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**EDUCATION, TRAINING AND AGRICULTURAL
TECHNOLOGY ADOPTION IN RESOURCE POOR AREAS
OF NORTH WOLLO: THE CASE OF MEKET WOREDA**

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"A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfilment of the requirements for the Masters of Science Degree in Economics (Human Resource Economics.)"



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*Education, Training and Agricultural Technology Adoption in Resource
Poor Areas of North Wollo: The Case of Meket Woreda*



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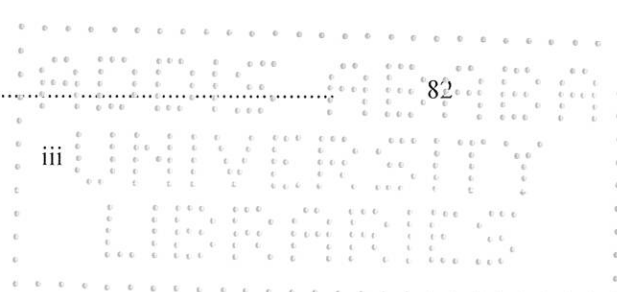
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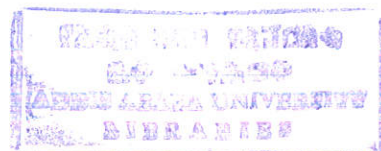
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ABBREVIATIONS

CSTC	Community Skill Training Center
MDP	Meket Development Programme
PA	Peasant Association
PADETES	Participatory Demonstration and Training Extension System
SG-2000	Sasakawa Global 2000
WAO	Woreda Agricultural Office
WEO	Woreda Education Office



ABSTRACT

In spite of its important contribution to the Ethiopian economy at large, the performance of agriculture was disappointing for decades. Cognizant of this fact, Ethiopia is now implementing Agricultural Development-Led Industrialization (ADLI) strategy which concentrates on accelerating growth through disseminating better performing crop and livestock technologies to farm households.

Differences on how quickly producers adopt such technologies can be explained by differences in human capital and differences in knowledge of the new technology. Having this idea in mind, a field survey was conducted in one of the resource poor areas of North Wollo (Meket Woreda) to identify the factors that influence the use of improved crop technologies and ownership of livestock particularly cow and sheep among farmers in the Woreda. This being the general aim of the Study, the chief objective was to see the impact of human capital variables on the adoption of these technologies. To this end, the probit model was fitted on primary cross sectional data collected from 144 farm households. An attempt is also made to see whether or not crop technologies are profitable or not by calculating the so called value cost ratio.

The result obtained from the estimated models showed that the education level of household head, family size, participation in agricultural training programs and farm income significantly affect the adoption of fertilizer and/or improved seeds (Crop technologies). On the other hand,

cow ownership is found to be influenced by total cultivated land, farm income and access to livestock credit. Similarly, sheep ownership is influenced by total cultivated land, age of household head, distance from main road and agro-climatic condition. The calculated value cost ratio indicated that income from barley production can be tripled if farmers apply the recommended rate of fertilizer on a hectare of land sown with local variety of barley. Similarly, wheat production can be doubled if improved seed is mixed with fertilizer.

Policies recommended from the findings of the study include infrastructural development dealing with education, strengthening agricultural training programmes and research activities and provision of livestock credit particularly to resource poor farmers. It is hoped that, such types of government action would improve agricultural production of the country in general and of the study area in particular.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Agriculture is the mainstay of the Ethiopian economy. In the 1960's, agriculture accounted for about 65% of GDP. Recently, it comprised about 48% of employment, 85% of export earning out of which coffee alone accounted for 60%. Agriculture provides raw materials for 70% of the country's large and medium sized agro-industries.

More than 90% of the land under cultivation is operated by smallholders, contributing about 96% of all agricultural output, including 98% of coffee production. The peasant agriculture has always remained (and will continue to do so for sometime to come) the single important source of growth in the country. However, in spite of its important contribution to the economy at large, the performance of agriculture was disappointing for decades.

According to the World Development Report of 1994, the annual growth rate of agriculture in the country was 1.9% between the year 1970 to 1980. The growth rate declined to 1.2% in the years 1980-92. In a similar fashion, the contribution of the sector to GDP was 56% in 1970 but only 48% in 1992.

Household food production was declining because of the failure of the government to fulfill the resource requirements of millions of subsistence farmers whose needs are not satisfied through the mechanism of the market. Poor farmers, lacking financial means and technical support, overexploit the natural resource base, including marginal areas to eke out a living. The degradation of the agricultural resource base particularly the deforestation and soil erosion in the highlands, has reached alarming proportion at present. As a result, the capacity of the country to feed itself has been severely eroded and the food security problem is common to most regions of the country.

Even if drought, political instability and civil wars are frequently mentioned as the major causes for poor performance of agriculture, inappropriate government policies are as much to be blamed for the stagnation and/or decline of agricultural production in Ethiopia. The period from 1974 to 91, for example, was the time of the dictatorial military regime, when the economy was led based on a central planning model with the aim of fostering socialist development. Through central planning, the government guided resources and income distribution by means of a vertically administered hierarchy. The marketing of most agricultural inputs and outputs was tightly controlled by the state. Staple goods were distributed through a mandatory procurement (quota) system linked to the urban rationing system, and rural factor markets were eliminated or strictly controlled. Prices paid to farmers for food crops were kept low to provide cheap food to people in the cities. These actions acted as disincentives to farmers to increase production. Besides, weak extension services have further constrained agricultural production and the proper management and utilization of natural resources.

Recognizing the seriousness of the problem in the country and the necessity of improving agricultural productivity and food security, if general economic growth is to occur, the Federal Democratic Republic of Ethiopia initiated a broad based Agricultural Development-Led Industrialization (ADLI) strategy in the early 1990's. The strategy concentrates on accelerating growth through focusing on the supply of fertilizer, improved seeds and other inputs. Although food production began to improve after 1994, the country is still facing widespread chronic and transitory food insecurity in most areas of the country (Mulat et al,1998).

The use of modern inputs requires that farmers be aware of their existence and know their properties in order to compare the distribution of returns under each technology. The accuracy or quality of a farmer's knowledge depends on his source of information and on his level of education. Gregory D.Wazniak (1987) propose that education enhances the ability to adjust to technological change. When a new technology has uncertain returns and fixed costs of adoption, some individuals will make reallocation decision faster than others. Differences on how quickly producers adopt to a changing set of production possibilities can be explained by differences in human capital and differences in knowledge of the new technology. Education helps to reduce subjective uncertainty and unnecessary anxiety as well as fatalistic acceptance of the status quo and thereby enhances the probability of adoption of new technology or practices by an individual (Netsanet,1998).

The dissemination of recommended agricultural technological innovations to farmers is chiefly carried out by extension agents. The Ministry of Agriculture has Extension Service Department at all levels (National, Regional, Zonal and Woreda level) whose responsibility is

to train and advice farmers on the use of improved technologies and better farming practices. The extension package currently practiced to intensify crop production in Ethiopia, involves innovations of several improved inputs and agronomic practices. Improved practices involving new varieties, seed rate, seed bed preparations, methods of sowing, weed control, fertilizer application, crop rotation, inter cropping, tillage practices, insect pests control and improved farm implements are among the major package components (Samia et al, 1996). The technological package designed to prevent post harvest crop loss also includes construction of modern storage systems and provision of oxen or horse propelled cart. Besides to food crops, technologies are also packed for the so called economically beneficial crops like vegetables, root crops and spices, pulses, oil crops, etc. The package components vary from one crop to another. But once again, one can observe the presence of proper land preparation, weed and pest control, application of fertilizer, crop rotation, the use of improved farm implements and modern storage system.

On the other hand, the livestock package includes fattening of small and big ruminants, distribution of cross heifers and improved poultry breeds, bull service, artificial insemination service, animal health care, forage improvements through planting of nutritious forage seeds, etc. But unlike the crop package, the livestock package has started very recently (only a year life time in the study area) and little has been done to improve the situation in this regard. Of course, this proposition does not neglect the attempt made to sporadically distribute very few improved poultry breeds and sheep prior to the preparation of the livestock extension package. So to speak, intervening in livestock extension particularly in resource poor areas like North Wollo is not a simple task. On the other hand, the livestock sector has significant

contribution to food security of the area under consideration.

Poor farmers often produce traditional crops that scarcely benefit from yield increasing technological innovations. Moreover, there is an acute shortage of grazing land which resulted from high population pressure. The rainfall pattern is erratic in nature and there is little chance of having adequate crop residues to feed animals. To mitigate this problem, weeds are left with the crops until they are fully grown so as to be used as animal feed (Asfaw et al, 1998). This again implies poor productivity of food crops and hence shortage of human food. The problem is further aggravated by poor fertility of the soil that results to low production of crops as well as animal feed. Therefore, the agricultural production situation in resource poor areas like North Wollo is very complicated and it seems reasonable to treat both the crop and livestock sectors jointly so as to take meaningful action to improve the food supply situation in such areas. Appropriate efforts need to be made to generate acceptable production technologies (both crop and livestock) that would help in solving the food shortage problem. The technologies to be chosen should suit the economic and social environment of the society under consideration. This may call for low cost and low risk technologies and preferably technologies that can be reproduced locally.

With regards to livestock production, such low cost and low risk technologies may include fattening of small ruminants, proper feeding of the traditional dairy cows for better milk and meat production and even for better draught power (in some areas of the country), etc. In a similar way, low external input use for crop production, atleast in the short run, may serve as a weapon in the war against poverty.

1.2 Statement of the Research Problem

It has been previously stated that Ethiopian agriculture is dominated by the small scale farmer sub-sector. Moreover, it has been mentioned that the performance of the agricultural sector in the country has been declining for decades due to faulty government policies and other factors.

Among the various reasons explaining a declining performance, low level of use of agricultural research findings particularly by small-scale farmers is cited as a major hindrance to agricultural development. For example, if we look at the history of agricultural technology dissemination over the last two and half decades, the Military (Derg) regime of the country had special interest in promoting cooperative and state farms and hence these farms, concentrated mainly in a relatively resource rich areas of the country, were the major beneficiaries of modern agricultural technologies and practices. However, although, the majority of peasants were aware of the usefulness of improved seeds and fertilizers, most of them did not use either because they were expensive or they were not available (Itana,1985). This being the case for crop technologies, the livestock technology extension has been more weaker than the crop due to various reasons. One reason could be the insufficient number of animal breeding stations. The other possible reasons could be shortage of feed, drugs, credit, technical expertise, etc. which hinder the distribution of improved animal and poultry breeds.

The major development theme of the existing government is to create an industrial society

firmly supported by dynamic agriculture. In agriculture-based economies, food self-sufficiency is a pre-requisite for food security. In order to attain food self-sufficiency, one must keep in mind that agricultural intensification has to be built on the basis of improved soil fertility management, with inorganic fertilizer at the core (organic fertilizers as supplements are important, particularly to build soil structure and organic matter content), crop protection, improved seeds and good husbandry [SG-2000,1996].

However, new technologies are accompanied by risk and uncertainty which potential adopters sometimes found too daunting. Therefore, in view of the food insecurity problem in the country in general and the study area in particular, efforts should be made to help farmers adopt at least the traditional technologies especially referring to the livestock technologies. To this end, a strong and effective extension system is required to bring about the required change in the area. Despite this fact, the effectiveness of extension has been limited in various ways. One of the important limits on what an extension service can do is the knowledge and educational level of the farmers to whom it is addressed. To take an example, if farmers are illiterate, an extension service can make little use of print to provide information to them. Therefore, there seems to be an overlap between the aims of extension and the aims of basic education.

Basic education for adults has, in fact attracted support partly because it was seen as a pre-requisite for development. Ethiopia in the late 1970s, after the revolution, had a campaign to make education available to the needs of the rural poor who made up the mass of the people and launched a program of basic education for adults. Expansion of education to

remote and rural areas is still the policy of the existing government.

Simon (1996) makes distinction between cognitive and non-cognitive effects of schooling on agricultural productivity. Within the former, he distinguished the formation of general skills, such as literacy and numeracy, and the transmission of specific knowledge. Literacy and numeracy enables one to follow written instructions on the use and to calculate correct dosages of modern farm technology. Functional literacy may also change allocative efficiency by altering the selected combination of outputs and inputs.

Education may also have non-cognitive effects, changing people's attitudes and practices. It may increase people's achievement-orientation, with greater awareness of the possibility of improvements in one's standard of living. There may also be a greater openness to new ideas and modern practices. Against this, it is often argued that education leads to disdain for agriculture, as students aspire to formal sector employment.

Besides to basic education to adults, the ongoing extension policy has a wider scope to train farmers in various agricultural skills that will accelerate the adoption and diffusion of new agricultural technologies and practices. However, apart from the skills training and the educational level of the farmer, other factors should also be considered for a positive adoption of agricultural innovations.

A key issue in technology adoption is that of "fit" with local agro-ecological and socio-economic conditions. This is particularly true for degraded, risk-prone and resource-poor

areas. Such areas are characterized by unreliable climatic conditions, poor productivity, poverty and unpredictability of outcomes. In such situations technology transfer may fail because standardized recommendations may fit to the needs of few farmers. This necessitates the study to look for various agro-ecological and socio-economic factors that led to a scattered and uneven pattern of technology adoption in the study area. As already discussed some where in this paper, this problem is more pronounced to livestock technologies. In any case, farmers who own livestock are more likely to adopt improved livestock technologies than those who did not. That is to say, the potential to introduce livestock technologies perhaps depend on whether farmers keep livestock or not. The justification to this could be the experience obtained from keeping livestock may assist farmers to adopt either the full livestock package recommendations or part of it which are useful to improve the performance of local breeds.

However, in spite of the apparent recognition and acceptance that there is a relationship between adoption of agricultural innovations and the aforementioned factors related to the farmers in general, much has not been done in such resource-poor areas to assess specifically the reason why different levels of adoption (be it for improved or traditional technologies) are observed. The research problem is, therefore, to identify the various agro-ecological and socio-economic factors that determine the adoption of agricultural technologies in North Wollo particularly in Meket woreda. The focus, however, will be to see the extent to which the education and training given to farmers affect technology adoption.

1.3 Objectives of the Study

The chief objective of this study is to identify the factors that influence the adoption of improved seeds and/or fertilizer among resource poor farmers of Meket Woreda with particular interest to see the role of education and training on technology adoption. The crops considered in this regard are Barley, Wheat, Teff. If a farmer used improved seeds and/or fertilizer in any of these crops, he is considered as an adopter or zero otherwise. Moreover, an attempt will be made to know what factors influence ownership of livestock particularly cow and sheep. The specific objectives of the study are:

- a) Assess the role of education and training on the adoption of improved seeds and/or fertilizer and ownership of cow and sheep.
- b) Identify other factors that influence the adoption and ownership process with special interest to draw policy implications for the acceleration and sustainability of adoption of improved crop and livestock technologies.
- c) To examine the profitability of use of fertilizer and/or improved seeds by calculating value cost ratio.

1.4 Significance of the Study

At present, there is a general believe among political leaders and agricultural experts that small-scale farmers can only increase their productivity and therefore, be lifted out of poverty with the use of appropriate inputs such as improved seeds, fertilizer and crop

protection chemicals, and not by continuing to practice the low yielding, old age traditional agricultural systems. The same is true to the livestock resource. Improving the performance of livestock through the introduction of improved breeds and better husbandry practices is given due attention. Therefore, it is high time to uncover the reasons why only few farmers keep livestock in order to facilitate the dissemination of new livestock technologies. To this effect, identifying the various social, economic and political factors that may accelerate or impede the use of these better technologies is of paramount importance.

By studying the determinants of adoption of improved technologies among resource-poor, small-scale farmers, implications will be made that would aid adjustment to improve and sustain farmers adoption of the recommended innovations. Tied with improving the adoption process, the study would provide evidence to policy makers that would be useful in their decision-making process regarding agricultural technology dissemination.

If broadly viewed, in a country like Ethiopia where agricultural intensification is given top priority in the country's development strategy, such studies that deal with the problem of rural and agricultural development are quite relevant and appropriate to bring about rapid and sustained increase in agricultural output.

To be specific, much has not been done to assess the role of education on the adoption of agricultural technologies. To the contrary, there is a crucial need to study the impact of education on agricultural productivity, mainly due to the following reasons. First, during the last decades, an average of 12 % of total government annual expenditure was allocated to

the educational sector. Different educational plans have been drafted and implemented. The central belief in all of these efforts was, and is, that accumulation of knowledge through education is a decisive factor for economic development. If education has any impact at all on the economic development of Ethiopia, it will be reflected in the agricultural sector which dominates the economy (Assefa et al, 1998). Therefore, in a situation where agriculture is the backbone of the economy, it is really imperative to assess the role of education on agricultural productivity in general and on technology adoption in particular.

Academically, the study is expected to contribute to the existing literature in the field and act as a stimulus for further research to refine the conceptual and /or the econometric methodology of the present study.

1.5 Scope of the Study

The study is a micro-level study limited to one wereda located in North Wollo Zone of the Amhara National Regional State. The Wereda has different agro-ecological zones. Therefore, it is believed that by drawing samples from the different agro-climatic zones in the wereda, the study would appreciate some sort of heterogeneity among farmers. But, since there also exists similarity among farmers living within the same agro-ecological zone in the wereda and even in neighboring woredas, it is hoped that the result could be widely applicable. Further, the study is confined in analyzing the various factors that influence technology adoption in the wereda. In particular, emphasis will be given to see the extent to which training and the educational level of the farmer affect the adoption process.



1.6 Limitations of the Study

One of the limitations of the study is that data was collected for the 1997/98 Meher (main) season because of the fact that the 1998/99 meher season crop was not fully harvested. As a result the information provided by farmers was based on a recall and accuracy and reliability of some of the information obtained from few farmers could be questionable.

Second, since schooling in the woreda is only up to grade 10, the investigator was not able to get enumerators that are 12 complete and used extension agents that are assigned at peasant association level. On the other hand, data collection was done by the time when farmers and extension agents were actively engaged in soil and water conservation and other activities and this had its own impact on the data collection process.

1.7 Organization of the Study

The rest of this paper is organized as follows. Chapter two is literature review part and presents some of the findings of previous studies made in Ethiopia and else where which are relevant to the problem under investigation. Chapter three deals with research methodology. Analysis and interpretation of data is made in chapter four.

Finally, in chapter five, summary of the main findings, conclusions derived from the findings and implications for policy are presented.

CHAPTER TWO

LITERATURE REVIEW

2.1 Definitions

According to D.Colman and T.Youg (1989), technology is defined as a stock of available techniques or a state of knowledge concerning the relationship between inputs and a given physical output. Technological change, on the other hand, is an improvement in the state of knowledge such that production possibilities are enhanced. In another agenda, they defined adoption to mean the use or non-use of a particular innovation by individuals (say farmers) at a point in time, or during an extended period of time. Adoption, therefore, presupposes that the innovation (source of technological change) exists.

To Schumpeter, new agricultural technologies or agricultural innovations refer to the use of chemical fertilizers, insecticides, bactericides, fungicides, improved seed varieties, improved farm implements, new cultural practices and management techniques which have not been used by the farmer earlier (Itana, 1985). He further classified new technologies or innovations as mechanical (e.g. tractors, threshers), biological (hybrid seeds, superior cattle breeds), chemical (fertilizers, herbicides and insecticides) and agronomic which includes cultural practices and management techniques such as optimum seeding rate and crop

rotations. These technologies, especially the divisible one's, may be introduced in packages while some of them could be adopted independently.

Rogers (1962) definition of the adoption process is well documented in Itana (1985) and Legesse (1992). According to him the adoption process is defined as the mental process an individual passes from first hearing about an innovation to final adoption. He further identifies the various stages through which the process occurs. These series of stages are: Awareness - a farmer first learns about an innovation, Interest - a farmer develops an interest in the innovation and seeks more detailed information, Mental decision - the farmer evaluates the innovation and makes up his mind to try it, Trial - the farmer tried out the innovation, Adoption - the farmer decides that the innovation is good enough for full-scale and continued use. The time required to pass from one stage to the other, however, is different for different individuals. Farmers are categorized as innovators, early adopters, early majority, late majority, late adopters and laggards based on the reaction of the farmers to innovations. Acceptance of use of the innovations decreases as one moves from innovators to laggards in the above order. That is, laggards are the least to react and accept innovations (Itana, 1985)

Webster's Dictionary defines the word adoption to mean to take up or accept especially a practice or tenet often evolved by another. Similarly innovation, which refers to new technology, is defined as the introduction of something new that differs from existing forms.

2.2 Theoretical Foundation

As pressure increases more marginal land is brought under cultivation, particularly in the developing countries, and existing land resources are further degraded in many parts of the world. The trend will not be reversed until the agricultural land productivity in developing countries overtakes population growth on a continuing basis. Sustainable agricultural systems require, among other things, increased investment in developing and transferring appropriate technology to men and women farmers and upgrading farmers' technical and managerial knowledge and skills (FAO, 1990). The national agricultural extension intervention program document for the year 1995 also supports this proposition. It says "much of the progress achieved elsewhere in the world in increasing the productivity of food crops in small-scale agriculture has resulted from the utilization of simple technical innovations from research and development consisting largely of improved seeds, fertilizer application and better crop husbandry practices. Sustainable development under Ethiopian context, therefore, requires among other things support in terms of provision of agricultural inputs, credit and extension services".

Improvements in varieties of plants and animals and in the other inputs that are necessary to make these varieties more productive are sources of agricultural growth. The dynamics of the process can be understood only by understanding the determinants and manner of adoption of new agricultural technology and how it comes to be produced on a continuing basis. Continued change, however, is likely to rest more on the series of smaller, less dramatic developments. For this reason, improvements in rural education facilities, especially literacy

and extension services must play an important role (Mark Nerlove, 1988).

Scientists, planners, and laymen will agree that one of the most difficult challenges facing third world nations is the need to increase agricultural production. Experiences in countries such as the United States and Japan demonstrate that modernization of agricultural techniques has been instrumental in bringing about a revolution in agriculture in these countries. In most third world nations today, innovations are also seen as a vital component of their rural farm strategy. Disseminating innovative techniques among farmers who are their potential beneficiaries, however, has met with mixed results, and many promising programs have been frustrated at this point (Steven K. Pontius, 1983).

Dejene Aredo (1995) underscored the difficulty of agricultural transformation by stating that technical change, though vital, is only one aspect of transformation. The pace and path of the transformation process is determined by factors such as patterns of resource endowments, institutional set-ups, cultural and social environment, and political system. In another topic, he listed the numerous problems facing Ethiopian agriculture which include soil fertility losses, increased weed problems, widespread infestation of pests, accelerated erosion and recurrent and widespread drought periods. Continuing his discussion, he said “population pressure has been singled out as one of the major factors that gave rise to these problems and it has been a common belief since long time that these problems could be overcome only through massive use of new technologies. But this argument has grossly neglected the complementary roles that traditional inputs (such as organic materials, household labour, indigenous technical knowledge of the rural people, indigenous institutions, etc.) can play in

raising agricultural output or in maintaining acceptable consumption levels per head” (Dejene,1996).

However, in any of the above propositions the importance of use of improved agricultural technologies to enhance the productivity of agricultural outputs is not underestimated. But what factors influence the use of these technologies ?

Zvi Griliches (1988) argue that the level and rate of adoption of new agricultural technologies responded to economic incentives, that variations in adoption could be explained by variables that represented the profitability of such adoptions. New technologies are adopted faster where their profitability is higher. Similarly declines in the relative price of new techniques would stimulate their learning process and speed up the rate of adoption. In describing the role of education in technology adoption, Z.Griliches stated that better educated entrepreneurs have the advantage of comprehending the ongoing changes faster and adopting the new technology quicker. This leads to an interaction between the rate of technical change and the levels of human capital.

To Msiko (1976), farmers adoption behavior depends on two major influences: incentives and disincentives. This necessitates the need for comprehensive identification and analysis of the factors that influence the adoption behavior of farmers so as to strengthen incentives and suppress disincentives.

2.3 Empirical Studies

2.3.1 Studies made out of Ethiopia

V. Ballabh and B.M. Sharma (1984) studied the adoption of high yielding varieties of paddy and wheat in flood prone and flood-free districts of Uttar Pradesh. For analysis they used the following logistic function,

$$P_t = \frac{K}{1 + e^{-(a+bt)}}$$

Where P_t = proportion of area under high yielding varieties in period t

K = ceiling (saturation) level of adoption

a, b are parameters to be estimated, and

t = time variable with 1967-68 as the base year

After determining the ceiling value of paddy and wheat of each district, the logit equation,

$$\log \left(\frac{P_t}{K - P_t} \right) = a + bt$$

$K - P_t$

was estimated. The result indicated that technology and environment (flood in this case) are the crucial factors in explaining adoption.

J.C. Flinn et al (1984) undertook a tobit analysis on the adoption and use rates of fertilizer on wheat in the eastern tarari of Nepal. According to him, the tobit model is advantageous in a sense that a) it provides an estimate of the probability that a specific farmer will be an adopter b) for adopters, to know the level of fertilizer use. The specified equations for estimating the factors influencing adoption and fertilizer rate were,

$$I = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n = f(x_i)$$

and $Y = g(I)$

where $Y = 0$ if $I < I^*$

$Y = I - I^*$ if $I \geq I^*$

I is an index reflecting the combined effect of the X factors which hinder ($b_i < 0$) or promote ($b_i > 0$) fertilizer use. I^* is the critical value of an index and is distributed as an $N(0, \sigma^2)$ variable while Y is the amount of fertilizer used. If I is less than the critical value I^* , the farmer is a non-adopter so $Y = 0$. If I exceeds the threshold I^* , the farmer is an adopter and Y is positive.

The finding of this empirical study showed that factors significantly related to fertilizer use on wheat were the area under wheat, the extent of irrigation, fertilizer transport cost and operator's tenure status. Owner farmers with larger areas of wheat were more likely to use fertilizer and at higher rates than tenants with smaller wheat areas. However, whether the farmer used formal sources of credit, his years of schooling, and the intensity of extension visits were not. The unexpected result was guessed to occur partly due to the fact that owners tended to farm larger holdings than tenants, and were better educated.

A study made by Ram D. Singh (1982) to see the relationship between location and the rate of adoption of new agricultural technologies in a developing agriculture extended the previous location-adoption analysis to incorporate in the conceptual model the human capital variable expressed in terms of the schooling of farm population and the information systems disseminating knowledge about new production technology. The inclusion of education and

information variables in the model was considered to be important, because the new technology demands the possession of knowledge and information on the part of farm operators. To account for the effects of these variables, the study formulated a model as under:

$$\text{ADOPT} = f(\text{LOCAD}, \text{EDUCA}, \text{INFOR})$$

$$f_2, f_3 > 0 > f_1. \quad (f_1, f_2, f_3 \text{ are partial derivatives of } f)$$

The estimated result indicated that location has a strong adverse impact on the rate of adoption in the study area. This means that as villages move away from the urban-industrial centres, there is a relative decline in adoption. The education variable, though inversely correlated with location, exercised a positive impact on adoption. That is, the result demonstrates the significant effect of schooling on the diffusion process. Moreover, the adoption of new agricultural technology is found to be positively influenced by information.

Gregory D. Wozniak (1987), in his study to present a model of early adoption behavior of farmers, used individual observations from Iowa farmers to fit probit and logit models. The intent was to see the role of human capital and information on the early adoption of technology. To this end, he hypothesized that the probability of being an early adopter of a profitable innovation is an increasing function of the agent's endowments of education and experience. The findings suggest that increases in education and experience reduce the costs and uncertainty of adoption and thereby raise the likelihood of early adoption.

A farm level survey and a multiple regression analysis made by Mook Peter (1971) in Vihiga division of western province of Kenya found formal education, extension visits and attendance at field demonstrations to be positively related to adoption of innovations.

Misiko (1976) used a combination of techniques to analyze data obtained from Bungoma district in Kenya and found that contact with extension officers, family size, income, social participation and endowment to be significantly related to adoption. Muturi (1989) also analyzed the factors influencing the use of fertilizer among small holder farmers in Murang'a district, Kenya. The study found that fertilizer credit, price of fertilizer and producer prices are statistically significant factors influencing use of fertilizer by Small holder farmers. Extension contact, literacy and price of manure were not found to be statistically significant factors influencing use of fertilizer.

2.3.2. Studies specific to Ethiopia

Bisrat Aklilu (1976) conducted a study to identify the factors that explain the pattern of fertilizer intake in Ethiopia's minimum package program Areas (MPPAs). To this end a macro analysis of fertilizer diffusion in 20 MPPAs and a Micro-analysis of fertilizer adoption of farmers in two MPPAs (Jimma and Bako) was undertaken. The Model employed for analysis was a logistic Model. The result of the study indicated that in Jimma MPPA, the level of use was explained by the input's objective profitability and its complementarity to available resources, while in Bako, it was the extent of contact with extension agents that determined level of use.

A case study Made by Itana Ayana (1985) to analyze the factors affecting the adoption and diffusion of agricultural technologies in two extension districts in Ethiopia employed probit regression technique and discovered that farm size, literacy and adequacy of rainfall positively and significantly affect the use of improved seeds and fertilizer in Wolenkomi Extension Centre, while unavailability of cash for down payment and price of inputs affect it negatively and significantly. In Dillala Extension Centre it was found that the value of livestock owned, price of farm output and non-farm income positively and significantly affect the adoption of improved seeds and/or fertilizers, while unavailability of cash for down payment is found to be negatively and significantly related to it.

Mulat et al (1998) utilized a selectivity model to analyze the factors affecting whether or not fertilizer was used, and the level of fertilizer used per hectare by households in a sample of 361 Woredas. The result indicated that factors affecting whether or not households in the woreda used fertilizer were related to access to fertilizer, credit, and extension services. The dominance of teff in production patterns was also found to be important determinant of fertilizer use. The percentage of female-headed households was positively related to the probability of fertilizer use. But perhaps surprisingly, neither rainfall, elevation, average farm size, nor livestock assets significantly affected whether or not fertilizer was used in a given Woreda.

A Similar Study was made by Andre et al (1998) using a nationally representative data set. The estimated Tobit model of fertilizer adoption and demand by farmers in Ethiopia indicated

that Credit, household size, Cattle ownership, education of the farmer and the value-to- cost ratio are all found to positively and significantly influence demand for fertilizer.

Legesse Dadi (1992), conducted a study to analyze the factors that influence the adoption of wheat and maize technologies in Arsi Negele area, Ethiopia. The technologies chosen were fertilizer, improved varieties and herbicides and the models employed for analysis were the probit and logit models. According to his findings, factors shown to significantly influence the probability of adoption of fertilizer and herbicide in the econometric analysis include experience, credit, expected profitability as represented by viable expected yield, cash availability for down payment, participation in farm organizations as a leader and close exposure to technology.

Farm size was not found to be important factor affecting the probability of adoption of improved varieties and intensity of fertilizer adoption. However, its effect on intensity of adoption of herbicide in weed control in wheat, was negative and significant. Direct extension visits by extension agents was not found to be significantly influencing adoption because of the limited frequency of direct extension agents visits to non contact farmers. On the other hand, the variable close exposure to technology significantly affected the probability of adoption of improved varieties.

Berhanu Taye (1993) applied multiple regression and partial budgets to analyse the factors influencing fertilizer consumption and access to fertilizer credit in the former Ada Awraja. The results of the data analysis showed that the existing level of fertilizer consumption is

seriously affected by land fertility, percentage of area under improved variety of seeds, annual farm income, farm size, timely availability and distribution of fertilizer, and education.

Getachew Olana (1993) studied farmers' response to new coffee development technologies and factors influencing it in Gimbii, Wollega. Age and experience of the household leader, household size, role of the farmer in the extension system, sufficient food production and perception of coffee prices are found to be insignificant in influencing responses to these technologies. In contrast, total farm and coffee area cultivated, labour availability, livestock owned, knowledge and skill, leadership in local associations and material conditions of the household were positively related to adoption of technologies.

Lelissa Chalchissa (1998) employed probit and Tobit models to examine and quantify the determinants of fertilizer adoption and the intensity of its use in Ejere District. The results showed that agro-climatic, and land tenure condition, credit, extension services, oxen ownership, age of the farmer, family size, farmers' level of education, manure, ratio of price of crops to fertilizer cost, distance to fertilizer distribution center and cropping pattern are the most important determinants of fertilizer adoption and intensity of its use.

A multivariate probit analysis made by Tesfai Tecele (1975) to examine the adoption of newly introduced wheat varieties and chemical fertilizer within the Gonde extension area of Hilalo Agricultural Development Unit (CADU) in Ethiopia indicated that the probability of adoption increases with farm size, availability of cash for down payment, membership in local associations and literacy. But, the negative coefficients associated with tenurial classification

and extension contact (or distance from extension center) indicate that the probability of a farmer using CADU provided farm input will decrease as the distance between the extension center and the farm increases (or as the number of extension contacts decreases), and if the farm is a tenant and not an owner-cultivator.

Asfaw et al (1997) selected variety, fertilizer and row planting as three maize production technologies to examine the factors that determine the adoption of these technologies in the Bako area of Ethiopia. The logit regression model was estimated for each of the three selected maize production technologies. Age and formal education of household head, family size, farm size, number of oxen, credit and extension participation were taken as regressors to estimate the dichotomous dependent technology dummy variable. Their finding indicated that extension activity, which is represented by farmer's attendance at the field days was the only variable which is found to significantly and positively influence the adoption of improved maize variety. The adoption of fertilizer technology in maize production was positively and significantly influenced by the farmers' use of credit and by the level of formal education of farm household head. Extension was also found to be positively related to fertilizer use even if it is not significant. Planting maize in rows was positively associated with a farmer's age, formal education, and number of oxen owned. But only formal education and number of oxen owned are statistically significant. Credit is not needed for row planting and is not included in the analysis.

Chilot Yirga et al (1996) conducted a study to determine the factors influencing adoption of new wheat technologies in Addis Alem and Wolmera Woredas of Ethiopia. The

technologies chosen were fertilizer, improved seed and herbicides. The fitted Probit and Tobit regression models indicated that the perceived profitability of the new wheat technologies and the timely availability of fertilizer and herbicide had the most significant effect on farmers' decisions to adopt. The number of contacts with extension workers significantly and positively influenced the probability of adopting new improved wheat, but its effect on the intensity of fertilizer and 2-4 D use was minimal. On the other hand, distance of respondents' homes from extension centers influenced the probability of adoption decisions of farmers. Moreover, extension efforts and input availability were most crucial in influencing adoption. Farming experience, though not significant, positively influenced the probability of improved wheat adoption but had a negative and weak impact on the intensity of fertilizer and 2-4 D use.

Literacy was positively and significantly related to the intensity of 2-4D use, but not significantly related to the probability of adopting improved wheat. Cultivated land per person was not significantly related to adoption. Wealth of the household as represented by house type and / or radio ownership positively and significantly influenced the probability of adopting improved wheat as well as the intensity of using 2-4 D. Number of livestock owned was significantly and positively related to the intensity of fertilizer use.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Sampling Procedure and Data Collection Techniques

In this study, the farm household head, who usually makes the day to day decision on household matters was taken as the basic sample unit. The sample frame to select the sample unit was chosen to be the peasant association since all household heads are organized into peasant associations.

The study woreda has different agro-ecological zones. The zones are classified as kolla (low land), woyna dega (middle altitude), dega (high altitude) and wurch (frost zone). To appreciate variations among the zones, the study utilized a two-stage stratified random sampling technique in selecting farmers for interview. At the first stage, eight accessible peasant associations (two from each agro-ecological zone) were selected randomly out of all accessible PA'S in the woreda. Accessibility was taken for granted because of the limited time available for the survey. In the second stage, systematic random samples were taken from each stratum using updated peasant association membership list of the 8 selected PA'S. The stratified random sampling technique enabled the investigator to select samples from each stratum rather than selecting samples from the whole population. By doing so, samples of adequate size were obtained from each stratum. Stratified random sampling gives more precise result than a simple random sample if differences between strata are greater than differences within strata (E.K Brown/Martin K.Starr, 1982).

Considering once again the limited time available for the study and to provide an adequate sample for each stratum, a sample size of 144 farm household heads-18 household heads from each PA (36 household heads from each agro-ecological zone) were chosen randomly. This total number of 36 farmers from each agro-ecology is assumed sufficient owing to the shortage of time and other resources. Moreover, farmers in each agro-ecology more or less face the same environmental conditions (soils, topography, rainfall pattern, Cultivation and Cropping pattern). Therefore, there is a high degree of homogeneity that guaranteed possible representation with a sample size of 36 in each agro-ecology.

To administer the survey, a structured questionnaire was prepared and translated to Amharic to ease the process of data collection. Then the questionnaire was pre-tested on 12 household (3 from each agro-ecological zone) and revised accordingly before actual data collection was undertaken. Eight enumerators and one assistant supervisor with education level of 12 + 6 months and above and working in the woreda as government employee were involved in the data collection. Prior to pre-testing the survey questionnaire, the enumerators and the assistant got a three days training which focused on the content and method of filling the questionnaire.

In addition to getting data by interviewing farm households using a structured questionnaire, focus group discussions and review of secondary data from governmental offices at zonal and woreda level was made. As to the administration of the survey in general, the investigator has made every attempt to closely supervise the work.

3.2 Model Specification

This study recognizes that the adoption of agricultural technologies is a bi-modal discrete choice problem: a farmer can either adopt the technologies or not. Binary choice models assume that individuals are faced with a choice between two alternatives and that the choice depends on identifiable characteristics. Thus, one purpose of qualitative choice model is to determine the probability that an individual with a given set of attributes will make one choice rather than the alternative (R.S pindyck and D.L Rubinfeld, 1998). Among the binary choice models, the Probit model is used to analyze the data. The advantage of this model is the probability is bounded between 0 & 1. Specification of the model is done in such a way that farmers are categorized in to two groups based on whether or not they adopt the specified agricultural technologies. Thus if the dependent variable (the decision to adopt or not) is designated by Y, it will take only two values. That is:

Y= 1 represents adopters

Y=0 represents non-adopters

Models such as the linear probability model can be specified to analyze adoption behaviour of farmers but the model has several limitations such as non- normality of the error term, heteroscedasticity, and the possibility of the estimated probability lying outside the 0-1 bounds (D.N Gujarati, 1995). Moreover, in relationships where the dependent variable is dichotomous, certain specification of the classical regression model are violated and ordinary least square estimates of some standard statistics, such as t-ratios are incorrect.

The logit model can also be used instead of the probit model. But according to D.N Gujarati (1995), the logistic and probit formulations are quite comparable, the chief difference being

that the logistic curve has slightly flatter tails, that is, the probit curve approaches the axes more quickly than the logistic curve. Therefore, the choice between the two is one of (mathematical) convenience and ready availability of computer programs. On this sense, this study chooses the probit model because many adoption studies in Ethiopia utilized this model (e.g Itana 1985, Legesse 1992, Lelissa 1998 used this model in studying adoption behaviour) and it is also convenient for computer analysis.

The other advantage of the probit model is it helps not only in assessing the effects of various determinants of fertilizer adoption but also provides the predicted probabilities of farmers' future adoption willingness. Asfaw et al (1997), in their study to determine factors affecting the adoption of maize technologies in Bako area, fore example, used this model to indicate the likelihood of adopting fertilizer technology by a given farmer as his (her) level of education changes keeping other factors constant.

The probit probability model is associated with the cumulative normal probability function. The decision of the household to adopt or not improved agricultural technologies depends on unobservable index I_i that is determined by a vector of explanatory variables (s) X_i , such that the larger the value of the index I_i , the greater the probability of the household to adopt the technologies (D.N Gujarati, 1995). The vector X_i may represent farmers social, economic, physical etc factors.

R.S Pindyck and D.L Rubinfeld (1998) used the same approach in describing the probit model. They designated the index which is determined by a vectors of explanatory variable(s) X_i by Z_i and express it as:

$$Z_i = \alpha + \beta X_i$$

Where α is the intercept and β is a set of parameters that explain the impact on adoption decision of a change in the explanatory variable (s). Observations on Z_i are not available. Instead we have data that distinguish only whether individual observations are in one category (high values of Z_i) or a second category (low values of Z_i). Probit analysis solves the problem of how to obtain estimates for the parameters α and β while at the same time obtaining information about the underlying index Z . Further, they explained the issue by assuming that, for each household, Z_j^* represents the critical cutoff value which translates the underlying index into adoption decision. Then the farmer adopts the technologies ($y=1$) if $Z_i > Z_j^*$ and does not if $Z_i \leq Z_j^*$.

The probit model assumes that Z_i is a normally distributed random variable, so that the probability that Z_j^* is less than (or equal to) Z_i can be computed from the cumulative normal probability function. The index Z may take any value between $-\infty$ & ∞ , and its transformation ensures that all corresponding probability lie between 0 & 1.

This paper specifies the probit model as follows:

$$Z_j = \beta_0 + \beta_1 X_{1j} + \beta_2 X_{2j} + \dots + \beta_n X_{nj}$$

Where: $j = 1, 2, 3, \dots, j$ observations

Z_j = the unobserved index for the j^{th} observation

X_{nj} = the n^{th} observable explanatory variable for the j^{th} observation

B_n = an unknown parameter to be estimated

3.3 Estimation Technique

When one is using either the probit or the logit model with individual observations, the most suitable estimation technique is maximum likelihood (R.S Pindyck and D.L Rubinfeld, 1998). The maximum likelihood estimation procedure has a number of desirable statistical properties. All parameter estimators are consistent and efficient asymptotically. Therefore, following R.S Pindyck and D.L Rubinfeld (1998) and D.N Gujarati (1995), the models (equations) on this paper are estimated using maximum-likelihood estimation technique.

The computer packages that are used to enter and estimate the data are the statistical package for social sciences (SPSS) and STATA.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview of the Study Area

Meket Woreda, the subject of this study, covers an area of 2196 Km² (SOS-Sahel, 1998) and is part of North Wollo administrative zone within the Amhara National and Regional state. The woreda town Flakit is about 665 kms North of Addis Ababa, 145 Kms far from Woldia-the zonal town and 215 kms far from Bahirdar-the regional town. The 360 km all weather road linking Woldia with Bahirdar cuts across the woreda town Flakit.

The Woreda comprises of 35 rural and 1 urban kebeles which sum up to give 36 administrative kebeles. According to the census of 1994, the total population of the woreda was 188,922 (44,142 households). This represents an average population density of 96 persons per Km², but actual densities would be considerably greater in the mid and highlands, and lower in the low lands (SOS-Sahel, 1998). At the current rate of population increase in the region estimated at 3.2%, the present total population of the woreda is estimated to be 210803. Of these, 106907 are male and 103896 are females (Meket WAO,1999).

In the Woreda, altitude is the most influential factor on local climate, ecology and farming systems. Within Meket, the 4 main agro-climatic zones of highland Ethiopia are found, ranging from 2,000 meters above sea level to 3,400 meters. These zones are wurch or high plateau (above 3200 masl), Dega or plateau (2,800-3,200 masl), Woyna Dega or mid-land (2300-2800

masl), Kola or lowland (below 2,300 masl). In the plateau and high plateau (which is characterized by frost and hail), annual rainfall is over 1,000 mm and is bimodal. Rainfall decreases and average temperature increases as we move down to the low lands, where precipitation is around 600 mm per year (SOS-Sahel, 1998).

The topography of the Woreda ranges from gently undulating slopes to hilly terrain. The dominant soil types are reddish brown (37%) and dark (black) soils (36%) while giracha comprises of 27% of the soil type (meket WAO, 1996). The fertility status of the soil is deteriorating as a result of improper land use practices.

Traditional, low input, subsistence agriculture remains by far the most important means of livelihood for the population. Livestock production is probably the most significant component of local agriculture, but traditional grazing and hay-making systems are under threat from arable production (SOS-Sahel, 1998). Farming is carried by using traditional plough which is pulled by a pair of oxen or a horse and an ox. The dominant crops that grow in the highlands are barley and wheat, while in the midlands and low lands a wider range of crops are grown, including tef, sorghum, peas, beans, chickpea, safflower and flax etc. Production of crops is mainly dependent on Meher (main season) rain. Only about 8 kebeles use the belg (short period) rains and the belg rains are usually short and irregular.

Meket is a drought prone and degraded Woreda with soil erosion evident in all areas. Population increase which put more pressure on the land has led to over-cropping and grazing on steep and unprotected slopes. Traditional farming systems are no longer able to meet farmers' subsistence needs and the unreliable rainfall (usually low and un-evenly distributed) have a much greater negative impact on household food security. As a result, the Woreda has

depended on food aid since the droughts of 1984/85 and traditional coping mechanisms are now becoming over-stretched (SOS-Sahel, 1998).

Off-farm income generation is limited to a few artisan activities (blacksmithing, weaving, carpet making and pottery) and petty trading. In any case, these activities are considered to be the few options available to augment farm incomes.

Meket has 24 elementary (grade 1-8 in two cycles) and 1 secondary (grade 9-10) schools. The distribution of the elementary schools according to agro-climatic zone is as follows: 14 in Woyna Dega, 6 kolla, 20 Dega and 2 Wurch. The Secondary school is located in Flakit-the Woreda town. Only five out of the eight surveyed Kebeles have 1 elementary school each (Meket WEO). According to the same office, the education coverage of the Woreda is only 21.65%.

The Woreda has one community skill training centre in Flakit. Farmers of the Woreda got skill training on carpet making, weaving, blacksmithing, pottery etc. But usually, due to lack of resources, very few trainees are entertained, as compared to the total population of the Woreda. For example, the number of trainees in 1995, 96,97 were 21, 21 and 47 respectively. No training was given in 1998. Since the start of the training programme in 1994, only 105 farmers (54 male and 53 females) were trained in various skills. The duration of training ranges from 15 days in 1997 to 4 months in 1995 (Meket Woreda CSTC, 1999). The other non-formal adult education programme is literacy and/or numeracy programme. In the surveyed Kebeles, 1132 (983 male and 149 female) out of the 1329 registered farmers are currently attending the programme, i.e Total drop outs are 197 (Meket WEO,1999).

The people of Meket belong to the same ethnic group, the Amhara. About 95% of them are Orthodox Christians. Followers of Islam are few in number and mostly found in the low lands. In areas where Muslims and Christians live together, all live harmoniously.

The dissemination of agricultural technology to Meket farmers has a very recent history. It began in Mid 1980s when relief organizations distributed fertilizer with the hope to increase agricultural production. But the extension activity at that time was very weak and farmers used to sell the fertilizer to urban dwellers with cheap price and the latter in turn used the fertilizer to decorate their houses. The small number of extension agents has contributed a lot to the poor dissemination of agricultural technologies in the Woreda. For example, the number of development agents at Kebele level in 1992, 93, 94, 95 were 1, 3, 12, and 14 respectively. The number has increased to 31, 39 and 52 for the years 1996, 97, 98 respectively (Meket WAO). Following the launching of the new extension programme (PADETES), the extension activity began to improve and at present a considerable number of farmers have started using improved agricultural technologies.

4.2 Descriptive Statistics

4.2.1 Household characteristics

Table 1 and 6 depict that the average age of the sampled household heads is 43.95 with standard deviation of 11.63. The average age is lower for frost zone whereas it is nearly the same for the rest three ranging from 43.5 to 47.06. Of the total 144 sampled farmers, 137 (95.1%) are males and 7 (4.9%) are females. Four of the females are found in frost zone and 3 in Kolla. In terms of their religion, 141 (97.9%) are Orthodox Christians and the rest 3 (2.1%) are

muslims and found in Kolla. This finding confirms that the dominant religion in the woreda is christianity and followers of Islam are few and mostly found in the lowlands.

With regards to the educational attainment of the sampled household heads, 33 of them (22.9%) are currently attending or have attended formal schooling. Of these, 21 are from grade 1-4 and the rest 12 are from grade 5-9. Moreover additional 30 farm household heads which did not attend formal schooling can read and write. Altogether, 63 farm household heads (43.75%) can read and write. The agro-ecological distribution of formally schooled sampled household heads is as follows: 10 in frost zone, 9 in Dega, 6 in Woyna Dega and 8 in Kolla.(See Table 1 for details).

The educational level of respondents and the type of technology adopted is summarized in table (2). Of the 33 formally schooled respondents, adopters of fertilizer, improved seeds and fertilizer and/or improved seeds are 19, 11 and 19 respectively. Even among the formally schooled farmers, the highest fertilizer and/or improved seeds adoption percentage is recorded for those farmers who are from grade 5-9 (75%) as compared to those who are from grade 1-4 (47.6%). However, those who adopt both fertilizer and improved seeds together are only 11. Those who can only read and write and who adopt these technologies (in the above order) are 7, 6 and 7 and those who are non-literate are 27, 17 and 27. Being able to read and write only has the lowest fertilizer and/or improved seeds adoption percentage (23.3%) which may call for further research in the study area.

Table 1: Household Characteristics of sampled farmers as expressed in number and percentage, Meket Woreda, 1997/98

No	Household Characteristics	Frost		Dega		Woyna Dega		Kolla		Woreda Total					
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Adopters		Non-adopters		Total	
										Num	Percent	Num	Percent	Num	Percent
1	Sex Male	32	88.9	36	100	36	100	33	91.7	52	98.1	85	93.4	137	95.1
	Female	4	11.1	-	-	-	-	3	8.3	1	1.9	6	6.6	7	4.9
	Total	36	100	36	100	36	100	36	100	53	100	91	100	144	100
2	Age 20-35	16	44.4	9	25	6	16.7	7	19.4	7	13.2	31	34	38	26.4
	36-50	14	38.9	19	52.8	18	50	19	52.8	35	66	35	38.5	70	48.6
	51-65	6	16.7	8	22.2	10	27.8	6	16.7	9	17	21	23.1	30	20.8
	>65	-	-	-	-	2	5.5	4	11.1	2	3.8	4	4.4	6	4.2
	Total	36	100	36	100	36	100	36	100	53	100	91	100	144	100
	Average age	39.14		43.53		47.05		46.08		45.15		43.25		43.95	
3	Education Non-literate	14	38.9	18	50	22	61.1	27	75	29	54.7	52	57.1	81	56.3
	Read and Write	12	33.3	9	25	8	22.3	1	2.8	5	9.4	25	27.5	30	20.8
	Grade 1-4	6	16.7	7	19.4	3	8.3	5	13.9	10	18.9	11	12.1	21	14.6
	Grade 5-9	4	11.1	2	5.6	3	8.3	3	8.3	9	17	3	3.3	12	8.3
	Total	36	100	36	100	36	100	36	100	53	100	91	100	144	100
	Marital status Married	32		35		34		33		50	94.3	84	92.3	134	93
	Unmarried	-		-		-		-		-	-	2	2.2	2	1.4
	Divorced	-		-		-		-		-	-	-	-	-	-
	Widowed	2		1		-		2		2	3.8	3	3.3	5	3.5
	Separated	2		-		-		1		1	1.9	2	2.2	3	2.1
	Total	36		36		36		36		53	100	91	100	144	100

Table 1 Continued.....

5	Family size ≤ 2	2	5.6	1	2.8	-	-	2	5.6	1	1.9	4	4.4	5	3.5
	3 - 5	21	58.3	14	38.8	22	61.1	13	36.1	18	34	52	57.1	70	48.6
	6 - 8	12	33.3	19	52.8	13	36.1	17	47.2	29	54.7	32	35.2	61	42.4
	9 - 10	1	2.8	2	5.6	1	2.8	4	11.1	5	9.4	3	3.3	8	5.5
	Total	36	100	36	100	36	100	36	100	53	100	91	100	144	100
	Average Family Size	4.94		5.86		5.38		5.72		6.2		5.1		5.48	
	Religion Chirtian	36	100	36	100	36	100	33	91.7	53	100	88	96.7	141	97.9
	Muslim	-	-	-	-	-	-	3	8.3	-	-	3	3.3	3	2.1
	Total	36	100	36	100	36	100	36	100	53	100	91	100	144	100
7	Occupation														
	7.1 Major occupation														
	Farming	36	100	36	100	36	100	36	100	53	100	91	100	144	100
	7.2 Secondary occup.														
	None	29	80.6	31	86	34	94.4	30	83.3	46	86.7	78	85.7	124	86.1
	Trading	7	19.4	2	5.6	-	-	1	2.8	3	5.7	7	7.7	10	6.9
	Carpet making	-	-	1	2.8	-	-	-	-	-	-	1	1.1	1	0.7
Masonry	-	-	2	5.6	1	2.8	1	2.8	3	5.7	1	1.1	4	2.8	
Weaving	-	-	-	-	1	2.8	4	11.1	1	1.9	4	4.4	5	3.5	
	Total	36	100	36	100	36	100	36	100	53	100	91	100	144	100
8	Main farm activity														
	Crop Cultivation	3	5.56	2	5.55	18	50	15	41.66	15	28.3	23	25.3	38	26.4
	Livestock husbandry	1	2.78	-	-	-	-	-	-	-	-	1	1.1	1	0.7
	Mixed farming	32	91.67	34	94.45	18	50	21	58.34	38	71.7	67	73.6	105	72.9
	Total	36	100	36	100	36	100	36	100	53	100	91	100	144	100

Table 2. Education and improved crop technology adoption of sampled farmers, meket, 1997/98

Education Level	Frost				Dega				Woyna Dega				Kolla				Woreda Total							
	NA		FA		ISA		FA and/or ISA		NA		FA		ISA		FA and/or ISA		NA		FA		ISA		FA and/or ISA	
	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.
Non-literate	8	6	2	6	11	7	4	7	15	7	5	7	20	7	6	7	54	66.7	27	33.3	17	20.9	27	33.3
Read and Write only	12	-	-	-	6	3	2	3	5	3	3	3	-	1	1	1	23	76.7	7	23.3	6	20	7	23.3
Grade 1 - 4	5	1	-	1	2	5	-	5	1	2	2	2	3	2	1	2	11	52.4	10	47.6	3	14.3	10	47.6
Grade 5 - 9	2	2	1	2	-	2	2	2	1	2	2	2	-	3	3	3	3	25	9	75	8	66.7	9	75
Total	27	9	3	9	19	17	8	17	22	14	12	14	23	13	11	13	91	63.2	53	36.8	34	23.6	53	36.8

Note:- Farmers who adopt fertilizer and improved seed together are 34(23.6% of the total sampled farmers)

- Adoption percentages for each education level is calculated taking the total number of non-literates to be 81, those who can read and write only (30), from grade 1- 4 (21), from grade 5 - 9 (12).

Code

NA= None-adopters

FA= Fertilizer adopters

ISA= Improved seed adopters

FA and/or ISA = Fertilizer and /or improved seed adopters

The average family size of sampled farmers is 5.48 with standard deviation of 1.79. The range, however, is from 1-10. In terms of agro-ecology, the average family size in frost zone is 4.94. Whereas it is almost the same for the rest of the zones ranging from 5.39 to 5.72. Seventy five household heads have a family size of ≤ 5 and the rest 69 have 6-10 family members. It is discovered that adopters of improved seeds and/or fertilizer have larger family size as compared to those who are non-adopters. Responses regarding the number of family members assisting the household head indicate that 86 heads have one to two assistants, 27 have three to five, 1 have above five and the rest 30 have no assistant. As a result, farmers who faced labour shortage during ploughing, planting, weeding and harvesting are 9,24,33 and 27 respectively. The rest 51 said they did not face this problem. The solution to the problems also varies from one individual to another. 44 of the respondents solve these problems by employing hired labour, 34 using family labour, 2 using mutual aid teams and the rest by other means.

The major occupation of all sampled households in all agro-ecologies is farming. Of the total sampled farmers, 38 are involved in crop husbandry, 1 in livestock husbandry and the rest 105 are mixed farmers. Farmers are categorized as mixed farmers if they are involved both in land cultivation and rearing of livestock. Regarding their secondary occupation, 10 are found to be traders, 1 carpet maker, 4 masons and 5 weavers.

4.2.2. Farm Characteristics

4.2.2.1 Land Use

Farmer's response with respect to allocation of land is summarized in table 3.

Table 3: Summary of Average (mean) results of a land allocation in hectar of sampled household heads by agro-ecology, Meket, 1997/98 (Meher)

No	Farm Characteristics	Unit	Frost	Dega	Woyna Dega	Kolla	Woreda		
							Adopt-ers	Non-Adopters	average
1	Private land holding	ha	1.11	1.2	0.95	1.40	0.9	1.4	1.17
2	Cultivated land (own plus others)	ha	0.68	0.83	0.87	1.15	0.73	1.13	0.88
3	Own cultivated land	ha	0.53	0.62	0.49	0.72	0.51	0.74	0.59
4	Sharecropped in land	ha	0.15	0.21	0.38	0.43	0.22	0.39	0.29
5	Rented in land	ha	-	-	-	-	-	-	-
6	Sharecropped out land	ha	0.30	0.20	0.13	0.21	0.1	0.26	0.21
7	Rented out land	ha	-	-	-	-	-	-	-
8	Fallow land	ha	0.08	0.11	0.18	0.22	0.12	0.19	0.15
9	Own grazing land	ha	0.20	0.27	0.15	0.25	0.17	0.21	0.22
10	Pieces of land cultivated	Plots (Pieces)	2.8	2.6	1.78	2.05	2	2.12	2.31

As depicted in table 3, the average land holding of sampled farmers is 1.17. This figure includes own cultivated, sharecropped out, fallow and grazing land. It is discovered that non-adopters of improved seeds and/or fertilizer have larger private land holding as well as cultivated land. This may indicate that farmers with a relatively smaller land size practice crop intensification. Among the four agro-ecologies, a relatively better land holding is observed in kolla. Land renting is discovered to be non-existent. The practice of sharecropping is there but not that much significant. In a similar way, the average size of private grazing land is small which may indicate that the need for more cultivatable land has dramatically decreased the land to be grazed. Fallow land is also small because of the small proportion of per capita land

holding. Land fragmentation as measured by cultivable plots of land per farmer is also recorded. On average, sampled farmers have 2.31 plots of land. Land fragmentation is an indication of diversity of fertility of land in the area (Itana, 1985). The more the diversity of land in an area, the more likely is the fragmentation of the land holding.

4.2.2.2 Cropping pattern and the use of improved crop technologies

The cropping pattern of farmers of meket worda is essentially traditional. Farmers mostly plant traditional crops with very low external input use. The major crops grown in the Woreda are barley and wheat (see table 4) even if one can find different types of crops growing as one moves from one ecological zone to another.

Table 4: Percentage share of different crops of sampled farmers, Meket, 1997/98 (Meher Season)

No	Crops	Frost	Dega	Woyna Dega	Kolla	Woreda total
1	Barley	46.05	32.57	23.81	4.05	26.62
3	Wheat	14.48	23.22	27.38	4.97	17.51
4	Teff	-	1.01	21.43	31.10	13.39
5	Sorghum	-	-	-	22.3	5.58
6	Horse beans	7.89	9.09	16.67	5.42	9.76
7	Field peas	-	2.02	1.19	7.50	2.68
8	Lentils	-	5.05	1.08	2.56	2.17
9	Chick peas	-	3.03	1.19	22.1	6.58
6	Linseed	28.95	19.97	2.49	-	12.85
10	Others	2.63	4.04	4.76	-	2.86
	Total	100	100	100	100	100

Table 4 indicates that barley, wheat and teff covered 26.62, 17.51 and 13.39 percent of the sampled households land. Barley and wheat are major crops in the highlands of Meket where as teff, Sorghum and chick peas dominate in the lowlands.

With regards to the use of agricultural technologies, fertilizer is the major input adopted by farmers. Research institution advocate that the production response of fertilizer is very high when it goes hand in hand with improved seeds. But improved varieties of some crops like barley are not wide spread (even if they exist) and farmers who are major producers of such types of crops may not have option except mixing local varieties with fertilizer if they need to intensity the production of food crops. On the other hand, for crops like wheat and teff, different types of improved varieties are present and there is a possibility of applying the whole crop package.

The rate of application of these improved technologies, particularly fertilizer did not show significant variation among sampled farmers. This could be explained in two ways. One, adopters of these technologies are mainly participants of the new extension programme and as a result they apply the recommend dose through close supervision of development agents. Two, land holding per individual is usually very low implying that the amount of fertilizer and seed provided to farmers is very low such that the possibility of reducing the recommended does is almost non-existent.

Farmers who did not use improved technologies were asked to tell the reason why they did not apply fertilizer and improved seeds on their farm. The recorded responses for fertilizer are: not heard about their existence (13.61%), price very expensive (12.59%), can not afford the price (5.79%), do not expect yield difference (18.71%), was not sure of the result (37.41%) and other

reasons (2.03%). For improved seeds the responses are: not heard about their existence (60.77%), not available (4.5%), price expensive (9%), do not expect yield difference (6.43%), was not sure of the result (12.54%), can not afford the price (5.79%) and other reasons (0.96%).

Regarding fertility of land and application of animal dung, 57 said their farms, on average, are fertile and 87 said unfertile. 23 applied animal dung on their farm land where as 121 did not.

4.2.3 Extension and Skill Training

Several conditions are responsible for the transfer of agricultural technologies. These conditions may be described as parts of the context in which the transfer takes place. One of the most important conditions probably is the availability of know-how to use them. This could be achieved by relevant and effective farmers training programs. On the other hand, farmers can have a high degree of knowledge of farm innovation, but low adoption rates. This can be interpreted to mean that farmers were favourably disposed to new farm practices but that progress towards adoption was retarded by poor extension work. Therefore, strong agricultural extension system is essential to help farmers adopt improved agricultural technologies.

The aim of agricultural extension is to communicate information to farmers about better farming technologies such that the production of agricultural outputs is enhanced. Farmers' training are usually components of a given extension activity. Farmers of the study woreda got training on natural resources conservation, livestock production, crop production, etc. Such training are organized by government offices (mainly the office of agriculture) and non-governmental organizations. In addition few farmers got skill training on off-farm income generating activities such as carpentry, pottery, Masonry, weaving, carpet making, etc. in

Meket community skill training center (CSTC). Sampled farmers responses for questions related to agricultural extension and skill training are summarized below.

With regards to participation of farmers in the new extension programme, 78(54.9%) said they have been or are participating where as the rest 66 (45.8%) said they did not.

Farmers were also asked how frequent per month is their contact with extension agents. 141 farmers responded to this question and the recorded response is never (3 farmers), one to two (75), three to four (39), five and more (24). With respect to availability of trial or demonstration plots around their farms or home, 106 (73.6%) said no and 38 (26.4%) said yes there is. The recorded attendance of field days organized by extension agents in the 1997 production year is: 26 farmers attended once, 26 twice and 2 attended four times.

Responses related to agricultural and other skill training are the following. Of the sampled 144 farmers, 40 (27.8%) have attended agricultural training programs during the 1997/98 crop season. The duration of the training is 1-3 days (9 farmers), 4-8 days (21), 9-15 days (6), above 15 days (4 farmers). The topics of training are general agriculture (4 farmers), soil and water conservation (26), crop protection (1), extension methodology (4), animal health (1) and others (4 farmers).

Farmers were also asked whether they have ever got training in any of the farmers training canters in the country. According to the answer obtained, only two farmers got the training once. The duration of the training is 15 days for one of the farmers and 1 month for the other. As a summary, the general opinion of farmers regarding agricultural training is affirmative. 81.7% of the trained farmers said the training were relevant and timely, 92% said they were

helpful in developing skill, 2.56% gave no comment and 5.44% said they were not helpful.

The other forwarded question was did you participate in any other skill training programs? 6 farmers said yes and the kind of skill training mentioned was carpentry (1 farmer), weaving (4), carpet making (1 farmer).

4.2.4 Livestock Resources

Livestock production is an important component of the agricultural system of the woreda, particularly Meket is one of the few Woredas in North Wollo known for their sheep production. Moreover, one can find other types of livestock and ownerships of livestock as presented by average ownership per sampled farmer is presented in the following table.

Table 5. mean summary of livestock ownership of sampled farmers, meket woreda, 1997/98.

No	Types of livestock	No. of farmers owning	Mean	Standard deviation	Maximum	Minium
1	Cow	106	1.56	0.71	4	1
2	Oxen	99	1.48	0.67	5	1
3	Heifer	89	1.83	1.04	6	1
4	Sheep	87	8.26	5.93	31	1
5	Goat	39	4.61	3.18	12	1
6	Mules	10	1.1	0.31	2	1
7	Horse	40	1.45	0.78	4	1
8	Donkey	32	1.5	0.67	3	1
9	Chicken	93	3.39	2.03	10	1

As can be seen from Table 5, 106 sampled farmers own 1 to 4 cow. Sheep ownership show the highest range. Ox is an important animal particularly for cultivation. The average ownership of

oxen is 1.48 with standard deviation of 0.67. In terms of agro-ecology, the average number of oxen is 0.778, 1.06, 0.889, 1.33 for frost, dega, woyna dega and kolla respectively. Sampled farmers were asked if they have faced shortage of oxen during the 1997/98 production season. 142 farmers responded to this question and 95 (66.9%) farmers said yes, 47(33.1%) farmers on the other hand, said no. With regards to solving the problems of shortage of oxen, the recorded responses are oxen sharing (52.08%), oxen renting (27.08%), using hand tools (3.12%), using horse (12.5%), leaving the land uncultivated (5.22%).

Table 6. Summary of Mean and standard deviation of variables used in the regressions

VARIABLES	FROST		DEGA		WOYNA-DEGA		KOLLA		WOREDA	
	Mean	Stan. Dev	Mean	Stan. Dev	Mean	Stand. Dev	Mean	Stan. Dev	mean	Stan Dev
SEXHHH	0.888	0.319	1	0	1	0	0.917	0.280	0.951	0.216
AGEHHH	39.1	9.96	43.5	9.85	47.06	12.33	46.1	12.9	43.9	11.6
EDUCHHH	1.30	2.35	0.833	1.59	0.972	2.35	0.861	1.76	0.99	2.02
REWRHHH	0.611	0.494	0.5	0.507	0.389	0.494	0.333	0.478	0.46	0.5
FAMSIZE	4.94	1.71	5.86	1.71	5.39	1.32	5.72	2.24	5.48	1.79
TOTLANCU	0.680	0.539	0.830	0.582	0.870	0.292	1.150	0.100	0.880	0.597
DFERTLAN	0.444	0.504	0.389	0.494	0.194	0.401	0.556	0.504	0.396	0.491
OWNGRAZI	0.200	0.165	0.270	0.232	0.150	0.100	0.250	0.090	0.220	0.102
DUSEMANU	0.167	0.378	0.139	0.351	0.278	0.454	0.056	0.232	0.159	0.368
D ₁ AGEC	0	0	1	0	0	0	0	0	0.25	0.435
D ₂ AGEC	0	0	0	0	1	0	0	0	0.25	0.435
D ₃ AGEC	0	0	0	0	0	0	1	0	0.25	0.435
NUMOXEN	0.778	0.681	1.06	0.791	0.889	0.785	1.33	1.15	1.48	0.67
TOTVALLS	1433	1129	1472	1316	1186	967	1718	1332	1453	1198
EXTCONTA	2.97	0.810	2.42	0.906	2.25	0.649	2.75	0.769	2.59	0.831
DAGRTRIN	0.333	0.478	0.25	0.439	0.278	0.454	0.25	0.44	0.278	0.449
DSKILTRA	0.028	0.167	0	0	0	0	0.028	0.167	0.014	0.117
DEMOPLLOT	0	0	0.167	0.378	0.444	0.504	0.444	0.504	0.264	0.442
DOTHCRED	0.361	0.487	0.222	0.421	0.194	0.401	0.389	0.494	0.292	0.456
FARINCOM	980	692	1260	1098	692	962	1173	660	1091	808
DISEXTE	5.09	3.88	1.59	0.981	2.72	1.51	5.21	4.07	3.65	3.31
DISROAD	4.14	3.71	1.20	1.02	6.07	5	5.07	4.20	4.12	4.17

4.3 Technology Profitability Analysis for Major Food crops

Technology profitability analysis using value cost ratio method is well documented in Mulat (1996), Mulat et al (1998) and SG-2000 (1995). According to Mulat et al (1998), "The value cost ratio (VCR) measures the return farmers receive from investing in a technology, for example, fertilizer. It is generally believed that farmers would like to see a 100% return or a VCR equal to or greater than 2 in order to make the necessary investment decision".

The VCR calculated for the two major crops of the Woreda, namely Barley and wheat is presented in table 7. Fertilizer and seeds are the only inputs considered in cost and return calculations owing to the shortage of accurate information on cost details of other inputs. Average yield per hectare of the selected crops with and without using improved technologies is calculated using the raw data collected from sampled farmers. Information on price and quantity of straw is obtained from secondary data. Price of fertilizer and seeds are farm gate prices (See appendix I for details).

The VCR for barley even without including the value of straw is above the Critical threshold of 2. This result is very much pleasing in a sense that productivity of barley, being a major crop in the woreda, can be substantially enhanced if farmers apply fertilizer on their barley land though the crop variety is local. Including the value of straw in the calculation, the VCR for the same crop is 3 which means, income from barley production can be tripled if farmers use fertilizer. On the other hand, the computed VCR for wheat is below the critical threshold when excluding the value of straw and almost equal to it (1.98) when including the value. For this crop the technologies seen are fertilizer and improved wheat seeds such as ET 13, K 6295-4A and K 6290 Bulk. A VCR below 2 may illustrate why the risk of bad years would create considerable

strain on farmers and may seriously jeopardize repayment of seed and fertilizer loan (Mulat et al, 1998). In view of this, in areas like Meket where the rainfall pattern is unreliable, indepth profitability analysis of fertilizer with and without improved seeds may be needed to recommend which combination of inputs is better, at least in the short run, to minimize risk.

Table 7. Value-Cost Ratio Estimates of two Major Crops (Labour Cost Excluded) Calculated using farm gate price, Meket, 1997/98, Meher Season.

Crop Type	cost of Production							Income from Production					Value-Cost Ratio		
	Fertilizer				Seed			Grain		straw		Total income (Birr/Ha)	Exclud ing Straw	Includi ng straw	
	DAP		UREA		Tot. Fer t. Cost (Birr/ha)	Amount (Kg/ha)	Cost (Birr/ha)	Tot.Prod Cost (Birr/ha)	Yield (Qt/ha)	Value (Birr/ha)	Amt. Produc ed (Qt/ha)				Value (Birr/h a)
	Amnt. (kg/ha)	cost (Birr/ha)	Amount (kg/ha)	Cost (Birr/ha)											
<u>Barley</u>															
-With out Impro. Tech.	100	255	50	120	375	125	238	238	7.47	1307	17.5	315	1622		
-With improve. Tech.	100	255	50	120	375	125	238	613	12.66	2216	29.6	533	2749		
-Difference due to tech	100	255	50	120	375			375	5.19	909	12.1	218	1127	2.42	3
<u>Wheat</u>															
-Without improve. tech	100	255	100	240	495	150	285	285	6.96	1322	27.8	389	1711		
-With improve. Tech.	100	255	100	240	495	150	433	928	12.13	2305	48.5	679	2984		
-Difference due to tech	100	255	100	240	495		148	643	5.17	983	20.7	290	1273	1.53	1.98

Note: Refer to Appendix I for assumption taken to calculate Value cost-ratio

4.4 Econometric Analysis

4.4.1 Hypotheses and Definition of Variables

4.4.1.1 Hypotheses

A farmers' decision to adopt or reject agricultural technologies at any time is hypothesized to be influenced by many factors including human, economic, social and other factors. However, the degree of influence of these factors vary from place to place and the following variables are hypothesized to affect agricultural technology adoption in the study area.

4.4.1.1a Fertilizer and/or Improved Seed (Crop Technologies)

Age of household head: In areas like Meket where the food security problem is serious, farmers may be apt to try out any method that is proposed as "a remedy to mitigate poverty". Especially, Farmers living in the area for so long and hence having long years of farming experience are assumed to accept crop technologies easily because their long years exposure to traditional and little or no input use and improved farming practices may initiate them to appreciate the problem very easily. Therefore, it is hypothesized that age of household head is positively related to fertilizer and/or improved seed adoption.

Education of household head: Education is believed to enhance farmers ability to obtain, understand and utilize new ideas and concepts. Moreover, farmer's with a relatively higher education level are considered to make better resource allocation decisions than those with

lower education level. Therefore, it is hypothesized that, farmers with higher education are more likely to adopt agricultural technologies.

Family Size: Resource poor farmers mainly rely on family labour to produce food. The demand for family labour increases as farmers use improved crop technologies. In view of this, limited family labour may discourage the adoption of agricultural technologies. Therefore, family size, as a proxy for the supply of family labour, is assumed to positively and significantly affect technology adoption.

Total cultivated land: Land shortage is a serious problems in the study area. Also, agricultural extension education has a very recent history. Therefore, farmer's having relatively larger farm size are assumed to allocate atleast part of their land to try recommended technologies as compared to farmers with smaller land size. This hypothesis is in line with the theory that supports the risk aversion behaviour of farmers.

Use of manure: If farmers apply manure on their farm land, they may not be motivated to incur additional cost to purchase inputs. Application of manure, therefore, is assumed to negatively affect the use of improved crop technologies particularly the use of fertilizer.

Number of Oxen owned: In the study area, ploughing is done using traditional plough which is mainly pulled by a pair of oxen, though, animals like horses could also be used. Therefore, oxen shortage may result to the untimely operation of farm activities and the latter in turn may lead to the non-effectiveness of the applied technologies. Hence it is hypothesized that the number of oxen owned by farmers is positively related to the adoption of crop technologies.

Agro-climatic condition: The study area in general is characterized by unfavourable weather condition for crop production. However, some sort of variation is expected among the different agro-ecological zones. Therefore, farmers operating in a relatively better weather condition are assumed to adopt better crop technologies. These farmers are expected to be found in Dega and Woyna Daga agro-ecological zones than in Frost and Kolla zones.

Attendance of Agricultural training programmes: farmers training is one of the major components of the present agricultural extension activity. Training on the importance and use of improve agricultural technologies is necessary to accelerate the popularization and/or transfer of these technologies. Therefore it is hypothesized that farmers having access to agricultural training programs are more likely to adopt the specified technologies.

Close exposure to technology: Availability of extension demonstration plots and/or trial sites in close vicinity to farmers in general is taken as a proxy to close exposure to technology. Farmers who are near to these sites are supposed to develop positive attitude of using improved technologies and therefore close exposure to technology is hypothesized to be positively related to adoption.

Extension contact: Agricultural extension service is essential to communicate information about better technologies so as to help farmers produce more food. Hence, it is hypothesized that farmers who have greater extension contacts with extension workers are more likely to adopt agricultural technologies.

Value of livestock owned: In the study area, livestock mainly sheep rearing is complementary to crop farming. Ownership of livestock can be a proxy for the wealth position of the farmers.

Therefore, it is hypothesized that farmers with a relatively higher values of livestock are likely to adopt crop technologies.

Farm income: Farmer's problem with regards to shortage of cash to either pay downpayments or settle previous loans can be partially tackled if there is an increase in farm income. Therefore, farm income as measured by the income obtained from crop and crop residues is hypothesized to be positively related to adoption of agricultural technologies.

4.4.1.1b Cow and Sheep ownership (Traditional Livestock Technologies)

Literacy: Farmers who can read and write are considered to accept new ideas and concepts easily. This is probably because education enhances their decision making ability. In the study area, where the rainfall pattern is unreliable, crop failure is evident in many of the years. Therefore, those who are better educated may keep livestock as a security for times of such disaster. In view of this, literacy level is hypothesized to be positively related to ownership of cow and sheep.

Agro-Climatic condition: The type of livestock owned by farmers vary from one ecology to another. For example, in the case of small ruminants, highlanders own more sheep than goats and lowlanders own more goats. Therefore, Sheep ownership is expected to be positively related to the agro-ecological dummy variable representing Dega and negatively related to the agro-ecological variable representing kolla. The hypothesis regarding cow ownership is, farmers who own livestock are more likely to be present in Dega and Woyna Dega than in Kolla and Frost Zones.

Family Size: It is mentioned some where in this paper that farmers of the study area are resource poor farmers. On the other hand, increase in family size may require more money to satisfy atleast basic needs of the family and this again may imply little or no money for asset ownership like livestock. Hence, it is hypothesized that family size is negatively related to ownership of cow and sheep.

Total land Cultivated: The larger the size of land to be cultivated, the better the amount of animal feed to be produced and the more likely to own livestock. Therefore, this variable is expected to be positively related to ownership of livestock.

Own grazing land: Farmers who own private grazing land are more likely to keep livestock. This variable, therefore, is hypothesized to have positive influence on livestock ownership.

Attendance of agricultural training programmes: Training, especially the one that focus on livestock husbandry is expected to have a positive impact on livestock ownership.

Access to Credit: Resource poor farmers may require credit to own farm assets. Hence, it is hypothesized that farmers who have access to livestock credit may be motivated to own sheep and cow.

Farm income: The higher the farm income of a household, the better the chance to diversify production and the higher the probability of ownership of livestock. Therefore, this variable is expected to positively influence the specified dependent variables.

4.4.1.2 Definition of Variables

4.4.1.2.a Crop Technologies

a) Dependent Variable

DEPADOPT = 1 if the farmer used improved seeds and/or fertilizer
= 0 Otherwise.

b) Independent variables

1. SEXHHH = 1 if household head is male
= 0 otherwise
2. AGEHHH = Age of household head in years
3. EDUCHHH = Formal education of household head as measured by grades achieved or number of years in school
4. FAMSIZE = Family size representing the total number of household members in a given household.
5. TOTLANCU = Total land cultivated in hectare
6. DFERTLAN = 1 if land cultivated is fertile
= 0 otherwise
7. DUSEMANU = 1 if manure is applied on plot of land
= 0 Otherwise
8. D₁AGEC = 1 if agro-ecological zone is Dega
= 0 Otherwise

- 9.D₂AGEC = 1 if agro-ecological zone is Woyna Dega
= 0 otherwise
- 10.D₃AGEC = 1 if agro-ecological zone is Kolla
= 0 Otherwise
- 11.NUMOXEN = Number of oxen owned by the household
- 12.TOTVALLS = Total Value of livestock owned by farmer
13. EXTCONTA = Average number of extension contacts per month made by
farmer with extension agent
14. DAGRTRIN = 1 if household had attended agricultural training programmes
= 0 otherwise
- 15.DSKILTRA = 1 if farmer attended skill trainings other than agriculture
= 0 otherwise
- 16.DEMOPLOT = 1 if there is extension demonstration plot or trial site in the
vicinity of own farm/home as a proxy for close exposure to
technology
= 0 otherwise
17. FARINCOM = Total farm income in birr
- 18.DISEXTE = Distance of respondent home form extension center (Kms)

4.4.1.2.b Ownership of cow and sheep

a) Dependent Variables

1. REARCOW = 1 if the farmer owns cow
= 0 otherwise

2. REARSHEE = 1 if the farmer owns sheep
= 0 otherwise

b) Independent Variables

1. SEXHHH = 1 if household head is male
= 0 otherwise
2. AGEHHH = Age of household head in years
3. REWRHHH = 1 if farmer can read and write
= 0 otherwise
4. FAMSIZE = Family size representing the total number of
household members in a given household
5. D₁AGEC = 1 if agro-ecological zone is Dega
= 0 otherwise
6. D₂AGEC = 1 if agro-ecological zone is Woyna Dega
= 0 otherwise
7. D₃AGEC = 1 if agro-ecological zone is Kolla
= 0 otherwise
8. TOTLANCU = Total land cultivated in hectare
9. OWNGRAZI = Grazing land in hectare owned by the respondent
10. DAGRITRIN = 1 if household had attended agricultural training
programmes
= 0 otherwise
11. DOTHCRED = 1 if farmer has access to livestock credit
= 0 otherwise

12. FARINCOM = Total farm income in birr
13. DISTROAD = Distance of respondent home from main road

4.4.2 Empirical Results

Results of the estimated probit models for each of the selected technologies is presented in table 8, 9 and 10. The marginal effects of the explanatory variables on the probability of farmers adoption decision are also shown in these tables.

The maximum likelihood ratio test indicates the overall goodness-of-fit for all the models at a probability of less than 1%. The observed probabilities of fertilizer and/or improved seeds adoption, cow and sheep ownership is 36.8%, 75% and 61% respectively. On the other hand, the predicted probabilities of these variables in the above order is 34.6%, 82.3% and 63.2%. The pseudo R^2 for cow and sheep ownership is low (19.5% and 16.4% respectively) as compared to its value for fertilizer and/or improved seed adoption which is 24.5%.

Variables that are found to significantly explain the decision of farmers to adopt fertilizer and/or improved seed are EDUCHHH, DAGRTRIN, FAMSIZE, and FARINCOM. These variables, besides being significant, are positively related to the dependent variable DEPAADOPT. On the other hand, ownership of sheep is influenced by AGEHHH, D₃AGEC, TOTLANCU and DISTROAD. However, cow ownership is significantly affected by TOTLANCU, DOTHCREC and FARINCOM.

Detailed discussion of the relationship between the explanatory variables and the decision of farmers to adopt the specified agricultural technologies is discussed below.

4.4.2.1 Fertilizer and/or improved seeds adoption

4.4.2.1.1 Human Resources Variables

The quantity and quality of human resources possessed by a peasant household may be measured by the amount of family labour, educational background, age and gender of the household head (Mulat et al, 1998). In line with this explanation, the effect of these variable on adoption decision of farmers is presented below.

Education of Household Head (EDUCHHH)

The education variable, as expected is significantly and positively related to adoption of improved seed and/ or fertilizer at the 10% significant level. This finding is consistent with the conclusions drawn by most previous agricultural technology adoption studies that are reviewed in this paper. The studies, with few exceptions, concluded that farmers education increase productivity of outputs and the tendency of farmers to adopt agricultural technologies. For example, Andre et al (1998) found that education of the farmer is one of the factors that positively and significantly influence demand for fertilizer in Ethiopia. Similar findings are reported by Berhanu (1993), Asfaw et al (1997) and Lelissa (1998). The marginal analysis also showed that other factors held at their mean level, a change of farmer's schooling from the lower to the next higher level has a marginal effect of about 4% on his/her probability to adopt improved seed and/or fertilizer.

Participation in agricultural training programmes (DAGRTRIN)

This variable is also positively and significantly related to the adoption of fertilizer and/or improved seed as anticipated. The marginal effect of this variable on probability of adoption of

these technologies is 29%.

Participation in other skill training programmes (DSKILTRA)

This variable negatively affects fertilizer and/or improved seed adoption even if the effect is not significant. Had it been significant, it may reveal that training farmers on professions like carpentry, carpet making and masonry, etc. negatively affects the probability of adoption of these technologies.

Sex of household head (SEXHHH)

The sign of this variable is negative though not significant for the dependent variable DEPADOPT. The justification to this is not obvious at the moment which may call for further investigation.

Age of household head (AGEHHH)

Eventhough age of household head is not significantly related to fertilizer and/or improved seed adoption, its sign is as expected. This implies that age difference among households has no influence on the decision of farmers to adopt these technologies.

Family size (FAMSIZE)

The relationship between adoption of fertilizer and/or improved seed and family size is found to be strong as originally hypothesized, indicating that this variable is important in influencing the decision of farmers to adopt these technologies. The direction of relationship of these variables is as expected and is significant at 1% level. Assuming that family size is an appropriate proxy for family labour, it is very likely that households endowed with a relatively reasonable family size have the opportunity to undertake appropriate cultivation practices (such

as proper timing of planting and weeding) which are components of crop production packages.

The result, once again, is consistent with Andre et al (1998) and Lelissa (1998). A study made by Misiko also showed a similar result. However, to Getachew (1993), household size was found to be insignificant factor in influencing the adoption of coffee technologies in Gimbii, Ethiopia. The marginal effect of family size on the probability of adoption of these technologies is 8.3%.

4.4.2.2 Other factors influencing adoption

Total land cultivated (TOTLANCU)

As opposed to what is hypothesized, the coefficient of this variable has negative sign though not significant in the case of fertilizer and/or improved seed adoption. The negative sign perhaps indicates that farmers who cultivate relatively larger farm size practice crop rotation which is useful to increase crop production. Legesse (1992) also found that farm size, though with positive sign was not important factor affecting the probability of adoption of improved varieties and intensity of fertilizer use. However, Itana (1985) discovered that farm size positively and significantly affects the adoption of Wolenkomi extension center.

Fertility of land (DFERTLAN)

As one may expect, this variable negatively affects the dependent variable DEPADOPT which obviously indicate that the more the land is fertile, the less the probability of using fertilizer. However, the result shows that the influence is not significant.

Use of Manure (DUSEMANU)

As expected DUSEMANU it is negatively related to DEPADOPT because the application of



manure on farm land decreases the probability of adoption of fertilizer.

Agro-Climatic Condition

The three dummy variables (D_1 AGEC, D_2 AGEC and D_3 AGEC) created to capture variations among the different agro-ecologies showed similar signs (positive) when the dependent variable is DEPADOPT. Moreover, all of them are insignificant. This result may indicate that fertilizer and/or improved seed adoption in the study area is not influenced by variations in agro-ecology.

Extension Contact (EXTCONTA)

This variable has the expected positive sign, though not significant, in the case of fertilizer and/or improved seed adoption. Legesse (1992) also reported that direct extension visits by extension agents was not found to be significantly influencing adoption of wheat and maize technologies in Arsi Negele because of the limited frequency of direct extension agents visits to non-contact farmers. Tesfai (1975) came across with a negative sign for the variable extension contact. However, Chilot et al (1996) found that number of contact with extension workers significantly and positively influenced the probability of adopting new improved wheat. The marginal effect of this variable is less than 1% which may need further investigation.

Availability of Demonstration Plot (DEMO PLOT)

DEMO PLOT is positively related to fertilizer and/or improved seed adoption but is not statistically significant. The marginal effect of this variable is about 19.7% implying that for discrete change of this dummy variable from 0 to 1, the probability of adoption of these technologies will increase by the same percent, all other factors being constant.

Number of Oxen Owned (NUMOXEN)

Number of oxen is positively but insignificantly related to fertilizer and/or improved seed adoption. Its positive sign may indicate that ownership of oxen is essential to run farm activities timely. The marginal effect of NUMOXEN on DEPADOPT is only 2%.

Total Value of Livestock (TOTVALLS)

This variable entered as a proxy for wealth status of respondents has a positive sign (as one may expect) but is not statistically significant in influencing the probability of adoption of fertilizer and/or improved seed.

Farm Income (FARINCOM)

As expected, farm income is positively and significantly related to DEPADOPT. Households with higher farm income are more likely to use fertilizer and/or improved seed may be because they have the cash to pay for down payments or even to purchase the inputs in cash. Berhanu (1993) also found that the level of fertilizer consumption in the former Ada Awraja is seriously affected by annual farm income.

Distance from Extension Center (DISTEXTE)

DISTEXTE as measured by the distance of the respondents' homes from the extension centers (kms) negatively but not significantly affects the adoption of fertilizer and/or improved seeds. The negative sign may show that the farther the respondents home from extension centers, the less likely the farmer will have access to extension information.

Table 8. Determinants of Fertilizer and/or improved Seed Adoption (Probit Estimates)

Variable	Coefficient	T-Ratio	Marginal Effect
SEXHHH	-0.493657	-0.661	-0.192709
AGEHHH	0.0152424	1.108	0.0057887
EDUCHHH	0.1181392	1.732***	0.0445735
D1AGEC	0.7112561	1.594	0.2677687
D2AGEC	0.1978334	0.403	0.078709
D3AGEC	0.0296786	0.067	0.0002097
FAMSIZE	0.224026	2.668*	0.0832043
TOTLANCU	-0.517521	-1.455	-0.1839796
DFERTLAN	-0.0756724	-0.265	-0.0441717
DUSEMANU	-0.3251166	-0.830	0.1194903
DEMOPLT	0.5169767	1.566	0.1968826
EXTCONTA	0.019938	0.109	0.0057089
DAGRTRIN	0.7615486	2.259**	0.2905417
DSKILTRA	-1.043452	-0.955	-0.2815429
FARINCOM	0.0005862	2.219**	0.000213
TOTVALLS	0.0000663	0.362	0.0000232
NUMOXEN	0.0555688	0.289	0.0200391
DISTEXTE	-0.04643	-1.018	-0.0172769
CONSTANT	-2.881492	-2.758*	
Number of Observation = 144 LR Chi 2 (18) = 46.44 Prob > chi 2 = 0.0001 Pseudo R2 = 0.2451 Observed probability = 0.3680556 Predicted probability = 0.3459138			

Note = *, ** and *** indicate significant level at 1, 5 and 10%, respectively.

4.4.2.2 Cow and Sheep ownership

4.4.2.2.1 Human Resources Variables

Literacy (REWRHHH)

The variable REWRHHH has a positive sign but is not statistically significant. The positive sign may indicate that farmers who can read and write are more likely to own livestock, in this particular case cow and sheep. This finding perhaps signifies the importance of education even in adopting traditional technologies. The marginal effect of being able to only read and write on ownership of cow and sheep is nearly the same-about 5%.

Participation in agricultural training programmes (DAGRTRIN)

The influence of agricultural training on ownership of cow and sheep is insignificant. However, the sign of DAGRTRIN is negative for REARSHEE. The suspected reason for the negative sign is that agricultural training given to farmers in the study area are crop biased and hence little or no effort to train farmers on livestock husbandry. In any case, this calls for further research.

Sex of household head (SEXHHH)

The sign of SEXHHH is positive for both REARSHEE and REARCOW. However, it is not statistically significant. This may imply that sex difference does not create significant variation among farmers in ownership of cow and sheep.

Age of household head (AGEHHH)

This variable is insignificant and negatively related to cow ownership. The negative sign again calls for further study but one may suspect the following reason. Aged people mainly have little opportunity to diversify their income. As a result, their limited income could be spend to satisfy basic needs of the family and hence rare chance to own such important assets (dairy cows). On the other hand, its effect on REARSHEE is positive and statistically significant at 10% level. The reason to this perhaps is, if aged farmers are not likely to own large animals, they will strive to own the smaller one's because livestock husbandry is major component of the agricultural system in the study area. However, the marginal effect of this variable on sheep ownership is less than 1%.

Family Size (FAMSIZE)

Ownership of Cow and Sheep are negatively and insignificantly related to this explanatory variable. The negative sign perhaps indicates that large sized families have little or no additional income to own these animals because they allocate most of their income to feed their family members.

4.4.2.2.2 Other factors influencing adoption

Total land Cultivated (TOTLANCU)

TOTLANCU is positively and significantly related to REARCOW and REARSHEE at 1 and 5% level respectively. This may partly be explained by the feed requirement of livestock. Shortage of private grazing land is acute in the study area and the alternative source of animal feed is crop residues. The larger the size of land to be cultivated, the better the amount of animal feed to be produced and the more likely to own livestock provided that

there are no constraints of ownership of livestock. The other possible reason is, farmers with bigger farm size are likely to fetch more harvest than farmers with small farm size which may enable them to own animals. The marginal effect of this variable on cow and sheep ownership is 29.4 and 26% respectively.

Own grazing land (OWNGRAZI)

The variable is positively related to ownership of sheep and cow, eventhough, it is not significant. The sign may imply that farmers who own private grazing land are more likely to own livestock.

Farm income (FARINCOM)

As expected, FARINCOM is positively and significantly related to cow ownership at 10% level of significance. It is also positively related to sheep ownership though not significant. This perhaps indicates that farm income is one and probably the major means to diversify production possibilities in the study area.

Agro-Climatic Condition

The dummy variables for agro-ecology show different signs for the two types of livestock. D_1AGEC is not significant in both cases but is positive in case of REARCOW and negative in case of REARSHEE. Eventhough D_1AGEC is not statistically significant, further study could be needed to dig out the reason why sheep ownership is negatively related to the agro-ecological zone Dega. By the same taken, D_2AGEC is also not significantly related to both of the dependent variables. But it has a negative sign when the dependent variable is REARCOW and a positive sign when the dependent variable is REARSHEE. D_3AGEC is negatively and significantly (at 10% level) related to REARSHEE which indicates that the probability of

ownership of sheep decreases where the agro-ecological zone is Kolla. This is consistent with the reality-goats are quite common in Kolla than sheep. The sign of this variable is negative but not significant in case of REARCOW. So one may observe that, unlike sheep ownership, variation in agro-ecology does not significantly explain cow ownership differences among farmers in the study area.

Distance from Main Road (DISTROAD)

DISTROAD, in the case of ownership of cow, has positive sign eventhough it is insignificant. But its sign is negative and its influence is significant in the case of sheep ownership. The possible explanations for the latter case could be the following. First, it is expected that population density decreases as one moves far from main roads. This may again mean less pressure on cultivable and grazing land. Such situation could induce farmers to own more sheep. Second, farmers living near main roads usually involve in petty trades and other secondary occupations besides to farming. As a result, time and other constraints may discourage them to diversify agricultural activities. In the case of cow ownership, the positive sign may indicate that the nearer the farmers are located to main roads, the more they are advantaged to sell milk and milk products.

Access to Other Credit (DOTHCREC)

Other credit refers to credit delivered to purchase livestock. Farmers, in the study area, sometimes get credit for purchase of animals mainly the small one's. Therefore, this variable is entered to see its impact on ownership of cow and sheep. The obtained result showed that DOTHCREC has a positive sign but is not statistically significant in case of REARSHEE but it is positively and significantly related to cow ownership.

Table 9 - Determinants of Cow Ownership (Probit estimates)

Variable	Coefficient	T-Ratio	Marginal Effect
SEXHHH	0.296823	0.489	0.0863678
AGEHHH	-0.0134376	-0.975	-0.0034893
REWRHHH	0.2059609	0.649	0.0538919
D ₁ AGEC	0.0334194	0.076	0.0086107
D ₂ AGEC	-0.1957872	-0.475	-0.0531161
D ₃ AGEC	-0.4940912	-1.155	-0.1422504
FAMSIZE	-0.0526108	-0.586	-0.0136614
TOTLANCU	1.132595	2.839*	0.2941011
OWNGRAZI	0.5540116	0.618	0.1438602
DAGRTRIN	0.1594783	0.467	0.0400454
DOTHCRED	0.5806905	1.766***	0.1339782
FARINCOM	0.0003767	1.654***	0.000978
DISTROAD	0.0408212	1.140	0.0106
CONSTANT	-0.32398	-0.404	
Number of Observation = 144 LR Chi 2 (13) = 31.52 Prob > chi 2 = 0.0028 Pseudo R2 = 0.1946 Observed probability = 0.75 Predicted probability = 0.8229641			

Note = * and *** indicate significant level at 1 and 10%, respectively.

Table 10 - Determinants of Sheep Ownership (Probit Estimates)

Variable	Coefficient	T-Ratio	Marginal Effect
SEXHHH	0.4188719	0.716	0.1640982
AGEHHH	0.0199354	1.664***	0.0075125
REWRHHH	0.1528193	0.566	0.0576614
D1AGEC	-0.300707	-0.782	-0.1154984
D2AGEC	0.4359036	1.131	0.156403
D3AGEC	-0.6763675	-1.796***	-0.2611811
FAMSIZE	-0.0063355	-0.084	-0.0023875
TOTLANCU	0.6923605	2.445**	0.26091
OWNGRAZI	0.689131	0.853	0.259693
DAGRTRIN	-0.0423423	-0.151	-0.0160053
DOTHCREC	0.2958265	1.080	0.1086437
FARINCOM	0.0001262	0.679	0.0000476
DISTROAD	-0.0913488	-2.824*	-0.034424
CONSTANT	-1.387668	-1.816***	
Number of Observation = 144 LR Chi 2 (13) = 31.56 Prob > chi 2 = 0.0028 Pseudo R2 = 0.1640 Observed probability = 0.6111111 Predicted probability = 0.6321743			

Note = *, ** and *** indicate significant level at 1,5 and 10% respectively.

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

5.1 Summary and conclusion

Agriculture is the mainstay of the Ethiopia economy. It provides livelihood for the majority of the population and constitutes a larger share of the country's GDP. However, agricultural productivity has been low for decades and the food security problems is quite common to most regions of the country. Several reasons can be cited for the low productivity of agriculture among which little use of better agricultural technologies is one.

Currently, attempts are being made to reverse this situation. One effort is to launch an extension system that can facilitate the use of improved agricultural technologies. Farmers training is one of the components of the extension system aimed at familiarizing farmers with the type, nature and use of the technologies. Training is more effective when the trainee can at least read and write. To this end, expansion of education deserves due attention.

Like many other place in the country, the use of improved agricultural technologies (both crop and livestock) in North Wollo, including the case study area Meket, is low. Therefore, with the aim of identifying the various factors that determine the adoption of improved crop technologies and ownership of livestock particularly Cow and Sheep, a field survey was conducted. The survey was handled in such a way that 144 farm households residing in 4 agro-

ecological zones (8 Peasant associations) were randomly selected and interviewed using a structured questionnaire. The econometric model chosen to analyze the data is the probit model. An attempt is also made to see whether or not improved crop technologies are profitable in the study area by calculating value cost ratio to Barley and Wheat.

The computed descriptive statistics for explanatory variables that are entered in the probit estimation indicated that the average age of the sampled household heads is 43.95 and their family size, on average, is 5.48. With regards to the educational attainment of sampled household heads, 33 of them (22.9%) are currently attending or have already attended formal schooling. Moreover, additional 33 farm household heads which did not or are not attending any formal schooling can read and write which means, altogether, 66 household heads can read and write. Of the 33 formally schooled respondents, those who adopt both fertilizer and improved seeds are only 11. This figure is 6 and 17 for those who can read and write and those who are non-literate. In total adopters of both fertilizer and improve seeds are 34(23.6%). But those who adopt fertilizer and/or improved seed are 53 (36.8%).

The average land holding of sampled farmers is 1.17. This figure includes own cultivated, sharecropped out, fallow and grazing land. Barley is the major food crop growing in the Woreda (26.62%) to be followed by wheat (17.51%).

Farmers' training is one of the components of the agricultural extension activities in the woreda. In 1997/98, 40 farmers (27.8%) out of the 144 sampled farmers have got training on general agriculture (4 farmers), soil and water conservation (26), crop protection (1), extension methodology (4), animal health (1) and others (4). Besides to agricultural training programmes, farmers got other skill training in which case 1 farmer was trained in carpentry, 4 in weaving

and 1 in carpet making.

With regards to livestock resources, 106 sampled farmers owned 1 to 4 Cows and 87 households own 1 to 31 sheep. The result indicated that livestock production is an important component of the agricultural system of the study Woreda.

The estimated value cost ratio to analyze the profitability of improved technologies showed that planting local barley seed with fertilizer is highly profitable with a value cost ratio of 3 as compared to planting improved wheat variety with fertilizer which has a value cost ratio of nearly 2.

The estimated probit models indicated that the factors that significantly determine the adoption of improved seeds and/or fertilizer in the study area are the educational level of household heads (EDUCHHH), family size (FAMSIZE), participation in agricultural training programs (DAGRATRIN) and farm income (FARINCOM). The result clearly uncovers the importance of human capital investment in the pace to increase agricultural productivity by disseminating agricultural innovations to farm households. With regards to livestock resources, it is discovered that, sheep ownership is significantly influenced by age of household heads (AGEHHH), agro-climatic condition (D₃AGEC), total land cultivated (TOTLANCU) and distance of respondents home (in KMS) from the main road. Cow ownership on the other hand, is significantly affected by total land cultivated (TOTLANCU), farm income (FARINOM) and access to credit (DOTHCREC).

The econometric and profitability analysis of technology adoption showed that the effort of the national as well as the regional government to boost agricultural production through

dissemination of diversified and region specific agricultural technologies is not a futile exercise. This is particularly true for crop technologies. The result of the study disclosed that, to make great strides in agricultural development, the use of improved agricultural technologies is something which demand due attention. Also, a concerted effort is required to uphold the already started dissemination of improved animal breeds especially in areas where the potential for increasing animal productivity is very high.

The major reason of farmers who did not apply fertilizer on their farm land is: was not sure of the result (37.41%) and do not expect yield difference (18.7%). This clearly calls for a strong and practical extension intervention in the study area. similarly, the recorded major responses for not using improved crop varieties are: not heard about their existence (60.77%) and was not sure of the result (12.54%) which still wakes up development practitioners to look into the extension undertakings in the study area.

In general, the exercise in this paper revealed the importance of human capital investment (be it in the form of formal schooling or non-formal agricultural skill training) and this may imply that, the expansion of quality education(both formal and non-formal) to the rural poor is crucial to achieve the long run objective of food security.

In this regard, a lot is expected from the government either is designing appropriate policies or in financing major development undertakings that assist the efforts being made is boosting agricultural production. This proposition in no way underestimates the role to be played by other stakeholders including the community.

5.2 Policy Implications

Several policies for the acceleration of use of agricultural technologies are implied by the empirical results of this study. First, the fact that education of household head is found to be a statistically significant factor affecting the use of fertilizer and/or improved seed calls for infrastructural development dealing with education. The outcome of the case study clearly supports the proposition that better educated farmers have greater access to information which will enable them to use better technologies. Therefore, easy access to formal education as well as promoting functional literacy for adults should be given due attention in the pace to increase agricultural productivity.

Second, participation in agricultural training programmes is the other significant factor influencing fertilizer and/or improved seed adoption. The task of training farmers is mainly accomplished by agricultural extension agents. The fact that this variable is significant calls for many action to be undertaken jointly. One action could be upgrading the skill and capabilities of extension agents who are responsible for disseminating appropriate and timely agricultural information to farmers. This can be done by providing frequent, up to date and relevant training to extension agents. Furthermore, upgrading their qualification so as to motivate them and even to make them more creative is something to be looked into. On the part of the farmers, every effort should be made to give them easy to understand and more practical training than simply dealing with complicated and theoretical scientific jargon. This should of course, be complemented by subsequent, timely and relevant training that deal with up to date information. If these and other endeavours are made to strengthen the extension system, considerable progress can be made in accelerating the use of better agricultural technologies.

Third, family size is the other significant factor discovered in the study. This may partly

explain the seasonality of agricultural activities and the need for more labour input during peak agricultural activities. But this should never induce the wrong impression that family size should increase indefinitely to accelerate the adoption of agricultural technologies. Rather, it is a reminder that government offices should encourage and facilitate the establishment of mutual aid teams and even device a mechanism to improve the rural labour market.

Fourth, encouraging farmers to increase their farm income may be by intercropping cash crops with food crops or by planting adaptable tree species on their farm land borders is the other issue to consider to accelerate the adoption of agricultural technologies.

Fifth, in places like the study area where there is low, unevenly distributed and generally unreliable rainfall pattern, crops that are fast maturing and drought resistant should be encouraged. To this end, strengthening research activities is of paramount importance. This undoubtedly demands considerable cash outlay on the part of the government. In a similar agenda, in such areas where the weather condition is unreliable, emphasis should be given to better agronomic practices such as timely planting and weeding, optimum plant population, the number of times ploughing and weeding is done, etc. This again indicates the importance of strong and effective extension system. Even, after all these efforts, the chance of crop failure could be high in such areas which makes investment in improved technologies a risky venture. Therefore, a mechanism should be devised to guarantee farmers from such hazards such as encouraging crop insurance systems. Otherwise farmers will be forced to sell their important assets like oxen to pay debts which ultimately may make poor farmers more poorer.

Sixth, the estimated probit models to identify the factors that determine ownership of livestock particularly cow showed that total land cultivated, farm income and access to livestock credit

significantly affect cow ownership. The fact that the last two variables are significant may indicate that availability of cash is an important factor to own dairy cow. Therefore, something has to be done to assist the relatively resource poor farmers own livestock especially dairy cow and small ruminants so as to diversify the agricultural production. This could be done through provision of livestock credit. Moreover, distributing better performing cross animal breeds that are adaptable to specific local conditions should be sought.

Last but not least, eventhough this study has tried to identify policy instruments that are thought to enhance technology adoption and thereby increase agricultural production, it is in no way exhaustive. Besides, most previous studies made in the country generally focus in resource rich areas neglecting the resource poor and the disadvantaged people. Therefore, appropriate measure should be taken to encourage research undertakings in such areas.

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APPENDIX I

Assumptions taken to calculate Value-Cost ratio

1. Application Rate

- Practically, traditional seeding rate per hectare is higher than what is recommended scientifically. However, due to lack of accurate information, the rate is taken to be the same for both traditional as well as improved practices. That is, 125 kg/ha for barley and 150 kg/ha for wheat. The wheat seed taken in this calculation is the treated one. So no need to include seed dressing chemical cost in the calculation.
- Fertilizer application rate is as per the recommendation of the Bureau of Agriculture in the region which coincides with the data obtained from the Woreda. That is, 100 kg Dap and 50 kg urea per hectare for barley and 100 kg Dap and 100 kg Urea per ha for wheat.

2. Straw

- The quantity of straw produced from a hectare of land and its corresponding price is purely a professional guess of an expert of North Wollo department of Agriculture. The guess is made based on his long years experience in the study area and his direct involvement in tasks related to field crops production. The guess is,

The total quantity of straw (in Quintals) produced from a hectare of land out of the total harvest from the same size of land is 70% and 80% for Barley

and wheat respectively. It means, the grain percentage of the crops, in the above order, is 30% and 20%.

- Straw price per quintal for barley and wheat is assumed to be 18 and 14 birr respectively.

3. Price of Fertilizer and the Crops

- The prices used for calculation purpose are farm gate prices. The details are:

- Fertilizer DAP = 255 Birr/Quintal
 UREA = 240 Birr/Quintal
- Local Barley seed (for planting) = 190 Birr/Quintal
- Improved Wheat Treated = 289.35 Birr/Quintal
 Untreated = 266.15 Birr/Quintal
- Crop selling price Wheat = 190 Birr/Quintal
 Barley = 175 Birr/ Quintal

APPENDIX II

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

EDUCATION, TRAINING AND AGRICULTURAL
TECHNOLOGY ADOPTION IN RESOURCE POOR AREAS
OF NORTH WOLLO: THE CASE OF MEKET WOREDA

SURVEY QUESTIONNAIRE

Remark: 1) Introduce yourself politely before you start
interviewing the respondents

2) Use pencil to fill out the questionnaire

3) Information is gathered for 1997/98 Meher (main) season

4) Use (X) mark where necessary

SECTION -1- : IDENTIFICATION

1.1) Kebele (Name and Code) _____

1.2) Agro-ecological zone:- Wurch Dega Woyna Dega
Kolla

1.3) Development agent's center _____

1.4) Respondent's Name _____

Sex _____

Religion _____

1.5) Name of Interviewer _____

1.6) Date of Interview _____

SECTION 2: HOUSEHOLD CHARACTERISTICS

2.1: Fill the following table which is to be asked for those families who are now living in the home.

No (0)	Name of Household Member (1)	Relation to HH head (2)	Sex: Male=1 Female=2 (3)	Age (Write 0 for age <1 year) (4)	Occupation		Educational background (to be asked for those whose age is 6 and above)					Marital status (12)	Has he/she ever lived else where for atleast one year? yes=1 No=2 (13)	If he/she ever lived elsewhere, reason for leaving this place (14)
					Major (5)	Secondary (6)	can he/she read a letter yes=1 No=2 (7)	can he/she write a letter yes=1 No=2 (8)	Has he/she ever attended school? Attending=1 Attended=2 Never attended=3 (9)	If attended formal school, highest grade completed (10)	For age (6- 25) if not attending, give reasons (11)			
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														

Code for Column 2

- 1 = Head of household-man
- 2 = Head of household-woman
- 3 = Wife
- 4 = Son
- 5 = Daughter
- 6 = Other (specify) _____

Code for Column (5) and (6)

- 1 = Farmer
- 2 = Trader
- 3 = Blacksmith
- 4 = Potter
- 5 = Tailor
- 6 = Weaver
- 7 = Mat Maker
- 8 = Carpenter
- 9 = Mason
- 10 = Herder
- 11 = Maid
- 12 = Student
- 13 = Under-aged
- 14 = Other (specify) _____

Code for Column 11

- 1 = School too far
- 2 = Shortage of money
- 3 = Lack of interest
- 4 = 12th grade completed
- 5 = Disabled
- 6 = Needed for HH work activities
- 7 = Marriage Case
- 8 = Other (specify) _____

Code for Column 12

- 1 = Currently Married
- 2 = Unmarried
- 3 = Divorced
- 4 = Widowed
- 5 = Separated
- 6 = Other (specify) _____

Code for Column (14)

- 1 = To live with relatives or friends
- 2 = Due to draught and famine
- 3 = Due to resettlement program
- 4 = Due to villagization
- 5 = Due to shortage of land
- 6 = Recruitment in to army
- 7 = In pursuit of better living opportunities
- 8 = Other (Specify) _____

2.2. If your main occupation is farming, what is your major agricultural activity?

- 1= Crop cultivation
- 2= Livestock husbandry
- 3= Mixed farming

2.3. If your major agricultural activity is crop cultivation or mixed farming, how long did you stay in this activity?

- 1= 1-2 years
- 2= 3-5 years
- 3= 6-9 years
- 4= 10-15 years
- 5= Above 15 years

How many members of your family assist you in farm operations?

- 1= 1-2 members
- 2= 3-5 members
- 3= Above 5 members
- 4= No member assisted me

SECTION 3 :FARM CHARACTERISTICS

3.1.Size of land holding

	Local Unit(Timad)	Hectare
3.1.1.Total Private farm land owned (a.1+b+c+d)		
a) Total land cultivated by household (a.1+a.2+a.3)		
a.1= Land belonging to the household		
a.2= Land sharecropped in		
a.3= Land rented in		
b) Own land cultivated by other households (b.1+b.2)		
b.1= Land sharecropped out		
b.2= Land rented out		
c) Total area of fallow land owned		
d) Total area of private grazing land		

3.2. At how many different places were your farms located during the 1997/98 Meher Season?

- 1= One place
- 2= 2-3 places
- 3= 4 and above places

3.3. Give details about 1997/98 Meher Season's planted area, fertilizer and improved seed use,output obtained, etc.

No. (0)	Crop Type (1)	Area covered by crop		Fertilizer used				seed planted		
		Local unit (timad) (2)	Hectare (3)	Dap		Urea		Variety	Amount	
				Local unit (specify) (4)	Kilo.gr. (5)	Local unit (specify) (6)	Kilo.gr. (7)	1=Improved 2= Local (8)	Local unit (specify) (9)	Kilo.gr. (10)
1	Barley									
2	Wheat									
3	Teff									
4	Sorghum									
5	Horse beans									
6	Field peas									
7	Lentils									
8	Chickpeas									
9	In seed									
10	Others (specify)									

Table 3.3 Continued.....

No. (0)	Crop Type (1)	Did you practice Soil and Water Conservation methods on your farm? (11) 1= Yes 2= No	If your answer to (11) is yes, what type of conservation methods did you practice? (12)	No. of times ploughed 1= 1 time 2= 2 times 3= 3 times 4= 4 times (13)	Did you use improved farm imple-ments 1= Yes 2= No (14)	Method of Planting 1= Row planting 2= Broad-casting (15)	Source of Water 1. Rain 2. Irrigation 3. Both (16)	No. of times weeded 1= Nil 2= 1 time 3= 2-3 times (17)	Did you apply herbicide? 1=Yes 2= No (18)	Did you apply pesticide? 1= Yes 2= No (19)	Did you Use modern Storage? 1= Yes 2= No (20)
1	Barely										
2	Wheat										
3	Teff										
4	Sorghum										
5	Horse beans										
6	Field peas										
7	Lentils										
8	Chick peas										
9	Lin seed										
10	Others (specify)										

Code for column 12

1= Stone terrace	7= Checkdam (wood made)
2= Soil terrace	8= Cut of drain
3= Soil and stone terrace	9= Grass Strip
4= Bench terrace	10= Bund stabilization
5= Fanyagu terrace	11= Strip cropping
6= Checkdam (stone made)	12= Following
	13= Others(specify)_____

Table 3.3 continued....

N	Crop Type	If better technologies were not used, what was the main reason for not using the technologies									
		Fertilizer (21)	Improved Varieties (22)	Soil and water Conservation methods (23)	Repeated Ploughing (24)	Improved farm implements (25)	Row planting (26)	Repeated weeding (27)	Herbi-cides (28)	Pesti-cides (29)	Modern storage system 1= Low production 2= construction material not available 3=other(specify) _____ (30)
1	Barley										
2	Wheat										
3	Teff										
4	Sorghum										
5	Horse beans										
6	Field peas										
7	Lentils										
8	Chickpeas										
9	Lin seed										
10	Others (specify)										

Code for column (21),(22),(25),(28) & (29)
 1= Not available
 2= Not even heard of the input
 3=Price very expensive
 4= Do not expect yield difference
 5= Can not afford the price
 6= Unreliable weather condition
 7= Other (specify)_____

Code for column (23)&(26)
 1= Labour shortage
 2= Not convinced of importance
 3= time consuming
 4= shortage of implements
 5= Other specify)_____

Code for column (24)
 1= Shortage of plough Oxen
 2= Labour shortage
 3= Not to make the soil loose
 4= Other (specify)_____

Code for column (27)
 1= Labour shortage
 2= To use the weed as animal feed
 3= Other (specify)_____

Table 3.3 continued....

No	Crop Type	How is the fertility of your farm plots? 1= fertile 2= not fertile (31)	Status of soil at your farm plots? 1= well drained 2= poorly drained (32)	Did you apply manure to your plots of land? 1= yes 2= no (33)	What did you use to Plough your land? 1= Oxen 2= Horse 3= Hand tools 4= Oxen & horse (34)	Type of cultivation you practice 1= crop rotation 2= inter cropping 3= sole cropping (35)	Reason for planting the crop (36)	was your crop damaged by frost & /or snow 1= yes 2= no (37)	Out put produced		Level of out put from the farms 1= High 2=Medium 3= Low (40)
									Local unit (specify) (38)	Quintals (39)	
1	Barley										
2	Wheat										
3	Teff										
4	Sorghum										
5	Horse beans										
6	Field peas										
7	Lentils										
8	Chickpeas										
9	Lin seed										
10	Others (specify)										

Code for column (36)
 1= Have higher yield
 2= Is more drought resistant
 3= Is early maturing variety
 4= A source of cash income
 5= Change in weather condition
 6= Other (specify)_____

3.4. Did you have any shortage of oxen during the 1997/98 meher season ?

1= Yes

2= No

If yes, how did you solve the problem?

1= Hiring oxen

2= Cooperating with others

3= Digging by hand tools

4= Using horses

5= Leaving the land uncultivated

3.5. For how many consecutive years have you been using fertilizer and/or improved seed varieties ?

1= One year only

2= Two to three years only

3= Four to five years

4= Above five years

3.6. If you used fertilizer during the 1997/98 meher season, does it require you additional labour (work) to weed, harvest or thresh ?

1= Yes

2= No

3.7 Should the same amount of seed be used when you fertilize crops as when you do not fertilize?

1= Less

2= The same

3= More

3.8 Have you ever encountered unanticipated problems as a result of improved seeds use?

1= Yes

2= No

If yes, what was it?

- 1= Poor quality of seed
- 2= Seed not adaptable to local condition
- 3= Others (Specify)_____

3.9. How do you compare the improved (high yielding) varieties with the local ones?

- 1= Equally good
- 2= The improved varieties produce less
- 3= The improved varieties produce more
- 4= The improved varieties require a lot of work
- 5= The improved varieties require less work
- 6= Other (Specify)_____

3.10 What is the most important consideration when deciding how much fertilizer to buy?

- 1= The amount of money available
- 2= The size of the land to be fertilized
- 3= The recommendation rate of extension agents
- 4=Others (Specify) _____

3.11 Among the following agricultural technologies /practices , which one do you consider to be the best?

- 1= Improved varieties and fertilizer
- 2= Better land preparation practice
- 3= Soil and water conservation methods
- 4= Others (Specify)_____

Why do you prefer your choice above?

- 1= Because it is more profitable
- 2= Easy to understand
- 3= Cheap to adopt
- 4= Other reasons(Specify)_____

3.12 Was it possible to adopt all agricultural technologies /practices taught by extension agents?

1= Yes

2= No

If no, why?

1= Some methods are complex to adopt

2= Some methods are not applicable to our area

3= Require a lot of money

4= My piece of land is small

5= Lack of enough labour

6= Unreliable weather condition

7= Other(Specify)_____

3.13 Are you satisfied with the present farm input supply arrangements?

1= Yes

2= No

If No, why not?

1= Late delivery of inputs

2= Right kind not available

3= Too much cost

4= Long distance to supply source

5= Other(Specify)_____

4. RAINFALL PATTERN

4.1 How was the rainfall distribution over the last 10 years?

1= Mainly uneven and inadequate

2= Mainly evenly distributed and adequate

3= Other (specify) _____

4.2 How adequate was the rainfall during the 1997/98 meher Season?

1= Adequate

2= Not adequate

3= Excess

5. LABOUR SUPPLY

5.1 Did you experience any labour shortage during the last 1997/98 meher Season?

1= Yes

2= No

If yes, during which of the farm operations did you have shortage?

1= Ploughing

2= Planting

3= Weeding and Cultivation

4= Harvesting

How did you solve the above problem?

1= Through mutual aid teams

2= By using the female and child labour of the family

3= Through hiring daily labourers

4= By leaving the land uncultivated

5= By sharecropping out the land

6= Others means (specify) _____

5.2 What are the religious holidays that you strictly observe by disengaging yourself from productive work?

Days in month (E.C.)

1	9	17	25
2	10	18	26
3	11	19	27
4	12	20	28
5	13	21	29
6	14	22	30
7	15	23	Friday
8	16	24	Saturday
			Sunday

Total days in month

6. EXTENSION CONTACT AND TRAINING

6.1. Did you participate in the new extension program?

1= Yes

2= No

6.2 On average how often per month do you meet the extension worker ?

1= Never

2= One to two times

3= Three to four times

4= Five and more times

6.3 Have you attended any demonstration or field days arranged by the extension agent during the 1997/98 meher Season?

1= Yes

2= No

If yes how often?

1= One time

2= Two to three times

3= Four and more times

6.4 Is there any trial/demonstration plot near your farm(s) or home?

1= Yes

2= No

6.5 Have you ever been consulted by extension agents or other professionals on the choice and /or generation of technologies that fit to your local condition?

1= Yes

2= No

If No, do you think this will create a problem on technology adoption?

1= Yes

2= No

6.6 Did you attend any agricultural training program during the 1997/98 meher season organized by the agricultural office or any other organization?

1= Yes

2= No

If yes, for how many days?

1= One - three days

2= Four - eight days

3= Nine - fifteen days

4= Above fifteen days

What were the topics of the training?

1= General agriculture

2= Soil and water conservation

3= Crop protection

4= Extension methodology

5= Animal health

6= Other (specify) _____

How about other skill trainings?

1= Yes

2= No

If yes, what kind of skill training?

1= Carpentry

2= Weaving

3= Pottery

4= Blacksmithing

5= Carpet making

6= Other (specify)_____

6.7 Have you ever visited farmer's training centre?

1= Yes

2= No

If yes, how many times?

1= Only once

2= Two times

3= Other (specify)_____

For how many days/months?

1= Fifteen days

2= Fifteen days - one month

3= 1 - 3 months

4= Other (specify)

6.8 If you attended any training program during the 1997/98 meher season, were they relevant and timely?

1= Yes

2= No

DECLARATION

The thesis is my Original work, has not been presented for a degree in any other University and that all sources of material used for the thesis have been duly acknowledged.

Declared by

Mulugeta Tassew

Candidate

Confirmed by

Dr. Mulat Demeke



Advisor