	0.0	14.75
7	% of area (package)	94.6	1.5	3.9	100	81.9	18.1	0.0	100.0
8	% of production (package)	98.8	0.2	1.1	100.0	90.0	10.0	0.0	100.0
9	% of area (total)	37.6	8.7	8.8	24.6	31.9	15.1	0.0	16.7
10	% of production (total)	58.2	4.5	13.1	45.5	49.5	20.9	0.0	30.4
11	incremental yield (% total)	155.3	51.5	97.7	181.3	155.2	138.7	0.0	178.3

Note: Figures for SN 9 and 10 show percentages from same column totals.

SOURCE: Compiled from Field Survey Results

In general, the result of the survey shows that, in the highlands, households who have participated in the program achieved greater access to adequate food supply and income. The food self-sufficiency and availability (as measured by months in which households can feed themselves from what they have produced and net calorie supply) at household level, for the adopters was 10.2 months and 3108 calories per head, which is over forty two per cent above the average for non adopters and the overall household samples.

In the lowlands wheat still dominates the production and extension system and remains to be the main target of the program. In this area about 70.4 per cent of the sample households were covered by the program. Yet the area covered by the program was 21.9 per cent and production obtained is only 9.5 per cent of the total production in the lowland sample *kebeles*. Wheat contributed to ninety per cent of the total production and 81.9 per cent of production of the total target crops. The yield of these crops was about 1562 kilograms (1716 kilograms for wheat, 863 for *teff*). The yield, here, is also high as compared to the over all yield in the ecology and to that obtained by non-adopters. However, yield of *teff* is no better than that produced in the conventional way. The yield of wheat is also low by fifty three per cent than that in the highlands. Here, moisture stress particularly rainfall variability is the main limitations, in addition to the problems indicated in the case of the highlands.

Table 21 shows the merits of adoption of the new package program. According to the data in the table adopters are in a better off position in many respects than non-adopters. However, most of these farmers are resource rich farmers who own large area of land, oxen, labor, livestock and income.

Table 21: Contribution of the package program to food security and characteristics of Adopters and Non-adopters

Description	Adoption		
	Adopters	Non adopters	Total
Self-sufficiency period (months)	10.2	7.3	9.3
calorie per head	3108	2182	2878
Production/head (kg)	480	255	415
share from total production	82.2	17.8	100.0
% of fertilizer used	81.8	18.2	100.0
% of improved seeds used	90.9	9.1	100.0
% of chemicals used	77.9	22.1	100.0
Labor force/family	5.6	4.7	5.3
Land/household	7.6	6.7	7.3
Area under crop/household	8.1	6.9	7.7
Oxen holding/household	1.9	1.7	1.8
Income/head (Birr)	2231	1307	1906
Level of education of the household	3.4	2.1	3.0

SOURCE: Calculated from Field Survey Data, 2000.

Production of vegetables is limited to small area, usually cultivated in gardens for household consumption. In some area production of onion is dominant and the crop is major source of cash income. But since the volume of production and the number of households who produce this crop is smaller the contribution it has on household food security at macro level is insignificant.

5.4. Livestock Production

Livestock production is the second largest enterprise in the areas and plays significant role especially in the supply of draught power and in the lowlands as means of hedge against risks, source of income and food. On the highlands and mid altitude zones of the sampled *kebeles* livestock production is only for oxen production. Due to shortage of grazing land in these areas the number of livestock resources per head is very small.

According to the survey there are about 589.2 TLU of livestock population which constitute about 78.4 per cent of cattle, 2.1 per cent of shoats, 19.1 per cent of equines and 0.4 per cent of poultry population. The per capita holding is as low as 0.6 TLU, on average, with the maximum holding size of 16.3 TLU. In the lowlands this average is higher to some extent dominated by shoats and equines.

On the highlands and mid altitude zones oxen constitute over 43.8 per cent of the total livestock population, while in the lowlands about 24.5 per cent are equines and shoats.

Depending on the ecology cattle is the most important source in the supply of oxen and milk and also source of cash income. Small ruminants (shoats) play major role for the poor households, and mostly these animals are sold to settle various household and other expenditures such as cost of agricultural inputs, tools, social obligations, etc., and also sold for purchase of food items in times of food shortages. Due to these reasons and the fact that they are kept for oxen production and a hedge against risks their contribution to household cash income is only 14.1 per cent of the total farm and non-farm income. In the lowlands, however, this proportion rises to twenty per cent (Table 22). Equines are the most important type of domestic animals in both ecologies especially in areas where accessibility to modern transportation system is not adequate. They are the main source of rural transport system and kept by about 70.5 per cent of the sample households; and on average every household has one equine in the area.

Table 22: Livestock Population of the Area

		Ecology		Wereda		
SN	Description	High	lowland	Hetosa	D/Sire	Total
1	Livestock Population (TLU)	433.7	155.6	331.4	257.8	589.3
	Cattle	345.4	116.6	263.2	198.8	462.0
	Shoats	6.0	6.6	5.8	6.8	12.6
	Equine	81.0	31.5	61.5	51.0	112.5
	Poultry	1.3	0.9	0.9	1.2	2.1
2	Holding per household(TLU)	4.4	3.5	4.4	3.9	4.2
3	Per capita holding (TLU)	0.7	0.5	0.5	0.8	0.6
4	Contribution to household income(%)	12.4	20.1	13.9	14.6	14.1
5	Contribution of animal products to income(%)	1.2	1.7	1.4	1.0	1.3
6	% of families rearing					
	Cattle	88.8	79.5	94.7	84.8	85.9
	Shoats	15.3	40.9	19.7	27.3	23.2
	Equines	72.4	70.5	67.1	77.3	71.8
7	% of draft oxen (from Cattle)	51.1	59.0	57.0	56.3	53.0
8	% of milking cows(from Cattle)	13.0	18.8	12.9	19.1	14.6

SOURCE: Compiled from Field Survey, 2000.

particular household is not compatible. That is, even those households who have more than a pair of oxen can face shortage of draft power. Such households constitute the majority of the households in the survey area.

Thus farmers with such constraints have three strategic options to alleviate these problems.

1) oxen sharing is one of the major means, where a household shares his oxen with another partner for a particular workdays. These options though it contributes to increased production in the short run, in traditional agriculture where the calendar should perfectly match with rainfall regime ox sharing hinders to cultivate the available land, thus it could be one of the causes of low production per capita and household food security.

2. Renting is the second form of access to farm oxen. The cost of an oxen day is about Birr 40 per *timad* and some times this is agreed up on the daily basis (10 Birr/day). This option is used only by farmers who have additional off-farm income and has insignificant role in the production system.

3. Farm mechanization is another important alternative available to the farmers. About 22.5 per cent of the farmers are users of farm mechanization service during the planting and harvesting time. The cost of mechanization service is about Birr 180 per hectare for plowing, Birr 90 for harrowing, and planting/sowing and Birr twelve per quintal for harvesting and threshing with a farm transportation cost ranging from Birr one to two per quintal. Most of the farmers used the service during peak agricultural season. Since the cost of mechanization service is high for poor farmers it is mostly used by contract farmers and those who have adequate land and income. However, the service plays a significant role in agricultural production and modernization of the sector.

The relationship between the number of oxen, farmland, volume of production and food self-sufficiency at household level is strong and those with farm oxen are more food secured than those who have not. Table 23 shows the number, distribution, and ratio of oxen to farmland.

Thus the food availability situation and food security of the household depend on the ecology, weather condition and resource endowment of a particular household.

Thus using the 186 kilograms (1710 KCl) of grain equivalent of the per capita food consumption and deducting crop sale, post harvest loss and seeds the average food crop available for consumption at household level is 1775 kilograms per household or 240 kg per person per annum.

In the lowlands food availability is only 3.8 per cent below the annual per capita requirement and most of households depend on the purchase of crops. This figure shows the average level of daily consumption for the whole sample households in the lowlands. Interhousehold variations are highly significant due to variations in access to socio-economic resources. On the highlands and mid altitude zones, however, food availability is 2050 kilograms per household or 322 kilograms per capita owing to high productivity of the land and reliable rainfall.

But since for almost all farm households crop is the dominant source of income to purchase other food items, agricultural inputs, education and health services, transport, clothing, farm tools and others, what is remained after these expenditures cannot feed even the average resource rich farmer. For example, the survey result show that, on average, the average farm household roughly expend 30.2 per cent on food items, 11.5 per cent on education and clothing, four per cent on taxes, 16.2 per cent on farm inputs and tools 5.4 per cent on social obligations and various contributions. This is equivalent to about eleven quintals of crops (forty two per cent of total production) at farm gate prices- in wheat equivalent. Thus it is only fifty eight percent of the total production that remained at household level for consumption, post harvest loss, seeds and other domestic uses. For resource poor farmers whose volume of production is meager the proportion of sales to settle obligation particularly fertilizer, seeds, chemicals, household economic and social needs determine and affect the level of food security in the household in particular production year.

Two major methodologies were taken into account to identify household food security condition and the number and type of households who are food secured or insecured. The first one is to take food self-sufficiency period of the household from what they produced, as understood by the households themselves. This was obtained by direct interview of the households. The second method is to calculate the food available at household level by considering total production at family level; sales and purchases; seeds, post harvest losses and other uses. This will give the net crop available at household level.

Depending on the first scenario about 12.7 per cent of the households can feed themselves only up to six months, 26.1 per cent are self-sufficient from six to nine months in a year. It is only 34.5 per cent of the households that can feed adequately throughout the year (irrespective of the nutritional status of their food intake). Table 24 shows the number of households by food self-sufficiency period.

Table 24: Household Food Self-sufficiency Period by *Wereda* and Ecology (%)

Description	Wereda			Ecology		
	Hetosa	D/Sire	Total	High	Low	Total
1.Sulf-sufficiency	76	66	142	98	44	142
Less than 3	1	5	6	2	4	6
3 to 6	4	8	12	4	8	12
6 to 9	20	17	37	21	16	37
9 to 12	20	18	38	32	6	38
12 and above	31	18	49	39	10	49
2. Average period						
% under3 months	1.3	7.6	4.2	2.0	9.1	4.2
% under 6 months	6.6	19.7	12.7	6.1	27.3	12.7
% under 12 months	59.2	72.7	65.5	60.2	77.3	65.5

SOURCE: Household Survey, 2000

These households were characterized by small land holding, large family size, inadequate farm oxen, and low agricultural inputs (fertilizer, seed) utilization, few livestock holding and no off-farm income. The self-sufficiency period has strong correlation with these variables and their contribution to the level of food self-sufficiency period is larger than any other associated variables. The land holding, input utilization and family size, especially have greater impact than the variables included under this component. The relationship, contribution and impact of these variables will be explained in detail in the next chapter.

Table 25: Percentage Distribution Of Household Food Consumption Per Head (Calorie Per Day)

Calorie Category	Ecology			Wereda		
	High	Low	Total	Hetosa	D/Sire	Total
500-750	6.1	38.6	16.2	6.6	27.3	16.2
751-1000	4.1	9.1	5.6	3.9	7.6	5.6
1001-1250	7.1	9.1	7.7	9.2	6.1	7.7
1251-1500	4.1	4.5	4.2	5.3	3.0	4.2
1501-1750	2.0	2.3	2.1	2.6	1.5	2.1
1751-2000	6.1	0.0	4.2	3.9	4.5	4.2
2001-2250	5.1	6.8	5.6	2.6	9.1	5.6
2251-2500	9.2	0.0	6.3	10.5	1.5	6.3
2501-2750	2.0	0.0	1.4	2.6	0.0	1.4
2751-3000	6.1	9.1	7.0	6.6	7.6	7.0
3001-3250	4.1	2.3	3.5	2.6	4.5	3.5
3250-3500	4.1	4.5	4.2	2.6	6.1	4.2
> 3500	39.8	13.6	31.7	40.8	21.2	31.7
Total	100.0	100.0	100.0	100.0	100.0	100.0
Average calorie Available	3373	1775	2878	3543	2112	2878
Percent below the standard	23.5	63.6	35.9	27.6	45.4	35.9

SOURCE: Calculated from Household Field Survey, 2000

The food availability again varies by ecology and household resource endowment. On the highlands the daily consumption (availability) is about 3373 calorie per head and only 23.5 percent of the population could not fulfil adequate calorie. In the lowlands, on the other hand, 36.4 percent of the sample households have access to adequate calorie and the daily consumption is on average 1775 calories. In this ecology there are also a wide variation in the availability of calories from *kebele* to *kebele*. In the lowlands about 45.5 per cent (20 households) consume below 1000 calorie per day per person where as on the highlands only 10.2 per cent (10 households) consume below this figure.

The condition of food insecurity, though marginal as compared to the country and other parts of the region, in the lowlands, as mentioned above, is exacerbated by rainfall variability, absence of off-farm activities, shortage of draught oxen, and general poverty of the population. For example, the average farm income of the farm family, roughly, is about Birr 1906 per household, while on the highlands about Birr 2159 per household. Only 15 per cent of the farm income is expended on modern agricultural inputs (fertilizer, seeds and chemicals) and about 34.1 per cent, on the other hand, on food items, which is the most indicative measure of household food insecurity and poverty.

CADU/ARDU model farmers. Again about 21.8 per cent have an experience of 10-20 years with agricultural extension. As a result among the current package program users about thirty five percent (49 households) are those who have adopted the extension program carried out long ago. Likewise these households form the largest proportion of households who use the highest volume of fertilizer and improved seeds. Table 25 shows the number of farmers by year of adoption of extension services, proportion of agricultural inputs used by category and regularity in participation of extension services.

Table 26: Indicators of Agricultural Extension Program Adoption

Description	Year of Extension Service Experience				
	≤ 10	10- 15	15-20	≥ 20	Total
Number of farmers	62	21	10	49	142
Cultivated Area (%)	40.2	16.2	7.5	36.1	100.0
Total production (%)	47.6	11.8	6.4	34.2	100.0
fertilizer used per hectare (kg)	74.4	62.2	79.7	91.1	78.0
Improved seeds/ha (kg)	28.2	10.2	0.2	23.1	23.1
Volume of chemicals/head (liter)	0.7	0.3	0.3	0.4	0.3
Food self sufficiency period (months)	9.2	8.5	9.0	9.3	9.3
Participants of the package program (%)	53.2	47.6	50	50	50.7
% using fertilizer	93.5	76.2	50	50	507
%using improved seed	32.2	28.6	40.0	28.6	31.0
Yield /ha (kg)	1402	959	1406	1465	1348
Average farm income (Birr/HH)	2286.3	1544.3	1477.25	1633.1	1905.6
Use of mechanization	18.4	12.5	27.3	27.5	22.5

SOURCE: Calculated from Household Survey, 2000.

As shown in Table 26 the earlier and the longer the farmers have experience in agricultural extension, the larger their productivity, sustained use and higher volume of inputs and the better acquainted to modern agricultural technologies. In addition the correlation between years of adoption of extension services, land and labor productivity, household food security and use of improved inputs and farm income is significantly high. Even though, there is an adequate number of development agents in the sample areas their major focus is on the package program, which is aimed at increasing the agricultural productivity through intensive use of fertilizers, improved seeds, chemicals and farming practices. Thus, owing to the long experience these households have with extension services and improved agricultural technologies by 1999 almost over 57 per cent of these sample households are participants of the program. Of the average family farmland about 20.2 per cent is currently cultivated by using the program's inputs. The elements of this program are, however, no more new to these farmers as they have long experience in using them in one way or another except the rate of fertilizer application.

Thus the contribution of the number of extension staff as criteria for efficient agricultural extension system is no more valid. Instead the extension service should focus on efficient utilization of natural resources and build capacity for off-farm employment opportunities, modern small-scale dairy farming and other animal production systems.

Owing to the above factors most of the agricultural production and farming system is under fertilizer and improved seeds together with wide use of chemicals such as herbicides and pesticides. Currently about 95.9 per cent sample households on the highlands and seventy five per cent in the lowlands use commercial fertilizer; while 41.8 per cent of the households on the highlands and 9.1 per cent in the lowlands use improved seed. Chemicals such as herbicides and pesticides are widely used irrespective of the ecological setting of the households. Fertilizer application per hectare is 105 kilogram on the highlands and 42.5 in the lowlands. Use of improved seeds is, however, insignificant due to the fact that farmers kept their own seed for two to three years; shortage of supply of required seeds; absence of varietal change for a long time by suppliers; high prices that cannot be affordable by small scale resource poor farmers, absence of significant yield change of the improved seeds over local ones. However, since the area has been under intensive use of improved seeds since the CADU period there are no as such known local varieties especially for wheat and barley. Most of the existing crop varieties are those introduced since the early 1980s and 1990s. According to the survey results farmers have high demand for new varieties which are more tolerant to diseases and high productivity than the existing ones. The low capacity of the suppliers to supply these inputs, however, has been serious constraint to fulfil the existing high demand. The expansion of mechanization in the highlands and consequently the increasing need for land renting exacerbated the existing shortages of improved seeds.

Despite these problems, area under fertilizer and improved seeds is higher than in other survey areas with distinct variation along different ecologies. In the highlands and mid altitude areas, area under fertilizer is as high as 85.1 per cent and fertilizer rate per hectare is about 123.6 kilograms (for fertilized area). In these areas about ninety six per cent of the farmers are users of this input. Improved seed application is, however, lower where only forty two per cent of the farmers are adopters and 24.2 per cent of the land is covered by improved seeds.

In the lowlands fertilizer application is only ninety-two kilograms (per fertilized area) per hectare and used by seventy five per cent of the sample households. Use of improved seed is insignificant in this ecology due to high risks of rainfall, existence of high number of resource poor farmers who cannot afford to buy the inputs.

Table 27: Area under Fertilizer, Improved Seeds, Chemicals and Number Of Users By Ecology

Description	Ecology		Wereda		
	Highland	Lowland	Hetosa	D/Sire	Total
Total area (*timad*)	658	406	538.0	526.0	1064
% of Area under					
Fertilizer	85.1	60.4	85.1	56.1	70.8
Improved seeds	24.2	2.0	21.0	8.6	14.9
Application rate fertilizer(kg)					
Per total area	105.2	42.5	95.5	66.5	81.2
Per fertilized area	123.6	92.1	112.3	118.4	114.7
Application rate Improved seed (kg)					
Per total area	33.9	8.1	112.2	13.1	24.3
Per area under seed	164.6	156.2	168.1	152.9	61.6
% of samples using					
Fertilizer	95.9	75.0	97.3	75.8	88.0
Improved seeds	41.8	9.1	42.1	18.1	31.0
chemicals	82.7	59.1	93.4	53.9	73.9

SOURCE: Calculated from Household Survey, 2000.

The use and amount of agricultural inputs directly related to land holding, experience of the farmers to extension services, oxen holding and other household resource endowments. Thus, since most of the farmers in the highlands are more favored due to natural conditions the benefit generated from the use of these inputs is higher than in the lowlands. High fertilizer and improved seed use is observed among the participants of the package program than non-users. In 1999/2000 of the total fertilizer and improved seeds distributed to these households the package program participants used most of them. They are also used almost all on wheat crops and insignificant amount on pulses, maize, *teff* and barley. Thus the opportunity of the non-participants to apply adequate fertilizer and improved seeds as well as on the crops that have important role in the household food security is low.

The impact of fertilizer and improved seeds on yield is, undoubtedly, high. In 1999/2000 the average yield of major crops for which fertilizer is mainly used ranges between 1562 to 3480 kilograms (wheat, *teff* and pulses). This is true for all highlands, with slight positive change during favorable seasons.

Yields are significantly high in areas where the package program is widely adopted. Even though, the purpose of this study is not to evaluate the differential yields of crops under conventional and new extension system, sample observations from the survey data show that there are significant yield differences between the adopters and non-adopters. Wheat is the dominant crop for which almost over sixty eight per cent of fertilizer and ninety four per cent of improved seeds are applied on the highland sample *kebeles*. This has favored the growth in yield of wheat over other crops.

CHAPTER SIX
THE ECONOMETRIC ANALYSIS OF THE IMPACT OF SELECTED VARIABLES ON HOUSEHOLD FOOD SECURITY

To analyze the impact of various socio-economic variables in general and that of modern agricultural inputs (commercial fertilizer, improved seeds and chemicals) in particular on the household food security is the purpose of this chapter. The multiple linear regression model is selected as the best instrument for measuring the impact of the variables on household food security. The variables that are selected, as discussed in the previous sections, are land holding, livestock holding, amount of commercial fertilizer, improved crop seeds and chemicals used by sample households, oxen holding, family size, ecology (for impact of rainfall), family labor and household farm and non farm income.

On the second level of analysis special emphasis was given to biochemical agricultural technologies (modern agricultural inputs) to test the contribution of these inputs to household food security.

6.1. Description of the Model

There is no established agreement on the choice of a model that best describe the relationships between socio-economic variables. Otis Duncan (1975:151) for example argued that " your models can be no better than your ideas, there is no formula for doing science. If such a formula were paradoxically to be discovered, we would program it for a computer and have done with the tedious business of thinking for ourselves. Whether it is really any good must be determined on substantive grounds with the guidance of the best theory available (Duncan, 1976 as quoted by Tacq, 1997:115-127).

Duncan and other methodologists appear to be very conscious of the well-known distinction made in the philosophy of science between the " context of discovery" and "the context of justification". Causal analysis does not give us rules for the discovery of causal hypothesis, but it helps to justify postulated causal hypotheseses. Sewell wright (1921) had already considered his path analysis in this manner, viz., as a method of analysis which combines the knowledge which we possess with respect to causal relations, with the knowledge of the magnitude of the relations which is provided by the correlation coefficients (Tacq, 1997:115-127)

In this study the multiple regression models have been chosen to establish the relationship between household access to resources and household food security. Conventionally, linear regression analysis has been widely used in most economic and social investigations. This is due to the fact that it has some desirable properties for specific types of inquiry and data. It is easy to interpret and there is wide spread belief that it is a reasonable procedure even if some of the assumptions underlying it are not met in the data (Aldrich and Nelson, 1984 as quoted by Getachew, 1995). However, while estimates derived from linear regression analysis may be robust in the face of errors in some assumptions, other assumptions are crucial, and their failure will lead to quite unreasonable estimates (Getachew, 1995).

In this analysis, irrespective of the weaknesses inherent in it multiple linear regression model is chosen, because the nature of food security and its determinants has a linear and direct relationships as tested by various econometric and statistical tools.

The model is expressed as follows

$$Y= \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \ldots + \beta_k X_k + \varepsilon$$

Where α is constant (the value of Y when X is zero);

$\beta_1, \beta_2, \beta_3, \ldots \beta_k$ are coefficients or slopes of the independent variables that explain the impact of that specific variables on the explained variable;

$X_1, X_2, X_3 \ldots X_k$ are the independent variables that explain/predict the value of the dependent variable (Y)

Y = the dependent variable to be estimated

6.2. Analysis of the Impact of Modern Agricultural Inputs

Agricultural inputs especially fertilizer, improved seeds and chemicals have been considered as the deriving force for the development of the crop sector in Ethiopia for the last three to four decades. More emphasis has, however, been given since the inception of SASAKAWA GLOBAL 2000 and then after the adoption of the participatory package program. The aim as it has been indicated in the strategy documents of the government is to boost agricultural production in the short-term throughout the country irrespective of the ecological setting, socio-economic condition of the target group, research outputs and potentialities, especially during the first year of the program.

Yet the program advantage has proved to be positive in the highlands where the rainfall pattern seems conducive for crop production and response to fertilizer is positive. Though the program continues to expand in scope from time to time its contribution in alleviating the problems induced by drought, famine and food insecurity condition in the country is low.

This chapter tries to deal with the contribution of the agricultural inputs currently in use on household food security. For the analysis two dependent variables are taken into consideration. The first one is the self-sufficiency period described as the period in which a particular farm household can feed itself from what it produced in particular cropping season. The value of this dependant variable depends on the perception and responses of the farmers themselves. The second approach is food availability at household level as calculated from gross farm production, crop purchase and sale at household level, post harvest losses, seeds and other uses. This will give the net available crop for consumption at household level.

The multiple linear regression is used as specified in the following section.

I. Scenario I: Household Perception (Food Self-sufficiency Period)

The model is explained as follows:

$$MOFSS = \alpha + \beta_1 FRT + \beta_2 IMSD + \beta_3 CHEM + \varepsilon$$

Where α is constant term which explains the value of MOFSS when other explanatory variables remain to be zero;

β_1, β_2, β_3 are coefficients (incremental coefficients) of fertilizer, improved seeds and chemical use marginal contribution);

FRT = Amount of fertilizer used at farm level in quintals;

IMSD = Amount of Improved seeds used at farm level in quintals;

CHEM = Amount of chemicals used by sample households in liter;

MOFSS = self-sufficiency period (in months);

ε = error term

Depending on this econometric model it has been found out that the impact of fertilizer, improved seeds and chemicals on household food security explained only 21.1 per cent of the overall variations in household food security and the rest 79.9 per cent by other variables. The resulting equation is as follows:

$$MOFSS = 6.873 + 1.393FRT - 0.064IMSD + 0.383CHEM$$

The result shows that if the farm households do not use improved farm inputs the months of food self-sufficiency will be 6.873. On the other hand, one quintal increases in fertilizer use increases the food self-sufficiency period by 1.4 months at a household level. The partial and part correlation of this variable to MOFSS, as a share of contributions of the three inputs show that fertilizer has a contribution of about 16.7 per cent and significant at 95% confidence level (T-Ratio 5.27). Thus from this result one can conclude that fertilizer has a significant contribution in improving household food security, though this impact differs from ecology to ecology where in the lowlands its contribution is insignificant. On the highlands, however, since the response of fertilizer is high its impact is greater than the average for both areas.

Table 28: Values of the Multiple Regression Analysis of the Effect of Agricultural Inputs on MOFSS

Variables	β	β^*	Partial correlation	Part Correlation	Zero-order Correlation	T-Ratio
constant	6.873					14.748
FRT(β_1)	1.393	0.463	0.409	0.394	0.475	5.270
IMSD(β_2)	-0.064	-0.022	-0.022	-0.019	0.201	-0.256
CHEM(β_3)	0.383	0.052	-0.053	0.046	0.234	0.618
R^2						0.227
R^2 $\bar{}$(bar)						0.211
F-Value						13.541
SD						2.8686

SOURCE: Calculated from Household Field Survey, 2000.

Improved seeds have negative relationship with household food security. The result shows that increased use of improved seeds by one quintal will result in the decline of food self-sufficiency by 0.06 months. The T-Ratio also shows that the variable, besides its negative relationship with MOFSS, is not statistically significant at ninety five per cent confidence level. Thus improved seeds, as determinant factor for food security does not hold true both on the highlands and lowlands.

Chemicals, on the other hand, though they are positively correlated to MOFSS the contribution to improved food security are insignificant (T-Ratio 0.618). A one liter increases in the use of chemicals can only increase food self-sufficiency period by 0.383 month, other factors held constant.

In general the contribution of the improved seeds and chemicals to household food security is insignificant, as the amount of the inputs used in the crop sector is very small to show significant impact both on production and productivity. Only fertilizer has significant contribution owing to the long experience the households have to the use of these inputs, the large proportion of the households using the inputs, high application per hectare and the positive response the crop has to commercial fertilizer. Thus the larger the use of commercial fertilizer per household or per hectare the longer the food self-sufficiency period. By implication and from the results of descriptive analysis of the utilization of these inputs, though the calorie consumption at household level on the highlands of the sample areas is well above the national and regional averages, there are still significant number of households (above twenty three per cent) who cannot fulfill their bare daily calorie requirement.

The policy implication of the result of this study (as related to agricultural biochemical technology use and food security at micro level) is that no single strategy can improve food security and the use of modern agricultural inputs can serve the purpose only in combination with other household level socio-economic variables due to wide variation in income distribution, susceptibility of the production system to natural phenomenon and resource endowment of a particular household. Thus the policy dimension regarding this issue is that food security is complex and varies depending on the natural, soico-economic, socio-cultural, resource endowments of the particular community, in which all in one way or another, determine the ability of the household to have access and entitlement to food. The modern agricultural inputs are sufficiently used by those households who can afford to buy and live in favorable production environment. As far as income gap and differences in ecological setting and resource endowments between households exist, one could not expect much out of the modern agricultural inputs as a single contributory factor to improved household food security.

Thus the hypothesis of this research is proved to be true as the contribution of improved seeds and chemicals to household level food security is insignificantly low irrespective of the experience of the households have to these inputs and the policy environment in which they have passed. Only commercial fertilizers have significant impact on household food security, which also vary along varying agro-ecologies. Thus this will show that there are other factors beyond these inputs which determine the food security status. These variables may contribute to over seventy eight per cent of the variation or differences in the level of household food security than agricultural input (21.1%).

6.3. Analysis of the Impact of Multiple Variables

Household food security is a function of many variables and determined by the potentialities and constraints prevailing at household level. Due to variation in access to socio-economic resources, inequalities in income distribution and access to food among households, food security condition can vary from place to place and from individual to individual.

Most of the literatures on household food security clearly put that food security/insecurity at household level is determined by land holding, household labor and family size; opportunities to off-farm income and employment, oxen and livestock holding; access to credit and agricultural inputs; general policy environment as well as rainfall (environmental factors).

In this analysis eleven selected independent variables (as determinants of household food security) are selected. These are ecology (as proxy to rainfall reliability); Agricultural inputs (fertilizer, improved seeds, chemicals); land holding; total production at household level for major crops; family size and labor force. The econometric multiple regression analysis has shown that, in general, these variables explain about 35.6 per cent of the overall variations in household food security in the study areas with distinct variations in ecological setting.

The result of the regression is as follows:

MOFSS = 7.747 + 0.646FRT + -0.105IMSD + 0.143CHEM + 0.333NOX + 0.007PROD - 0.050LANHLD + 0.111LBFRCE - 0.352FAMSIZ -0.003ECO + 0.004LIVSTLU + 0.0004OFFARMIN + 2.6074

According to this result the contribution of fertilizer, number of farm oxen, use of chemicals, labor force, livestock ownership is positively related to household food self-sufficiency. Among these variables, however, only fertilizer, production, family size and slightly oxen holding are statistically significant.

On the other hand, family size, land holding, improved seeds and ecology is negatively related to household food security. The implication is that as family size increases, the self-sufficiency period at household level decreases and vise versa. That is family size has a negative contribution to household food security, and the larger the family sizes the less the household can be food secure; and the less contribution it has to increased farm productivity (Table 30).

This implies that there are limited resources to support and improve the productivity of large family size in a particular sample household.

Table 30: Results of the Multiple Regression Analysis of the Impact of Various Variables on Household Food Security (MOFSS)

Variable	β	β*	Partial correlation	Part Correlation	Zero-order Correlation	T-Ratio
Constant	7.747	-	-	-	-	5.955
FRT(β_1)	0.646	0.215	0.182	0.144	0.475	2.113
IMSD(β_2)	-0.105	-0.036	-0.040	-0.031	0.201	-0.454
CHEM(β_3)	0.143	0.019	0.021	0.017	0.234	0.243
LANHOLD(β_4)	-0.050	-0.070	-0.063	-0.049	0.271	0.722
LIVSTK(β_5)	0.004	0.027	0.028	0.022	0.193	0.318
NOX(β_6)	0.333	0.112	0.114	0.089	0.324	1.305
TPROD(β_7)	0.007	0.439	0.349	0.289	0.566	4.248
FAMSIZ(β_8)	-0.352	-0.274	-0.204	-0.161	-0.079	-2.372
LABFRCE(β_9)	0.111	0.050	0.052	0.041	0.043	0.596
ECO(β_{10})	-0.003	-0.066	-0.001	0.000	-0.227	-0.006
OFFRMIN(β_{11})	0.0004	0.040	0.050	0.039	0.100	0.574
R^2						0.399
$\bar{R}^2$						0.348
D-Watson						1.567
F-Statistics						7.837
SD						2.6074

SOURCE: Calculated from Household Survey, 2000.

The same holds true for ecology as determined by the rainfall variability. In the lowlands (where rainfall is unreliable) food insecurity prevails it expresses the variation in food security inversely by about one per cent. However, it is statistically insignificant to show the exact impact. This is because ecology is by itself cannot describe the amount, distribution, pattern and duration of rainfall that plays a determinant role in agricultural production

Land holding has also weak correlation to household food security and the result shows that there is no significant difference between households with larger plot size and those who have not.

The food availability scenario, on the other hand, show that the above indicated eleven variables explain eighty one per cent of the variations in household level food availability. As indicated above, here also chemicals, improved seeds, livestock holding and ecology have negative relationships with food availability. On the other hand, fertilizer, production, labor force and land holding have positive contribution to food security. Except for production, and improved seeds, the rest variables taken into consideration are not statistically significant at 95 per cent confidence level (Table 31). Among eleven variables taken into consideration the level of production has a significant contribution to household food security than other variables. The impact of fertilizer, though positive it is insignificant as explained by β^* coefficient (5.2%). Family size, oxen holding, labor force and farmland holding together contribute to 15.7 per cent.

Table 31: Result of Multiple Regression Analysis on the Relationships between Food Availability and Different Variables

Variable	β	β*	Partial correlation	Part Correlation	Zero-order Correlation	T-Ratio
Constant	1.278	-	-	-	-	0.444
FRT(β_1)	0.633	0.052	0.082	0.035	0.584	0.936
IMSD(β_2)	-1.656	-0.138	-0.273	-0.120	0.233	-3.240
CHEM(β_3)	-1.512	-0.050	-0.101	-0.043	0.277	-1.161
NOX(β_4)	0.109	0.009	0.017	0.007	0.394	0.193
LIVSTCK(β_5)	-0.121	-0.021	-0.041	-0.017	0.303	-0.469
TPROD(β_6)	0.543	0.887	0.811	0.584	0.891	15.823
LANHOLD(β_7)	0.076	0.026	0.044	0.018	0.460	0.498
LABFORCE(β_8)	0.167	0.025	0.036	0.015	0.314	0.406
FAMSIZ(β_9)	0.509	0.097	0.135	0.057	0.238	1.553
ECO(β_{10})	-0.896	-0.038	-0.070	-0.030	-0.267	-0.804
OFFRMIN(β_{11})	-0.0003	-0.012	-0.027	-0.011	0.102	-0.306
R^2						0.823
$\bar{R}^2$						0.808
SD						5.7655
D-Watson						2.012
F-Statistics						54.949

SOURCE: Calculated from Household Survey, 2000.

In general the results of the analysis of the eleven variables taken into consideration show that

1. the contribution of the variables are significantly high than in the first scenario (the agricultural inputs case only);

2. Agricultural inputs, here play significant role, except for improved seeds, which imply that they can contribute to the household food security only in case where they are supplemented with other inputs (oxen, land, and labor). Households who have sufficient oxen, labor as well as large plots of land have an opportunity to use high amount of inputs

than the resource poor farmers. As the farmer endowed with these resources, therefore the better opportunity to produce more and hence the more stable and reliable household food security level.

3. The overall impact of the eleven variables in contributing/explaining the variability of food security between households is stronger than the case of agricultural inputs only or eighty one per cent of the variations are explained by these variables. Though these figures show significant contribution in explaining variation in household food security still there are many variables to be taken into consideration in the formulation of food security strategies (as nineteen per cent are explained by others which were not included in this calculation). The contribution of environmental degradation, decline in soil fertility, shortage of efficient rural credit system geared towards other productive activities, shortage of off-farm employment opportunities particularly for those household members who have no access to land or other resources, weakly developed health, education and potable water supply infrastructures as well as environmental sanitation and nutrition interventions can be other major contributory factors that will explain the overall food security system in the sample areas.

CHAPTER SEVEN
CONCLUSION AND RECOMMENDATIONS

The Ethiopian agriculture which is characterized by its low output, backward technology and traditional form of subsistence production system, cannot feed the growing population let alone to generate significant capital for the development of the manufacturing and service sector. Yet the sector continue to generate most of the employment opportunities, foreign exchange and raw materials for the growing manufacturing industries. This contribution or the greater role it plays in the economic development can explain the overall low level of economic development of the country in general.

The agricultural strategies that have been pursued for more than three decades aimed at boosting the agricultural production and to reap the maximum benefit from the sector, in one way or another. The Ethiopian agricultural sector problems have many dimensions and complex attributed to constraints ranging from economic, social, political and natural forces.

In the 1960s, the feudal land tenure system, the emphasis commercial farming, infrastructure, urbanization and negligence of the smallholder agriculture were one of the major causes for declining agricultural production and worsening food security condition in Ethiopia.

After the 1974, though many of the rural institutional policies were improved and the sector has got priority, the macro economic policy adopted, particularly the command economy that emphasized the cooperative production system, the forced grain marketing and the villagization of the majority of the rural community have been the major disincentives for the agricultural sector. Added to these the weak infrastructure system, war and civil strikes in the country have worsened the life in the rural areas. The result of these policies was the strikingly high proportion of population below the poverty line, repeated drought and crop failures, dwindling food security system and the overall decline of the performance of the macro economy.

After 1991 the country has gone through radical economic and social changes mainly aimed at improving the rural life in recognition that the agricultural sector is the most dependable source of capital to rely on for the development of the Ethiopian economy. Beyond the macro economic policies that have been taken into effect the agricultural sector has got top priority especially in the front of expanding production-boosting technologies. One of the main differences of this strategy from those adopted since the 1960s is that the intensive use of bio-chemical agricultural technology through intensive extension advisory services.

Most of these strategies, which were based on the use of agricultural inputs, as has been experienced for long period, without significant impact on the development of the sector were doomed to failure. There has not been recorded significant impact on the livelihood of the majority of the rural population nor in urban areas. The poverty situation, famine, chronic and transitory food insecurity prevail throughout the past four decades. There are many reasons for the failure of the agricultural sector in general and the insignificant impact of the adopted technologies in particular. First, the technologies, though scale neutral, they are imported and in the country where foreign exchange is critically low expansive adoption of these technologies is impossible at least from the short to medium term; secondly, the technologies supplied for use to the peasant sector are costly and cannot be afforded by the majority of the poor farming community; thirdly; infrastructure and other rural institutions were not well developed to facilitate the wide adoption of these inputs, particularly, rural credit, land tenure, and community organizations; fourthly, the agricultural sector more or less totally depend on the distribution and pattern of rainfall. And as a result the incremental yield that could have been generated from increased use of inputs depend on the distribution of rainfall prevailing in particular cropping season; fifth the research capacity of the country is at its infant and lowest stage and thus there is little chance for the sector to develop from internal resources and potentialities; sixth the marketing, pricing and distribution network of the agricultural inputs and outputs were not developed to induce significant incentive on farming community.

With out tackling these inherent constraints to agricultural development and technology adoption there will be little room to improve agricultural production. The current agricultural strategy, though have significant impact in areas with suitable natural environments, but little contribution to improved food security system at micro level, is also formulated without adequate consideration to these inherent problems. In areas with suitable production conditions the program impact is significantly better in boosting crop productivity. Despite major changes in policy orientation and extension strategies in the country food insecurity, famine and drought still remain to be repeated phenomena in the country.

The objective of this research is, as indicated in chapter one of the paper, to find out whether these agricultural inputs have any significant contribution to household food security or not.

Based on this hypothesis the findings of the research clearly depicted that agricultural inputs have little contribution to household food security except in the highlands where there is more or less reliable rainfall. Among the inputs only fertilizer has significant impact on household food security whereas improved seeds and chemicals have negative or insignificant correlation to household food security. The contribution of three major inputs taken into consideration has a share of only thirty three per cent of the variation in household food security.

Thus beyond these variables household food security is determined by other numerous endogenous and exogenous variables such as land holding and tenure, livestock holding, better policy environment, availability of off-farm jobs and labor mobility, family size, ecology in which a household dwells in, use of modern agricultural inputs, accessibility to infrastructure, credit and institutions and other socio-economic factors. The analysis made to justify the contribution of these variables to household food security, taking family size, land holding, volume of agricultural inputs used, farm size, labor, oxen holding and livestock holding, total volume of production obtained, ecology as explanatory variables to self-sufficiency period (the number of months from which a household can feed itself from what it produced) also shows that the cumulative impact of these variables on self-sufficiency in food is 39.9 per cent, which is significantly higher than in the case of agricultural inputs.

In general the conclusion of this research is that:

1. food security is complex and multidimensional and a single strategy cannot solve the problem; and the strategy formulated for food self-sufficiency have little significant impact on household food security;

2. the use of biochemical agricultural inputs (fertilizer, improved seeds and chemicals) can boost agricultural productivity, but not improve the food security status in almost all cases. The impact they have on food security is below thirty per cent. Their impact also varies between households depending on the nature of the ecology, resource endowment of the target group, and the farming system. For some of the inputs especially for improved seeds and chemicals, their effect is negative to self-sufficiency period and food availability. Its

implication is that these inputs must be supplemented with other necessary conditions especially with adequate fertilizer, moisture, and crop protection technologies, despite improving their genetic capacity to give the maximum output than the local ones;

3. the extension experience a particular farm household has (particularly in use of agricultural inputs) has little effect on improvement in food security, but has significant contribution to the volume of the inputs used, volume of production obtained and to some extent on income.

4. the use of agricultural inputs is the highest for households who own adequate farmland, farm income, oxen and other resources. By implication, household food security status is better for these groups than others. Thus whether the use of agricultural inputs are determinant for food security or not depend on the income and wealth status of the particular household in consideration;

5. the last four decades strategy of food self-sufficiency through use of agricultural inputs are also a failure, particularly with improving household food security rather has significant effect on food self sufficiency;

6. food security/insecurity is a matter of having access to resources to purchase or produce the required amount of food necessary to subsist the household. Thus increasing the purchasing capacity or production capacity through appropriate policies is more important than the blanket recommendation of use of agricultural inputs;

7. it seems that from evidence of this study that the impact of bio-chemical agricultural technologies on household food security is not satisfactory due to the nature of the food security system at a micro level. Despite relatively better agricultural extension system, the long experience of the sample areas to different rural development programs, and in some better natural production environment; the resultant effect of the agricultural inputs is low. However, the role agricultural inputs play in improving self-sufficiency and productivity is so high that these areas are the most productive areas in the country. Both land and labor productivity is high. Inequalities in income distribution, land holding and tenure, inequalities in household resource endowment, dependence of the agricultural sector on distribution of

rainfall and its negative impacts in the moisture stress area, distribution of social and economic infrastructures are main causes in the variation of household level food insecurity.

The regression analysis carried out to prove that agricultural inputs alone cannot contribute much to household food security justify the same positively. Among the households who use these inputs, irrespective of experience, family size, amount of inputs used, etc, above 35.9 per cent of them cannot fulfill the standard calorie requirement (sixty four per cent in the lowlands) from major crops produced by the sample households.

At the same time the coefficient of the regression analysis made just by taking the three most important inputs shows that their contribution to household food security (self-sufficiency) explains only 21.1 per cent of the variations among the households. Again taking additional variables into consideration this effect raises to 35.6 per cent, which is better than the only input scenario. Own calculation based on the total production, purchases, sales, post harvest losses and requirement for seed, again show, however, better effect of both agricultural inputs and other multiple variables. According to this calculation the contribution of inputs will rise to thirty-three and that of the multiple variables to eighty one percent. In both cases the agricultural input variables taken into consideration are limited and cannot fully explain the variation and extent of food security among households. This shows that the strategies and policies related to improve household food security at household level should aim at numerous and multidimensional socio-economic, institutional, political, socio-cultural and natural phenomena of the particular locality and community than a single policy measures.
Thus since food security is different from food self-sufficiency by its nature, the strategy that could be formulated should incorporate various socio-economic variables beyond biochemical agricultural technologies. Therefore, the following recommendations are in order to improve the response of inputs and food security at household level.

1. rainfall is the major constraint to agricultural production. In Ethiopia almost all crop production is carried out under rainfed production system. Fluctuation of rain is serious and its frequency of failure is increasing from time to time. The pattern and distribution of rainfall also affect the performance and response of agricultural inputs. Bio-chemical agricultural technologies are non-responsive in moisture stress areas and most of the extension programs implemented in these areas were found to be a failure. Hence, the development of traditional and modern small scale irrigation schemes is important for, in

one hand to increase cropping intensity and labor productivity, and on the other, create off-farm jobs and employment and alleviate the constraints to crop production resulted from frequent failure of rainfall.

2. Cultural practices such as mulching, manuring, crop rotation and intensive cultivation of garden crops are alternative means to improve food security of resource poor farmers who have insufficient capacity to purchase these inputs. The extension system should also focus on these areas.
3. Currently government credit schemes are almost focus on the purchase of inputs. Most of resource poor farmers can not afford to pay either down payment or to purchase inputs. In addition the time for settling credits for inputs overlap with the time when the agricultural produce prices are low. In order to improve the use of inputs and household food security rural credits that target the poor farmers should be taken into consideration. The credit scheme should involve credits for oxen purchase, creation of off-farm jobs (petty trading, handicrafts, etc).
4. Women have significant role both in agricultural production and household food security. But due to variations in access to resources their contribution to production is low and as a result they are the most food insecure part of the population. Women consume most of their time and labor on household activities (chores). Rural credit targeted to improve the income of women (petty trading, dairying, fattening, handicrafts, etc) and dissemination of labor saving appropriate technologies, gardening, training in food and nutrition can improve the food security status of the households.
5. Studies made on the response of fertilizer shows that fertilizers can give the highest responses to yields when combined with improved crop varieties. Fertilizers not only increase yield of crops but also facilitate the growth of weeds and pests. Currently due to serious shortages of improved seeds most of the fertilizer distributed to farmers is used without improved seeds. The opportunity lost due to insufficient supply of seeds and benefits that could otherwise obtained from fertilizer application is high. Therefore, strengthening improved seeds multiplication sites (both government and private) as well as introduction of contractual seed multiplication practices on farmer's fields will improve the supply and use of the package inputs.
6. Most of the research outputs and strategies, beyond their weak performance, are highland oriented. Most of the seeds available and technologies developed by the existing centers are suitable for highlands where rainfall is adequate and other production systems are more

or less favorable. For the lowlands where food shortages are acute and moisture stress is determinant factor to agricultural production, technologies are either none existent, few or poorly developed to suit farmers' circumstances. To improve the development and supply of appropriate production technologies require investment to strengthen the existing research centers, opening up new centers, manpower training and other research facilities. In addition, applied research is needed that develop and use existing knowledge, resources and practices that best suit to farmers circumstances, particularly that of resource poor farmers.

7. Due to high population pressure most of the existing land is cultivated due to high population growth rates and consequently increasing food demand. Grazing land is declining from time to time. The possibility of extensive livestock production is almost exhausted both on the highlands and lowlands. In these areas intensive small-scale dairying and fattening schemes are the most suitable household venture to increase their cash income, supply of food and productivity.
8. Environmental degradation particularly deforestation, soil degradation, overgrazing and drought are major causes for declining agricultural productivity. Highlands are major areas of severe degradation processes due to intensive traditional cultivation practices, scattered plots, high population pressure, over grazing and deforestation. In the lowlands degradation is the combined effect of rainfall shortage and variability, other social and economic variables. Environmental conservation, on one hand, has an important contribution to increased production and food security through increasing land and labor productivity as well as improved cash income through generating off-farm employment opportunities. These may include catchment development, agro-forestry, soil conservation and afforestation on individual and communal plots.
9. Strengthening rural institutions such as cooperatives who deliver marketing of inputs and output, saving and credit services, have also important contribution in improving agricultural production and food security at household level.
10. As experiences in many developing countries show NGOs play an important role in household food security and working with the poorest part of the population who are the most food insecure living in difficult socio-economic environment. NGOs with their long experiences, capacities, readily available funds as well as targeting the most basic problems of the poor can play a leading role than most of other institutions working on the issues of poverty alleviation and food security. NGOs has a role beyond development activities in

providing targeted credits to the poor, development of entreprenuership, community empowerment and targeting the most needy part of the population. A coordinated effort of these NGOs are the most important to alleviate food insecurity and poverty situation of the resource poor rural households.

11. Weak social and economic infrastructures are other causes for household food insecurity. Poorly developed rural roads, health and education infrastructures, water supply and sanitation have direct impact on the level of production, income, food security, development level and well-being of a particular locality and community. In food security interventions social and economic infrastructures should, therefore, be important components.

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ANNEX I.

HOUSEHOLD FOOD SECURITY SURVEY QUESTIONNAIRE

(Summarized)

LOCATION NAME OF THE KEBELE____ WEREDA_____ ZONE____
REGION____

PART ONE: HOUSEHOLD CHARACTERISTICS

1. Name of the family household head
2. List of family members
3. Sex of each of the family members
4. Age of the family members (for each)
5. Relation of each of the family members to household head
6. Religion (for each)
7. Ethnicity
8. Level of education of each of the family members

PART TWO: AGRICULTURE

1. Agro-ecological Zones of Sample kebeles a. Dega b. Woina Dega 3. Kolla
2. Dominant forms of soils_____________
3. Status of soil fertility a. Highly fertile b. medium c.poor
4. causes for poor soil fertility a. Nature of the soil b. over cultivation c. erosion d. lack of fertilizer e. others (specify)
5. Sufficiency of rainfall of the area for crop production
    a. Excess b. sufficient c. medium d. insufficient e. low
6. Pattern of rainfall in the area. a. decreasing b. Increasing c. No difference
7. Is there any recorded crop failure in the area due to shortage of rainfall? a. Yes b. No
8. If yes indicate the years________
9. Total size of landholding of the household_____ *timad*
10. Land use types of the holding
    a. cropped land ____ b. grazing land_____
    c. fallow land _____ d.Garden area____ e. others____

11. Proportion of land allotted to perennials and annual crops perennial crops_______

Annual crops_______

12. Is the current land holding enough to support your family? a. Yes b. No

13. If no to No. 12 Reasons A. large family size b. poor soil fertility c. small holding size

d. unreliable rainfall e. others (specify)

14. For how many years have you cultivated the same plot ---- years

15. From where did you own this land?

a. parents b. government c. renting d. sharecropping e. borrowing f. others (specify)

16. Have you access to other forms of land tenure? A. Yes b. No

17. If yes, indicate the size of the land?

a. Renting _______*timad*

b. Borrowing ________*timad*

c. Share cropping ________*timad*

d. Others (specify)_______*timad*

18. What type of crops are you usually producing? ________________

19. Why do you produce these crops? Reasons ____________________

20. Have you ever changed your cropping pattern since the last ten years? A. Yes B. No

21. If yes to Question No. 20 State your reasons ___________________

22. Indicate the type of crops produced, land allotted to each crops and the volume of production obtained in 1998/99 and 1999/2000 cropping seasons (area in timad; production in Qts)

Type of crop	1998/99		1999/2000	
	Area	Production	Area	Production

23. Is what you produce annually a. increasing b. decreasing c. have no change

24. If increasing (quest. No. 23) Reasons ____________________________

25. If decreasing (quest. No. 23) Reasons ____________________

26. Do you practice fallowing? A. Yes b. No

27. If Yes, length of fallow period_____ years; Area under fallow_______ *timad*

28. If not, reasons ____________________

29. Have you sold crops from what you produced last year? a. Yes b. No

30. If yes, state the type, and amount and value of crops sold (value in birr; amount in kg)

Type of crop	Amount sold	Value

31. Reasons for selling these crops___________________________

32. Have you purchases crops from the market? A. Yes b. No

33. If yes, indicate the type, amount and value of crops purchased

Type of crops	Amount	Value
.		

34. Indicate the type , number and value of livestock you owned, sold and purchased (1999)

		Sold		Purchased	
Type of animal	owned	No.	Value	No.	Value

35. Main problems of livestock production in the area

Problem	a. very serious b. serious c. less serious d. not a problem	Remark

36. Are you well acquainted with extension services? A. Yes b. No

37. If yes since when?____________________

38. Are you a regular user of extension services? A. Yes b. No

39. What type of new technologies or ideas you have adopted since then?

40. Do you use these technologies on regular basis? A. Yes b. No

41. If no reason out for not regularly using it______________

42. How do you find extension services in general? A. Good b. bad c. indifferent

43. Are you a participant of the current extension package program? A. yes b. no

44. If Yes, since when? _______

45. What type of crops have you cultivated using the program's package? ____________

46. Indicate the type, area and volume of production you obtained (particular to the program) in 1998/99 and 1999/200?

Type of crop	1998/99		1999/2000	
	Area	Production	Area	Production

47. If you are not participant of the program, why? Reasons________________________

48. What are the major disadvantages of this program? ___________________________

49. Do you use commercial fertilizers, improved seeds and chemicals?

Fertilizer a. Yes b. No

Improved seeds a. Yes b. No

Chemicals a. Yes b. No

50. If yes for how long have you used them?

Commercial fertilizers, since _________

Improved seeds, since _________

Chemicals, since _________

51. Indicate the type of crop, amount of fertilizer on which you used fertilizer in 1998/99 and 19999/2000 cropping season

Type of crop	1998/99		1999/2000	
	Area (timad)	Amount (kg)	Area (timad)	Amount (kg)

52. Indicate the type of crop, amount of improved seeds on which you used fertilizer in 1998/99 and 19999/2000 cropping season

Type of crop	1998/99		1999/2000	
	Area (timad)	Amount (kg)	Area (timad)	Amount (kg)

53. Are you a regular user of the following inputs?

a. Commercial fertilizer 1. Yes 2. No

b. Improved seeds 1. Yes 2. No

c. Chemicals 1. Yes 2. No

54. If You are not a regular user state the reasons for not using them

Commercial fertilizers____________

Improved seeds ____________

Chemicals ___________

55. From where did you usually purchase these inputs (sources) ______________________

56. Are they available at regular time and amount (answer for each separately)?

1. Yes 2. No

57. If no indicate the the problems related to them (for each separately)

__________________________-

58. Do you know the recommended application rate for each of these inputs? 1. Yes 2. No

59. If yes Do you apply the recommended rate then? 1. Yes 2. No

60. If you don't use the recommended rate point out your reasons? ___________________

61. How do you often buy improved seeds?

1. Every year
2. Every other year
3. Every three year
4. After four to five years
5. No fixed time

62. What are the main problems in applying and using improved seeds?

Reasons_____________________

63. Indicate the type and amount of improved seeds that you want to purchase next cropping season

Type of crop/variety	Amount (kg)	Value/ price (birr)

64. Have you farm ox/oxen? 1. Yes 2. No

65. If yes, how many ------------------ (number)

66. If no how do you alleviate your problem of draught power?

a. Ox-sharing 1. Yes 2. No

b. Ox renting 1. Yes 2. No

c. Mechanization 1. Yes 2. No

d. Debo/wonfel 1. Yes 2. No

e. Ox- Borrowing 1. Yes 2. No

f. Others (specify)

67. If you use one of the above, particularly, renting, mechanization indicate the cost or rate per day or per hectare ______________

68. If Borrowing, Ox-sharing, wonfel/debo indicate the terms of agreement____________

PART THREE: FOOD SECURITY

69. What is the type of crop you cultivated and volume of production you obtained in 1998/99 and 1999/2000?

Type of crop	1998/99 (qt)	1999/2000(qt)

70. For how long is enough what you produced for family consumption? _______months

71. Is what you have produced enough to support your family? 1. Yes 2. No

72. If No how do you fill the food consumption and demand gap?

a. selling small ruminants
b. temporary migration to find jobs
c. selling of cows an oxen
d. help from relatives
e. relief/aid
f. reducing the number of daily meals eaten
g. changing the type of food to be eaten
h. others (specify)

73. What are the critical months in which you encountered serious food shortages?

______months

74. Is the situation of food insecurity persists in these months? 1. Yes 2. No

75. If yes since when? Since _______ (year)

76. What are the reasons for such changes? ______________________________

77. Is there any member of your family who died due to lack of food? 1. Yes 2. No

78. How many meals do you have each day?_______ (number)

79. What are your commonest meals you eat each day? ______________________________

PART FOUR: HOUSEHOLD FARM INCOME

80. Indicate the sources and amount of income you earned from each source in 1998/99

Source of Income	Unit	Amount	Value
1. Crop sales			
2. Animal sales			
3. Land renting			
4. Sale of fuel wood			
5. Charcoal selling			
6. Sale of other forest products			
7. Sales of animal products			
8. Others (specify)			

81. DO you and any member of your family have off-farm jobs?

    1. Head of the family
    2. Other family members

82.. If yes, indicate the type and amount of income earned from off-farm activities

Type of off-farm activity	Income (birr)

82. Are these off-farm jobs regular? 1. Yes 2. No

83. Did you get any help in kind or money from relatives this year? 1. Yes 2. No

84. If yes How many? Birr

PART FIVE: HOUSEHOLD EXPENDITURE

85. Indicate expenditure categories and the amount expended on them last year

Expenditure category	Total expenditure (Birr)
1. Food items	
2. Beverages	
3. Clothing	
4. Education	
5. Health	
6. Farm inputs	
7. Farm implements	
8. Land and income tax	
9. Social obligations (idir, equb, gifts, etc)	
10. Utensils	
11. Labor cost	
12. Rents (ox, land machinery ,etc)	
13. Fuel	
14. Transport cost	
15. Marketing cost	
16. Purchase of farm oxen	
17. Purchase of breeding animals	
18. Cost of construction (house, shelters, fences, etc)	
19. Other (contributions, etc)	

Name of the Enumerator __________ Signature__________ Date_______

Name of the Supervisor __________ Signature__________ Date_______

ANNEX II

LIST OF RURAL KEBELES IN DODOTA-SIRE WEREDA

1. Alelu Gasala**
2. Amigna dabaso**
3. Amola Xabo
4. Amude
5. Amuxa gasala
6. Awash Bishola
7. Badosa Batale
8. Balale**
9. Borara Chara'o
10. Danqicha Gafarsa Chancho
11. Dilfaqar
12. Dodota Alem
13. Gasala Chacha
14. Gasala Shashe**
15. Ibsata Huduga
16. Koloba Bale
17. Koloba Shameda
18. Lode Banaban
19. Lode Lamafo
20. Lode Sharbe**
21. Magacha
22. Qoro Dagaga
23. Tero Dasta
24. Ufura Agamsa
25. Xadacha Guracha

** *Sample Kebeles*

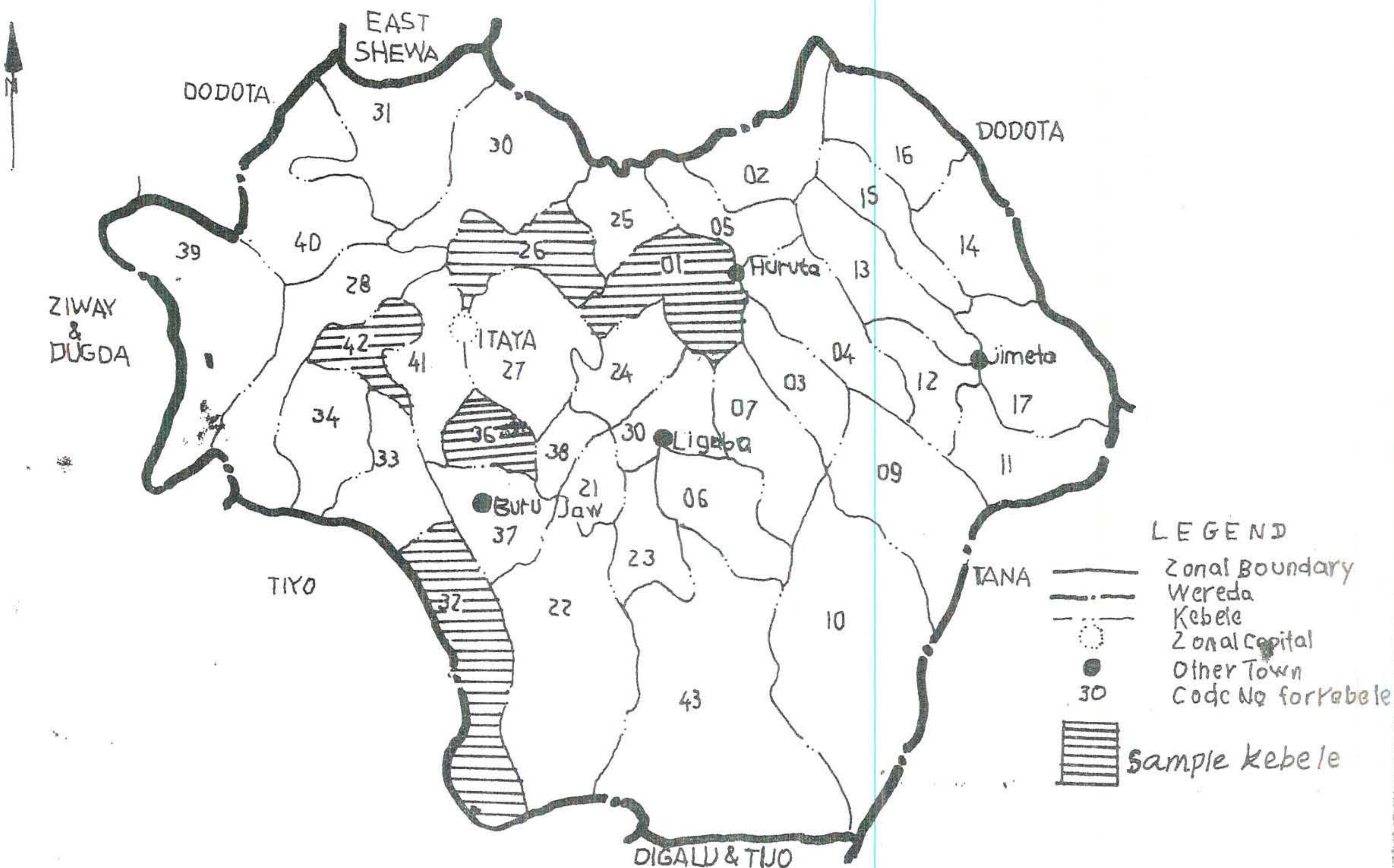
ANNEX III

LIST OF RURAL KEBELES IN HETOSA WEREDA

1. **Adamare****
2. Aleko H/salam
3. Anole Salan
4. Bonaya Iddo
5. Boru Hantuta
6. Boru Lencha
7. **Dabaya Adare****
8. Dabaya Dabaso
9. Fursa Hetosa
10. Gabe
11. Gonde Finchama
12. Gonde Qurchasa
13. Gudelcha
14. Gura harcho
15. Guti Dabula
16. Guticha Dawi
17. Habe Guchi
18. Harbe Adamonye
19. **Haxe Andode****
20. Ifa Lode
21. Jawwi Chilalo
22. Madda Bishani
23. Malka Jabi
24. Moye Danisa
25. **Oda Jila****
26. Qarsa
27. Qilxu Balda
28. Sero Ankato
29. Shaqi Sharara
30. Shaya
31. Sibu Abadir
32. Ticho
33. Tullu Bego
34. Tullu Jabbi
35. Tullu Yanbo
36. **Walargi****
37. Xado Arfan

** ***Sample Kebeles***

THE ADMINISTRATIVE DIVISION OF HETOSA DISTRICT



Source: Arsi Plannig and Economic Development Office