

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

**POVERTY AND FARMERS' ATTITUDE TOWARDS RISK: EVIDENCE
FROM HAWZEN WOREDA, TIGRAY, ETHIOPIA**

BY

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**“Poverty and Farmers’ Attitude towards Risk: Evidence from Hawzen Woreda,
Tigray, Ethiopia.”**

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Abbreviations

ADLI	Agricultural Development Lead Industry
AEU	Adult Equivalent Unit
bST	bovine somatotropin
CSA	Central Statistical Authority of Ethiopia
DAP	Diammonium Phosphate
ETB	Ethiopian Birr
FDRE	Federal Democratic Republic of Ethiopia
FGT	Foster, Greer, and Thorbecke measure of poverty
HDI	Human Development Index
IFAD	The International Fund for Agricultural Development
Kg	Kilogram
MoFED	Ministry of Finance and Economic Development
n.d.	No date
N.P.	No Publisher
PG	Poverty Gap
RESET	Regression Equation Specification Error Tests

SNNP	Southern Nations Nationalities and people
UNDP	United Nations Development Program
US	United State of America
VIF	Variance Inflation Factor

Abstract

This study focuses on the link between farmers' attitude towards risk and poverty while adopting fertilizer input. The starting point is the safety first model of Moscardi and de Janvry who found some associations of socioeconomic variables to risk. The multi stage random sampling method is used to select both sample areas and respondents. A total of 120 respondents from four "Tabias" each having 30 respondents were used for the analysis.

Based on the safety first model individuals were categorized according to their risk attitude- risk lover, risk neutral, and risk averse. We found that 57 and 63 farmers are risk lovers and risk neutral respectively. Result from the multivariate regression shows that high yield variety seeds, proportion of wheat farm to total farm size, and proportion of wheat income to total income have a negative statistically significant effect. On the other hand, source of finance significantly affects risk attitude positively. However, poverty has no significant effect on it.

The study argues, therefore, that investment on developing high yield varieties and timely dissemination are important. On top of this, with the increasing population pressure, it is recommending to design policies that reduce dependence on agriculture.

Key words: Safety First Model, FGT, Multivariate regression, Poverty, Risk, Hawzen, Tigray

CHAPTER ONE

INTRODUCTION

1.1. Background

Poverty is an economic problem existed in the society blocking individuals from graduating out of it. Poverty is widely seen in the developing countries where agriculture is the dominant source of income. Agriculture has an unpredictable yield in which those who depend their living on it are not secured with subsistence or above subsistence living condition. Production under agriculture is surrounded by full of risk and uncertainty due to the dynamic environmental conditions like erratic rainfall, poor functioning or missing markets, pests and disease (Nigist, 2007). Hence, poverty may prevail in the society in which the ability to reduce poverty through investment decisions may be affected. In such cases, poverty plays significant role at making decisions on the choice and adoption of farming inputs (Mahmud et al., 2009).

Poverty is more pervasive in rural areas and seems to more difficult to graduate from it in these areas. Technology adoption, in the form of; use of fertilizers, high yield seeds, and other agricultural inputs, is one of the tools for the reduction of poverty and graduating out of it through raising productivity. In almost all developing countries, farming is practiced according to their traditions, culture, and natural resources.

Ethiopia is one of the poorest countries in the world (Fredu et al., 2008), though it is endowed with diversified natural resources, ample arable land, large livestock population, and favorable agro climate. On the other hand, the level of education attained by its population is low due to insufficient investment on education. Moreover, natural resources have been heavily depleted

and farmers were not given much attention to the preservation of arable land. This exacerbates the chronic poverty of the nation to prevail for long periods of time. Combined with the low skilled manpower and prolonged war, the already existed problem is exacerbated and were a hindrance for the efforts that were done on poverty reduction.

Poverty is evidently present in Ethiopia in both rural and urban areas even though it is relatively more severe in the rural areas because of a strong dependence on rain fed agriculture. The prolonged history of war and civil strife in the country has had a significant impact on the modernization of the agriculture. This is manifested by the relative underutilization of modern inputs like fertilizers, high yield variety seeds, chemicals, and other inputs that raises the productivity of agriculture and minimizes soil degradation. Coupled with war, the lack of skilled manpower is another obstacle for the dissemination of required information on new farm technology to society that gives awareness about it. Due to these factors, Ethiopian agriculture is the most traditional despite it is the backbone of the nation's economy. The low adoption of technology worsens the impact of poverty which hinders the efforts to move out the subsistence living.

Being the region was a centre of most wars ever had in the history of the nation, it faces a shortage of both physical and human capital in which most war-hit regions have been faced difficulty. The region has a highly poverty stricken economy that requires huge resource.

The devastating nature of war make worse the productivity of agricultural production, making the nation one of the poorest nations in the world. Thus, generalized poverty, low income and productivity, unsustainable growth process, chronic poverty, unemployment, widespread social and economic problems remains to be characteristic features of the economy (Abu, *n.d.*).

Agriculture, which is the major stay of the economy, has been declining in its productivity that could not absorb the ever increasing population of the country. The size of the farming land is limited and the average size of land to a four- person is about 0.5 hectares. This is too small to support a family of an average productivity for cereal of 5-7 quintals per household (Kidane, *n.d.*). Moreover, with high poverty aggravated due to the low moisture carrying capacity of the land, centuries of cultivation without adequate attention to environmental degradation, and having topography with a rugged and denuded of trees and vegetation lost its productivity (Tekie and Getachew, 2004).

1.2. Statement of the Problem

To reduce poverty through modernizing the traditional economy, it needs farmers' decision on the use of farming inputs under any circumstance where they are. But agriculture is the most uncertain type of economic sector where determining in advance about the probability of occurring of the factors that lead to variations of output or yield is hardly possible. In other words, agriculture has an environment with unpredictable nature. Making a decision on such environment surrounded by uncertainty and risk would not optimize the yield. This is mainly seen in semi-arid areas characterized by full of risk and perverse uncertainties (Nigist, 2007). Specifically, risks and uncertainty are manifestations of the absence of information about markets, rainfall variability, technological change and natural hazards. Under such an environment, decisions undertaken with expectations on future benefits may not give farmers, especially poorest ones, sufficient confidence for optimal investments. Nigist (2007) contends that poorest farmers are more concerned primarily towards the downward income fluctuations when they face difficulty to cope up, and when investment decisions are constrained with ex post coping mechanisms. In this regard, decisions undertaken expecting to get future benefit may not

give farmers especially the poorest households a confidence. Risk will cause farmers to be less willing to undertake activities and investments that have higher expected outcomes. This is due to the fact that the outcome of adoption of fertilizers or other modern inputs has a stochastic outcome since it depends up on the uncontrollable environmental factors (De Janvry, 1972) farmers intend more to be averse towards it. Besides, the lack of wealth which is important to bear the loss during crop failure coupled with the absence of insurance schemes to repay the credit taken for purchase of fertilizer is another source of uncertainty for farmers.

A substantial proportion of the topography of Tigray is mainly rugged and mountainous land. Its economy is highly dependent on traditional and rain fed agriculture. The natural resources have been degraded as a result of wars and intensive cultivation. Besides, the increase of its population from time to time hastens the shortage of land leading to a repetitive tillage of land. The fertility of the soil is thus, decreased and hence, its productivity. The region relies on cultivation of crops and livestock production as its main type of agriculture. In addition, the mountainous land feature of the region specially and the country generally is another hindrance for using mechanized farming except in few areas. Oxen are the only means of traction and are considered as the real indicator of household wealth.

Modernization of farming through use of modern farming inputs such as fertilizers, machineries and high yield seeds have paramount effect on increasing productivity and reducing poverty. Rising land productivity with the prevailing diminishing sizes of land may have great importance at providing the food supplies at least for subsistent living for the ever increasing population. However, due to the natural hindrances (including topography) and the country's backwardness, the adoption of modern inputs is not usually seen exercised in the desired manner.

In Ethiopia, studies have been conducted on the determinants of technology adoption and farmers' attitude to risk. While works by Mahmud et al. (2009) focused on the impact of technology adoption on the production risk using the moment-based approach, Di Falco et al. (2006) conducted the impact of seed diversity on the level of risk. Besides to this, Nigist (2007) focused her study on the risk management of farmers to rainfall risks. Mosley and Verschoor (2005), using experimental approach, conducted a research on the effect of farmers' risk behavior on poverty. As to our best knowledge, study was not yet conducted on the effect of poverty on farmers' behavior towards risk while adopting technology in the Ethiopian context. Such study fills the gap in literature about poverty and risk in Ethiopia.

1.3. Scope and Limitation of the Study

While risk is a broader concept, this study particularly tries to see if poverty has an effect on risk attitude of farmers emanating from the adoption of modern agricultural technologies. It is based on data from Hawzen Woreda, one of the 47 Woredas found in Tigray regional state. Hence, the study does not represent the whole region. However, though farmers' willingness is so important during data collection, the experience of getting some incentives from previous researchers in the area have made them less willing to respond and thus, required much effort to convince.

1.4. Objective of the Study

It is expected that poverty has significant and positive effect on farmers' risk attitude which affect their willingness to adopt new technologies. Given this importance, this study tries to look the possible relationship between poverty and farmers' risk attitude. More specifically, the study addresses the following objectives:

- Determining farmers' risk attitude, and
- Examining farmers' level of poverty and its effect on their attitude towards risk

1.5. Significance of the Study

In Ethiopia, researches have been done on farmers' attitude towards adoption of modern farming inputs including the adoption of high yield varieties (Hailu, 2008; Mahmud et al., 2009; and Rahmeto, 2007). But the effect of poverty on farmers' risk attitude is not yet examined in the Ethiopian context. Therefore, this study sheds light on the consequence of poverty on farmers' risk attitude. The researcher does not have a belief that this study is complete, thus, it gives a bench mark for further studies. On top of this, it contributes to the literature in the academic arena.

1.6. Organization of the Paper

The paper has five chapters organized as follows. While chapter one introduced about the background of the study and pointed out the problem, chapter two assesses the theoretical and empirical literatures on poverty, adoption of modern inputs and risk. Model specification and selection of explanatory variables have been dealt in the third chapter. Chapter four discusses results obtained from the estimation of the three models. Finally, the paper deals with conclusions and policy implications in chapter 5.

CHAPTER TWO

REVIEW OF LITERATURE

2.1. Theoretical Review

2.1.1. Poverty: Definition and its multidimensional facets

Poverty is society's problem that deters the day to day activity during the course of life. While "according to Niang (2001), the hierarchy of needs taken as a means for defining poverty in Africa includes food, housing, clothing, and health in order of priority and importance" (as cited in Kassahun, n.d.:2), the world bank has given two definitions, based on monetary terms and consumption types. According to monetary terms, poverty is pronounced as a deprivation¹ in well-being who does not have enough income or consumption to command over commodities in order to put above some adequate minimum threshold. The monetary definition of poverty as to MoFED (2008) income poverty measurement assumes that there is a well-defined level of standard of living, called the "poverty line²," below which a person is deemed to be poor. In contrast, poverty on type of consumption is defined in terms of health, food, education, child mortality and so on due to the fact that it can measure the level of poverty directly without expressing in monetary basis. However, poverty in terms of consumption than any other dimensions of poverty, such as education or child mortality, it tends to be most closely related to changing economic opportunities (Dercon, et al., 2007) is used for most of the time in different literatures given the fact that there is a decreasing pattern of access to education and health. In contrast, Ravallion (1992) defined poverty based on the existence on society if one or more persons do not attain a level of material well-being deemed to constitute a reasonable minimum

¹ Deprivation encompasses not only material deprivation but also low achievements in education and health (World Bank, 2001).

² the poverty line is the minimum expenditure required by an individual to fulfill his or her basic food and non-food needs (World Bank, 2005)

by the standards of that society and mentioned that how much poverty is existed in the society should be given emphasis.

Generally, poverty is about the well-being status of which a deprivation from the normal condition. Here, the well-being can be expressed in terms of consumption type where the availability to command for consuming specific type of products like food, shelter, education, health, etc. in contrast the other type of defining well-being is the ability to command specific type of consumption over resources. Perhaps the broadest approach to well-being (and poverty) is the one articulated by Sen (1976) who argues that well-being comes from a “capability” to function in society. Thus poverty arises when people lack key capabilities, and so have inadequate incomes or education, or poor health, or insecurity, or low self confidence, or a sense of powerlessness, or the absence of rights such as freedom of speech (World Bank, 2005).

While the above operational definition is a common definition, poverty in Ethiopia is of consumption type (Dercon, et al., 2007) for the reason that other types of poverty have decreased more rapidly. However, poverty can be seen in terms of individual or household level having a multidimensional characteristic that requires multidimensional solution. It is characterized by the lack of assets, vulnerability, and low human development.

Referring poverty to “causes of a lack of welfare rather than lack of welfare itself or its consequences” Ellis specified the dimensions of poverty arise from “economic poverty, social poverty, political poverty, and legal poverty” (Ellis, 1984: 242). Here, economic poverty focuses on the cause for overall wealth that significantly deters the welfare. As to Ellis, economic

poverty may arise due to lack of financial, physical and/or human³ resources. The level of impact on the livelihood may depend on the nature of the resource lacked. That is some resources may have future impact rather than current on the level of welfare on which those resources that have significant impact on future rather than present period worsens the poverty level.

Concurrent to this the World Bank pointed that to determine the causes of poverty it is better to identify the dimensions of which lack of income and asset, sense of voicelessness and powerlessness, and vulnerability to adverse shocks (World Bank, 2001) are the different facets of poverty. The lack of income and asset here indicate the lack of assets and the return that they could earn from. As mentioned above, assets are both physical and human asset that have a return for which they affect the level of income and welfare that determine the poverty of individuals. Besides to these, the presence of poverty also can be seen with the lack of institutional capacity to protect from the violence and legal help toward poor. The poor is also vulnerable to different shocks having lack of capacity to cope up with the faced problems. The access to political influence and then to fair resource distribution of the poor diminishes that deepen the poverty level at all. In general, poverty is a multidimensional human deprivation not only in terms of income but also have a characteristics that is expressed in terms of unjust employment of children, destitution, prostitution, lack of domestic peace, inhuman treatment among tribes, and social exclusion of the poor.

³ Human resources are the skill acquired through educational investment in addition to the labour skill naturally every individual possess. But physical resources are resource such as land, infrastructure, and natural resources.

2.1.2. Causes and Consequences of Poverty

Poverty has multidimensional causes. Poverty prevails due to demographic characteristics, female headedness, inadequacies of labour market and other noneconomic barriers (that hinder the opportunity of employment and earning wages) that prevail in the economy (Mead, 1994). The size of the arable land that farmers own (Moene, 1992), family size (Lanjouw and Ravallion, 1995), low level of labor or farm productivity and lack of appropriate policy or less government attention are factors that cause it (World Bank, 2001). In almost all developing countries, the size of arable land has a decreasing trend that has low carrying capacity for a family's livelihood. On top of this, the number of population is increasing from time to time diminishes the already low sized arable land.

Alongside low productivity, the absence of markets, or low access to its due to the low level of infrastructure intensifies the problem. This is exacerbated if there is lack of appropriate government policies that favor the poor. Education and health improve labour productivity, which has significant impact for future generations. But lack of good policies that favor the poor is highly available in most developing countries as the attention of most governments gives high consideration towards strengthening their power through inflicting potential rivals (Hung and Makdissi, 2004). In addition, the effectiveness of the reallocation of resources by a government towards the poor heavily depends on the availability of capable implementing institutions and patterns of political commitments. Therefore, appropriate policies towards the poor such as provision of basic social services, complementing missed markets, availability of and provision of communication infrastructures is a better option to reduce the adverse consequence of poverty as government has the power and responsibility to divert a nation's resource to productive activity (World Bank, 2001; Fiorentino and Dean, 1974).

Though poverty has multiple causes, its consequences are also many in numbers. It depends on the type of poverty classified as a chronic or transitory poverty. Transitory poverty has a current impact while the chronic poverty is a serious one that has a persistent nature over time (Aliber, 2003; Mehta and Shah, 2003). The severely poor have very few financial, physical and natural resources which heavily depend only on its human capital and strives to improve its livelihood. The prevalence of poverty especially the chronic type reduces the provision of basic social services like education and health by a government and increases the vulnerability towards health problem, economic shocks, disasters, and violence. The low level of human capital has low opportunity for well paid jobs which reduces its productivity and needs luck for the casual employment. But having the ability to collect resources from its citizen and responsible to use on the protection of the livelihood of the poor, government may face a shortage of these resources needed for the provision of those basic services which worsen the problem.

The impact may have greater echo when it affects children who lack both mental and physical capacity as the absence of social services reduce their future productive capacity. Children under poverty have lack of physical strength, reduced mental development and have an effect on psychological attitude as poverty is seen ashamed. Acknowledging the group of society who are under chronic poverty Mehta and Shah pointed that, “Chronic poverty seems to be disproportionately high among historically marginalized groups such as scheduled castes, scheduled tribes, the elderly, women and the disabled. The multiple deprivations suffered by these groups make it harder for them to escape from poverty” (Mehta and Shah, 2003: 502). That is, the impact of poverty on children may have persistence over long period in the future reducing the availability of resources.

2.1.3. Measurement of Poverty

For directing resources towards the alleviation of poverty, it needs reliable information on the level of poverty. Measuring poverty gives a clue on its level of impact. Measuring poverty has broad objective of targeting resources based on priorities, designing appropriate policies, to predict the level of outcome and to follow up the effectiveness of policies and programs implemented towards the poor, and to evaluate institution in which their goal is geared to alleviation or reduction of poverty (World Bank, 2005). Measuring of poverty is helpful to address the different determinants, level of incidence and devise appropriate policies so as to combat or minimize its adverse effect on time before it is changed to chronic poverty. Chronic poverty may exacerbate the vulnerability of the poor in the future.

The choice of a best method for measuring poverty depends on the objective. As to Ravallion (1992:2), since measurement and policy are “inseparable” it is required to identify the objective before applying a method on measurement as its impact may be insignificant. While having the objective to know only the number of poor and assessing the overall progress of the poverty reduction strategy, committing error of miss-identification or missing the actual poor has different impact on the result of the measurement (Ravallion, 1992). Therefore, great care is needed during the selection of appropriate measurement to get better result that minimizes the loss of the needed information.

Finding the criteria which are indicators of well-being and aggregating these criteria are the basic problems in which most economists are faced while measurement (Ravallion, 1992). The most commonly used indicators of well-being are both income and consumption. But these two indicators have their own limitations while collecting the household data on poverty. According to most literatures, the consumption expenditure is a better indicator of well-being as

consumption may reflect household living standard. Measuring consumption is relatively easier than the income as income includes both monetized and non-monetized sources of income and it has a fluctuating behavior during a year because the harvest cycle in the rural economy and unpredictable income flows of the urban. Besides, the farm output may have limitation of getting the reliable price indices. But adopting the use of income as an indicator for measurement of living standard also has its advantage of comparing data collected from the different source of income which are expressed in terms of money such as wage.

However, the use of either consumption indicator or income indicator to measure the level, incidence and vulnerability of the poor should be associated with best among the different methods of measurement. According to different poverty literatures, there are different methods in which each measurement is associated with its own advantage and disadvantage. Commonly used measures “...the headcount index, represented as H , is a measure of the prevalence of poverty; the poverty-gap index (PG) is a measure of the depth of poverty, while the Foster-Greer-Thorbecke (P_2) measures the severity of poverty” (Ravallion, 1992: 35-36) (Details on these measures are discussed in the methodology part).

2.1.4. Technology Adoption and Agriculture

Agriculture has been a dominant economic activity throughout the world from ancient time until now, except in the advanced countries where its role and position on the economy is replaced by manufacturing and other economic sectors. It is highly damaged by man-made and natural weather conditions reducing its fertility. Hence, it necessitated for the development of different agricultural technologies that increases the productivity (Feder, et al, 1985), reduce soil erosion and maintain and/or increase its fertility. Agricultural technologies include inputs that raise the productivity and technologies that reduce soil erosion and increase or at least maintain the

fertility of land. Modern farm inputs that raise productivity include inorganic fertilizer, herbicides, insecticides, and construction of micro-dams and wells.

However, the benefit of modern technology depends on the level of adoption. But the introduction of these technologies has met only partial success depending on factors such as “lack of credit, limited access to information, aversion to risk, inadequate farm size, inadequate incentives associated with farm tenure arrangements, insufficient human capital, absence of equipment to relieve labor shortages (thus preventing timeliness of operations), chaotic supply of complementary inputs (such as seed, chemicals, and water), and inappropriate transportation infrastructure” (Feder, et al, 1985: 1). But even though these factors have their own effect on the rate of adoption, it is difficult to claim as significant determinant. In addition to these, farmers’ rate of adoption is influenced by behaviors of other individuals’ resided around them (Case, 1992) and factors that determine farmers’ differences in opportunity cost of human time, transaction costs and behavior in the face of risky events (Benito, 1976).

2.1.5. Theories of Risk and the Case in Agriculture

Farmers are surrounded by full of things which are beyond their control that affect the day to day activity and their decisions of production and investment. This is due to the nature of agriculture which depends on factors that have high degree of uncertainty (Harwood, et al, 1999). Uncertainty refers to the occurrence of things where the probability of a possible outcome is unknown (Hardaker, et al, 2004). The unpredictable nature of rainfall, the demand and its price of farm output, occurrence of pests, natural calamities, livestock disease, and wars during the time of farmers’ decision have an impact on farmers’ livelihood (Ellis, 1993). On top of this, government policies that affect farm production, such as restriction on the use of pesticides, too

many changes in income-tax provisions, can have high implications on profitability. Moreover risks are categorized in to different types according to the source. According to Harwood, et al, 1999 and Hardaker, et al, 2004, even though some of the risks are agriculture specific and others are common to other economic sectors; production risk, price or market risk, institutional risk, human or personal risks, and financial risks are the most common types of risk. The weather related changes causing production risk could affect more severe than the risk of changing in government policies and financial risks (Hardaker, et al, 2004). This specially could affect more to developing countries where their economy is highly dependent on rain fed agriculture. Hence, with no significant government policies and undeveloped financial systems existed, the level of risk for developing countries might be low.

Risk is the probability attached to the occurrence of the uncertain events of a production or investment decision by a farmer. But this probability level of occurring cannot be determined by human beings as it is beyond the control of them, that is, the probabilities of the possible outcomes are known (Hardaker, et al, 2004). For this reason, farmers took the past experience to make decision. Being it is uncontrollable it makes difficulty for a farmer to take a decision on investment and production for future gain on risky environment. The definition of risk is though according to most agricultural text books are based on the probability attached to uncertain things, the farmers' reliance on personal degree of judgment leads to take the following definition.

"...Risk still refers to probabilities, but these are now the subjective probabilities attached by farmer decision makers to the likelihood of occurrence of different events. The analysis of risk involves not just these probabilities but also the way they enter economic decisions. Hence the term ,risk" is used to describe the entire

mechanism by which farmers make decisions with respect to uncertain events” (Ellis, 1993: 85).

Risk is associated with adoption of new farm technologies for which Hardaker, et al. (2004: 5) specified risk as “uncertain consequences”. Farm technologies have importance of raising agricultural productivity. But the net gain depends on the level of variance. That is, deviation from the mean income. According to different literatures farmers can be risk averse, risk lover, or risk neutral depending on the level of preference towards making a decision on consumption and production. An individual is risk averse if the shape of his/her utility function is concave. To put another way, according to Arrow-Pratt measure of risk, if the ratio of the first derivative of utility function to its second derivative is negative, zero, or positive, then the individual, here in this context the farmer, is risk averse, neutral, or risk lover respectively.

2.2. Empirical Review

2.2.1. A Literature on Poverty of Ethiopia

Ethiopia is known for its chronic poverty for about three decades due to war, rainfall variability, and its agriculture based economy. Besides, the poor economic policy of the military regime exacerbates its failed economy. But after the dawn fall of the *Dergue* regime, that is after the 1991/92, the existing government did a lot of policy reformation that have been undertaken and some changes are coming in reference to literacy, income, health, and democracy. According to the United Nations Development Program annual report on HDI⁴, Ethiopia ranks 11th of the best world movers and first of the sub-Saharan African countries (UNDP, 2010). But according to this report still the number of poor who are in “multi-dimensional poverty” is higher (UNDP, 2010: 8).

⁴ A composite measure of health, education, and income and assesses the progress and developments much broader than that of gross national income (GNP)

Being agriculture is the dominant economic sector comprising 85% of employment; the erratic nature of rainfall hampered the running of the government to move out of poverty. Poverty in Ethiopia has the dynamic nature of ups and downs. Stated the other way, “there are more people who are sometimes poor than always poor” (IFAD, 2010:57). This is also shown in a study by Dercon and Krishnan (1998) using a house hold panel data collected from rural Ethiopia for three years, and found that poverty has shown a decline from 1989 to 1995 but remained unchanged between 1994 and 1995. Using the FGT decomposition and measure of robustness they found households with substantial human and physical capital, and better access to roads tend to lower the poverty level. The study has a limitation of coverage in time. That is only three survey periods were covered which may not reflect the actual dynamism of poverty. This is addressed in their finding that the “last result disguises substantial seasonal fluctuations in 1994” (IFAD, 2010:1). In addition, a study conducted by Bigsten, et al. (2002) using a panel data set of 1994 to 1997 shows that the incidence of poverty was declined from 42% to 36% at national level. Though this study revealed that the regional distribution of poverty reflected by their agro-ecological and economic conditions, the four years data may face some challenges to see the changes that could exist after policy reformations.

A work on the determinants of the consumption poverty by Dercon et al. (2007) in rural Ethiopia using linear regression, they found that visit of extension agents, use of fertilizer, availability of all weather-roads and distance to towns, land and family size, and shocks such as death and illness have been found significant determinants. According to their finding, they concluded these factors have great impact on poverty reduction and better to give attention to improve access to the roads and availability of fertilizers. The sex of the household head is also a

determinant factor in which chronic poverty is highly found on those rural where women headed is more due to the war effect such as Tigray (Dercon et al., 2007).

The Federal Government of Ethiopia has designed different policies aiming at poverty reduction and transferring the economy to middle income countries. But the impact of those policies is small and poverty is still persistent in nature. To strengthen this idea, productive safety net program which aims at providing transfers in a means of reducing natural resource depletion to food insecure households, is one of the policies in which its impact is minimal (Gilligan et al., 2009). According to the research finding used a survey data conducted on four regions, that is, Tigray, Amhara, Oromia, and SNNP regions and applying the propensity score matching method of probit estimation, the Safety net program has found little impact on the poverty reduction. According to Ministry of finance and Economic Development 2004/05 poverty report, poverty was widespread in Ethiopia though it has the tendency of declining and was high in the rural areas (39.3 percent) than the urban areas (35.1 percent) (MoFED, 2008). Even though poverty in Ethiopia has shown a decline, the regional poverty variation still remains the same. According to MoFED (2008), using the head count index measurement, poverty remains highest in Tigray as compared to other regions though it showed slight reduction from 56.1 percent in 1995/96 to 48.5 percent in 2004/05 a total decline of 13.6 percent within those years (see Table 2.1).

Table 2.1: Trends in Poverty head count indices and changes in poverty head count indices, by region, 1995/96-2004/05

Region	1995/96			1999/2000			2004/05			Change (%) between 1995/96-2004/05		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Tigray	0.579	0.457	0.561	0.616	0.607	0.614	0.510	0.367	0.485	-11.9	-19.7	-13.6
Afar	0.518	-	0.331	0.680	0.268	0.56	0.429	0.279	0.366	-17.2	-	-
Amhara	0.567	0.373	0.543	0.429	0.311	0.418	0.404	0.378	0.401	-28.8	1.3	-26.1
Oromiya	0.347	0.276	0.340	0.404	0.359	0.399	0.372	0.346	0.370	7.3	25.2	8.7
Somale	0.346	-	0.309	0.441	0.261	0.379	0.452	0.353	0.419	30.5	-	-
Benishangul-Gumuz	0.476	0.345	0.468	0.558	0.289	0.54	0.458	0.345	0.445	-3.8	-0.1	-4.9
SNNP	0.565	0.459	0.558	0.517	0.402	0.509	0.382	0.383	0.382	-32.4	-16.5	-31.5
Harari	0.133	0.291	0.22	0.149	0.35	0.258	0.206	0.326	0.270	54.5	12.1	22.9
Addis Ababa	0.404	0.300	0.302	0.271	0.362	0.361	0.299	0.326	0.325	-26	8.6	7.7
Dire Dawa	0.366	0.246	0.295	0.332	0.331	0.331	0.398	0.329	0.352	8.8	33.6	19.2
Total	0.475	0.332	0.455	0.454	0.369	0.442	0.393	0.351	0.387	-17.2	5.8	-14.9

Source: MoFED (2008) Dynamics of growth and poverty in Ethiopia (1995/96-2004/05)

2.2.2. Determinants of Agricultural Technology Adoption

The need for new technology is increasing from time to time due to different reasons. With diminished land size and reduction of land productivity, it is required to solve these problems to meet the requirement of food. To put in other words, “with the increasing scarcity of land and water, productivity gains will be the main source of growth in agriculture and the primary means to satisfy increased demand for food and agricultural products” (World Bank, 2008:158). This

need is exacerbated during this time due to the enormous world population increment and global climate changes besides the above mentioned productivity and land size problems.

The benefit of technology adoption may depend on the rate of adoption and diffusion to farmers. Different empirical literatures have pointed out that poverty level of the farmer, information and credit availability, level of education, and input and market availability determines the adoption rate and level (Simtowe et al., 2006; Saha et al., 1994; Cavatassi et al., 2010; Hailu, 2008). Risk attitudes and perception towards adoption of newly emerged inputs may or may not have impact on adoption. Saha et al. (1994) conducted a research in Texas dairy producers; on adoption with output uncertainty has found that the decision of farmers to adopt bST is affected by the adoption cost and farmers perception to the induced yield out of adopting the technology. Education, prior adoption experience, and plans to expand dairy operations, nature of household integration to market, ethnicity, and income are also strong determinants (Saha et al., 1994; Cavatassi et al., 2010; Godoy et al., 1998).

With the increasing literacy level of a household, the ability to understand and the information on new technology may decrease the cost of adoption. The labour intensive nature of some technologies is also affected by the availability of more laborers in the family. The partial and full adopters of the new technology are relatively having more families required for weeding activities (Hailu, 2008 and Simtowe et al., 2006). In contrast, the proximity to market and visit to extension workers has no effect on the adoption of new technology but age significantly determines adoption. However, this is in contrary to Cavatassi et al. (2010) where accesses to markets and to social capitals are determinants of adoption and access to market by itself deters the regional behavior which was found as significant factors on adoption decision. Moreover,

land size and off-farm income affects the adoption decision of farmers that is, fosters an increase in non-adoption level (Simtowe et al., 2006).

Not only formal education, but also the education acquired from neighborhood has great impact on influencing the decision towards adoption. The adoption attitude of neighbors to new technology significantly affects the decision of a farmer whether to adopt or not. The adoption by neighbors will give the time to look the effects on the yield compared to costs and other variables and its impact in relation to changing climate. This can be seen as a source of information when farmers are biased by attitude of others and it gives the opportunity to learn the new technology. However, the neighbors' actual adoption rather than the attitude on adoption influences attitude of farmers (Case, 1992). In addition, knowledge on the application and advantage of technology and the attitude of farmers about the traits of it imposes significant impact on adoption though agro-ecological variables have got as a decisive factor (Cavane, 2009) while as to Cavatassi et al. (2010) is non decisive variable.

2.2.3. Farmers' Risk Attitude, Poverty and Technology Adoption

Studies conducted on farmers' attitude towards risk have revealed that most farmers are risk averse. A research conducted in Turkey on farmers' attitude to risk on managerial decision has found that almost all farmers surveyed are risk averse. That is,

“... One hundred eighty-two out of 200 estimated Arrow-Pratt risk coefficients implied a risk averse attitude. A risk averse attitude is associated with managerial decisions that tradeoff a lower risk or variation in income for higher income” (Binici, et.al, 2003:311).

To stand with this finding, a study conducted in Nigeria to determine the level of attitude of farmers has revealed that almost 72% of the farmers are risk averse (Olarinde et al., 2007; Aye and Oji, 2005).

Risk aversion behavior of farmers is determined by different factors. A lot of studies conducted on the risk aversion behavior of farmers suggested that wealth is the most determinant. Hamal and Anderson (1982); Binswanger (1980) found that there is decreasing level of absolute risk aversion with the level of wealth. Besides, Binswanger revealed the relative risk aversion first decreased and later increased while Hamal and Anderson concluded that the level of aversion varies across individuals. That is, there is inverse relationship between risk aversion and wealth of farmers. Moreover, natural, social, technical and economic factors contribute towards the attitude of farmers to their risk averse behaviors (Olarinde et al., 2007; Moscardi and de Janvry, 1977; Ellis, 1993).

While farmers are risk averse, their attitude towards adoption of new technology is ambiguous. Technology may have either the ability to reduce the risk aversion attitude because it reduces production risk or increases aversion behavior due to the fostering the yield variability. That is it depends on the attitude in which farmers have on the implication of the technology. Using the moment-based approach of econometric estimation of risk attitude, a study on Ethiopian highlands, revealed that the risk implication of technology adoption vary by type of technology adopted (Mahmud et al., 2009). However, risk factors are a decisive determinant despite farmers' risk attitude and perceptions on the degree of risk associated with adoption of untried technologies has no determinant effect (Saha et al., 1994).

While risk attitude and its associated factors have an implication on technology adoption; the theoretical relation on poverty and risk shows that their link is based on the link that they have to new technology adoption. Poverty reduces the level of investment and the decision to adopt due to fear of production failure and lack of capital by the poor. But looking to the empirical literatures on risk aversion and poverty signifies that there is little relationship between them (Mosley and Verschoor, 2005). According to them, the ability of being low income could not be a problem for making decision on farm investment. But other factors determine the risk aversion of farmers towards decision on investment. In contrast, Aye and Oji (2005) revealed that not only poverty but also other factors such as age, extension workers visit and other socioeconomic factors are strong determinants of farmers' risk attitude.

CHAPTER THREE

METHODOLOGY AND DATA SOURCE

3.1. Description of the Study Area

Tigray is one of the regional states in Ethiopia. It has an area of 84,721.77 km² and a population of 4,664,071. Of the total, 80.5 percent of the population resides in purely rural areas with an average population density of 55.1 per square kilometer (CSA, 2010). Tigray borders with the state of Eritrea, Sudan and two other regional states, Amhara and Afar. It has five zones and one special zone, Mekelle city. According to CSA (2010) report, excluding Mekelle the region has 45 rural and urban Woredas.

The study area, Hawzen, is one of the rural Woredas in the region having a total population of 128,263. It is the second most densely populated Woreda from Eastern zone next to Atsbi Wonberta Woreda. Hawzen Woreda has a population density of about 67.8 persons per square kilometer – above the 61.6 persons per square kilometer average for the zone.

Tigray has three main agro ecological zones; namely, “Dogua” (i.e., highland areas), “Woinadogua” (i.e., midland areas), and “Kolla” (i.e., lowlands) (Fredu et al., 2008), and our area of study, Hawzen, encompasses all these kinds of agro ecological zones. The region is more favourable to the cultivation of wheat. It is selected for this study because it is one of the most cultivated crops in Ethiopia and has a high response to fertilizer (Gunjal et al., 1980).

The Woreda has 24 rural “Tabias” and one town, Hawzen, out of which four “Tabias⁵”- Debre Birhan, Gira“eras, Hatset and Mai Kado, are selected for study purposes using random sampling. Each “Tabia” has four “Kushets”. From the selected “Tabias”, random sampling was used to

⁵ Tabia is the lowest administrative level in which four Kushets form one Tabia.

select “Kushests” in which respondents are selected through the same procedure. A total of 120 farm households were surveyed with 30 farm households from each “Tabia”. Therefore, both a multi stage sampling and random sampling is employed to collect the primary data through questionnaires developed for this purpose. Besides to this, a secondary data is used from published and unpublished materials including market price from the Woreda Marketing agency.

3.2. Model specification

In order to address our objectives, FGT measures of poverty and the safety first model of risk (Moscardi and de Janvry, 1977), are used to measure the level of poverty and farmers’ risk attitude respectively. Finally, to determine the association of the poverty and farmers’ risk attitude, multivariate regression is applied.

i. Foster, Greer, and Thorbecke (FGT) Poverty Measures

To address the impact of poverty it requires assessing the level of poverty of a given society. Different literatures show that there are different measurements proposed by economists depending on the definition of poverty that they assume and the objective that they would like to achieve, i.e., either to rank some geographical areas or count the number of poor individuals. Again the lack of unique measurement yardstick as to whether money is important as a sole yardstick or other social factors should be incorporated is another problem for choosing a best measure. But, though there are different poverty measures, their applicability is limited by the weakness that they have. To say, different measurements have their own weaknesses and these weaknesses made to limit from general use.

Nevertheless, their limitation from general purpose measurements, most measurements which are commonly discussed on different literatures are:

- a. **Head count ratio:** it is commonly used to determine the proportion of poor from the whole society or region. It is a measure used to count the proportion of poor people or people below the poverty threshold. Despite it is the simplest measure, it lacks measuring the intensity and severity of the poverty. As Sen (1976) put, the head count index violates the monotonicity and Transfer axioms which show the sensitivity of poverty measures to changes in the income of a poor due to transfer of income from the poor to rich and a change in the income of a poor.
- b. **Poverty Gap index:** it is another measure which overcomes the drawbacks of the head count index of monotonicity axiom. It shows the amount to which individuals on average fall below the poverty line. It is expressed as a percentage of the poverty line. That is, the average of the difference of individual's income or expenditure to poverty line divided by the poverty line. It shows the depth of poverty and how much transfer is required to bring poor individuals' expenditure equal to the threshold (poverty line). However, this measure is also subject to limitations for its insensitivity of the severity that it could have among the poor. Therefore, though it complements the head count index another measure is required that includes both the severity and intensity of poverty.
- c. **Sen Index:** Amartya Sen, (1976) had revealed that the poverty Gap and Head count index could not provide sufficient and adequate information on the exact income distribution among the poor. He proposed an index that overcomes this drawback which sought to combine the effects of the number of poor, the extent of poverty and the distribution of poverty within the group. It is the average of head count poverty gap measures, weighted by the Gini coefficient of the poor. However like others, the index failed to decompose the total poverty as a sum of sub group poverty, i.e., lacks additively decomposable criterion (Foster

et al., 1984 and Ravallion, 1992) where additivity refers to the aggregate poverty as a weighted sum of poverty levels in the various sub groups. Besides, it also fails to satisfy the strong transfer axiom (Osberg and Xu, 2000).

- d. **Foster, Greer and Thorbecke measure:** a holistic measurement that incorporates the transferability and monotonicity axioms. It also overcomes the drawbacks of both the head count index and poverty gap index which are insensitive for measuring the severity of poverty. In addition, it has the property of additive decomposable in which the Sen Index lacks. The FGT measure therefore, enables to determine the extent, depth and severity of poverty. Moreover, the head count and poverty gap index belongs to this measurement. Therefore, being satisfies the monotonicity and transfer axioms and inclusive of other measures, that is, head count and poverty gap indices which are commonly used in practical arena, FGT model will be used for this thesis. And the model is specified as:

$$P_{\alpha} = \frac{1}{n} \sum_{i=1}^q \left(\frac{z - y_i}{z} \right)^{\alpha} \quad \alpha \geq 0$$

Where:

n is sample size

y is the variable of interest i.e. farm household per capita income or expenditure of household

q is the number of poor farm households

α is a non-negative index and is a measure of sensitivity of the index to poverty, which takes the values of 0, 1, and 2 and indicates the head count ratio, the poverty gap and the squared poverty gap, respectively.

i. Estimation of risk attitude using the Safety first model

Farmers' decision on production activities are bounded by uncertainties and risks. Factor and output prices, rainfall and outcome of adoption of modern inputs are stochastic by their nature and farmers attach subjective probabilities on their likelihood outcome. These subjective probabilities will influence on the decision to investment and production processes. That is, it depends on the preference of farmers' towards the associated risk. Risk is basically the subjective probability of the livelihood of occurrence of an uncertain event. It is resulted from the variance of an outcome. This risk is associated with the production process through its effect on profit maximization. But though most production theories emphasize that farmers' behavior is affected by the objective of profit maximization, Lin et al. (1974) found that the utility maximization behavior best predicts the attitude of farmers. While Von Neumann and Morgenstern studied the risk behavior using the expected utility theory, Arrow-Pratt formulated a measurement of risk attitudes using the expected utility. Accordingly, they categorized on three things based on the ratio of the second order expected utility derivative to its first order as risk averse, neutral, and risk taker (Varian, 1992). And based on the expected utility, economist has been formulated the behavior of farmers. However this measure is a local measure. It is not applicable for large or global risks (Pratt, 1964).

In contrast, the expected utility has the limitation that it is unable to provide a modest risk aversion account instead it shows risk neutral (Rabin, 2000) and fails to predict to the best the behavior of individuals that need to maximize it. Moreover, the Expected utility with the help of gambling method, risk attitude is somewhat time consuming, difficult to formulate and individuals have different opinions towards utility and disutility (Moscardi and de Janvry, 1977). According to Pyle and Turnovsky (1970), the utility function has an arbitrary nature in which it

is based on subjective criteria and come to the point for the need to have a measurement based on objective criteria. The objective criteria are an important to depart from reliance on subjectivity that would not reveal the actual behavior. Such objective criterion was set by followers of the safety first measure of risk in which Roy (1952) has proposed to use on measuring risk attitude of investors or portfolio holders. According to Safety first criteria, investors have some disaster level in their minds and try to optimize or minimize the disaster level. Besides, the safety first criterion is used to assess the risk attitude of farmers, as farmers' management to mobilize his/her productive resources and choosing among technological options depends on the security of generating returns large enough to cover subsistence needs (Moscardi and de Janvry, 1977; Olarinde et al., 2007). Therefore, the return that could outweigh the subsistence livelihood has a motivating factor on the decision of farmers.

Pyle and Turnovsky (1970), in their research, pointed out that both safety first and expected utility criterion gives the same optimization outcome. Minimizing the disaster level in the safety first will lead to equal return or output with the maximization of expected utility. Moreover, the safety first criteria can incorporate socio economic variables in which measuring farmers' attitude based on it makes easier as compared to expected utility. Being poverty is one of the socio economic factors that determine the production decision; this becomes an important criterion to incorporate the effect of poverty on the risk attitude as a prime explanatory variable of the regression.

According to Moscardi and de Janvry (1977) and Olarinde et al. (2007), risk is introduced in to economic decision making as a safety first rule. The estimation of the implicit production function is used to estimate the risk attitudes. The decision makers will be affected by the uncertainty and risk while making decisions on investment and production. But it is assumed that

farmers” produce only single product or otherwise multi-crop farming has no effect on the minimization of risk and hence no effect on risk attitude. Accordingly, the safety first rule tends to be followed whenever the satisfaction of basic needs may be at risk (Scandizzo and Dillon, 1976 as cited by Moscardi and de Janvry). The implicit production function is

$$y = f(dap, ure, qws, land, mdpt, atpt, u)$$

Where

y- is yield (in kilogram)

dap –DAP use in kilogram

mdpt- labour utilization (man days/ “tsimdi”⁶)

qws –wheat seed in kilogram

land -wheat farm size in “tsimdi”

ure- Urea use in kilogram

atpt- number of plough by animal traction per “tsimdi”

u-is the error term

The explicit production function should be written in terms of Cobb Douglas production function which is the most relevant and reliable type of production function for estimation and mathematical handling. It is written as $y = ax_1^{b_1}x_2^{b_2} \dots x_6^{b_6}e^u$, where *Xs* are representing the explanatory variables and *e* is the error term.

⁶ It is a local land measurement where one tsimdi is equivalent to 0.25 hectare

For applying the ordinary linear regression as it is easy for mathematical manipulation and interpretation, the double log Cobb Douglas production is estimated and following some mathematical manipulations the risk parameter will be estimated for each farmer using the relation, (Moscardi and De Janvry, 1977):

$$K_{(s)} = \frac{1}{\theta} \left[1 - \frac{P_i X_i}{P_y f_i \mu_y} \right]$$

Where:

P_i is the price of input i

$$\theta = \frac{\sigma_y}{\mu_y}$$

X_i is quantity of input i

σ_y is the standard deviation of the yield

P_y is the price of outputs

μ_y mean yield of the production function

$K_{(s)}$ is risk aversion parameter

f_i elasticity of production of the i^{th} input

From this, risk aversion parameter is estimated for each farmer and then, a multiple regression is applied to determine the significance and impact of poverty and other socio economic variables on the farmers' risk attitude. That is, the risk aversion parameter is a dependent variable and poverty and other variables are considered as independent variables. The model is:

$$K_{(s)} = f(hhs, hedl, wrty, davis, sex, aepcc, lwfa, sfin, faexp, hyv, U)$$

Where,

hhs -house hold size (in number)

$wrty$ – proportion of wheat to total income of the household

$hedl$ – educational level of a farmer (in years)

<i>davis</i> – number of contacts with Development Agents (extension workers)	<i>hyv</i> – dummy 1, if the wheat seed is high yield variety, otherwise 0
<i>lwfa</i> – proportion of wheat farm to total farm held	<i>sex</i> – Sex of the farmer, 1 if male, otherwise 0
<i>sfin</i> – Dummy 1 if fertilizer purchase is financed by own source, otherwise 0	<i>aepcc</i> – consumption per adult equivalent a proxy for poverty
<i>faexp</i> – farmer’s year of experience in wheat farming	<i>U</i> – Random variable

3.3. Selection of Explanatory Variables

A number of variables are hypothesized to influence farmers’ attitude towards risk aversion originated from adoption of fertilizer and variables that contribute to yield of wheat as explained below:

3.1.1. Selection of Explanatory Variables for Yield

From production theory, four inputs-land, labour, capital and entrepreneurship are the main factors of production. Considering the production process of wheat in the sample area and possibility to capture their data, the following variables are used as explanatory variables.

Quantity of wheat Seed (*qws*): For any production, seed is the basic input in which it is impossible to have yield without it. Yield is expected to increase with the quantity of seed sown. With high quantity of seed, a large part of land is covered with offspring and more progenies also come out to give yield within a given land size and hence, expected to have a positive sign.

Diammonium Phosphate (*dap*): It is an organic fertilizer with high content of water-soluble phosphorus produced in a way that most cropping systems show the best response to them (Barker and Pilbeam, 2007). Most crops require readily available phosphorus in which DAP holds this property. Therefore, it will have an effect on yield of crops where its outcome is expected to be positive.

Urea (*ure*): It is the most widely used dry nitrogen fertilizer in the world (Barker and Pilbeam, 2007). It is readily soluble in water and is a source of nitrogen for crops sown in a farm with shortage of nitrogen content. It is expected to have a positive relation with yield.

Size of wheat land (*land*): It is obvious that land is one of the four factors of production. Though the productivity of land depends on its quality, size has also its own contribution. Given the fertility of land, large sized land gives more space to have more progenies that will result in more yields. Therefore, the total size of wheat farm cultivated is expected to have a positive impact on yield.

Man days per “tsimdi” (*mdpt*): This implies the labour use per tsimdi during production which is another important input from the four factors of production. With increase labour, it may have either positive or negative effect on yield. From the theory of marginal productivity, we know that yield increases in the beginning but latter starts to decline. That is, the law of variable proportion starts to operate given the farm size after some level of employment. Therefore, there is no a priori expected sign of man days per tsimdi.

Animal tractions per “tsimdi” (*atpt*): Before and during sowing, it is important that the farm to plough. In Ethiopia, the means of plowing commonly used is the oxen traction. Most farmers

have the belief that cultivation of farm enhances the return of farming. Hence, it is expected that increasing the number of cultivation may have a positive impact on production.

3.1.2. Selection of Explanatory Variables of Risk

Acknowledging different literatures, the following variables are expected to affect the risk attitude and used to see if they can determine. The following explanatory variables are discussed accordingly for their possible relation that they could have.

Farming Experience (*faexp*): A previous experience of farmers on farming can be expected to either boost or diminish their level of confidence. During their course of life, farmers could understand the nature and behavior of fertilizer. They could differentiate the pros and cons of fertilizer. Therefore, with more experience, farmers could either become risk averse or lover based on what they got from experience. Thus, this variable could have either a positive or a negative effect on farmers' risk attitude due to the competing hypothesis regarding its effect on risk.

Number of visit by Development Agents (extension workers) (*davis*): Extension workers are anticipated to put their effect on farmers' attitude of using modern inputs. The teachings and contacts of extension workers may enhance the use of those inputs by acting as a means of information with regard to the benefits and effects of fertilizers, where extension workers are the only sources of information. Contact with extension agents (development agents) was hypothesized to decrease a farmer's attitude towards risk through addressing the benefit of fertilizer.

High Yield Variety (*hyv*): Use of improved seed is hypothesized to be positively related to the probability of adoption of fertilizer because high yield varieties are known to show greater

response to inorganic fertilizers. As a result, the use of high yield is anticipated to have negative impact on risk attitude.

Proportion of wheat to total farm (*lwfa*): Large size allotted to wheat means that small proportion of land is allotted for cultivation of other crops. This will increase taking high risk as crop diversification is a means for downsizing the possible risk due to crop failure. Therefore, this variable is anticipated to have negative sign.

Proportion of wheat to total income (*wrty*): Farmers' risk attitude could be affected by the probability of getting high yield from their cultivated land aside to off farm income. But the possibility of getting high yield will matter on risk bearing. So if the wheat yield shows an increment as compared to the total, farmers are then, willing to continue their act of adoption. Therefore, with high proportion, farmers are less risk averse and the variable is hypothesized to have negative relation.

Household size (*hhs*): Having large household size may increase or decrease the risk aversion. With an increase in the household size, it is likely to increase the consumption need and it is difficult to bear risk. However, with more household size also is a potential for generation of income that could minimize the risk and is willing to assume risk. Hence, the sign of the variable is not a priori determined.

Education level of household head (*hedl*): The levels of education have an a priori expectation of negative correlation with risk. That is, as years of schooling increases the more is likely a farmer to have awareness and information that will help his decisive power. Higher educational level has the possibility to create higher awareness.

Sex (sex): Households headed by male have the possibility to minimize the possible risks that could happen through diversifying the sources of income by engaging at different off farm activities. But female headed households, with the prevailed culture that deter off farm working and lack of individuals that supports caring for children during off farm employment hinders the possible diversification of income. Besides, the culture of the society in which females are restricted to work as a house maid only may create information fence on them. That is, they have less access to information about the possible inputs and benefits that come from. Hence, being male is hypothesized to have negative correlation with risk aversion.

Source of finance (sfin): The source of finance for fertilizer spending is expected to have both negative and positive correlation, that is, has no a priori sign. With own financing farmers may develop a confidence that with loss occurred, they are not liable to any debit so that they tend to bear risk. On the other side, they may not be willing to assume any risk rather the money, that is going to purchase fertilizer want to save for future consumption anticipating that crop failure may occur in the future.

Consumption per Adult equivalent (aepcc): Most efforts exerted by farmers on cultivation and production of crops are to have favorable supply of food to the household. With inadequate supply of food and consumption, that is, when poverty is prevailed it is difficult to assume any risk. Farmers will not have the confidence on the use of modern inputs for the sake of reducing crop failure even though those inputs are expected to raise yield. Poverty, here is measured using consumption expenditure. That is, household can be said poor if the total consumption expenditure is below the poverty line. So, a rise in it means individuals are far from the poverty line. Hence, we can use the consumption per adult equivalent as a proxy for poverty. Therefore,

consumption is anticipated to have a negative correlation with risk aversion; as poverty is expected to have the reverse association with risk.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1. Descriptive Analysis

A. Production Function or Yield

As can be seen from table 4.1, the average farm size of wheat cultivated is 0.72 “tsimdi” and the average yield of wheat is 145.5 kilogram. The yield level deviates across farmers by about 127 from the mean output. The size of wheat land is also deviates from the mean by about 0.4. Each farmer has sown an average of 28 kilograms of seed. In this regard, the lowest and highest quantity of wheat sown is 2 and 125 kilograms respectively.

Table 4.1: Descriptive Statistics of Production Function

Variable	Obs	Mean	Std. Dev.	Min	Max
Yield	120	145.5	127.1213	5	800
Quantity of wheat seed	120	27.625	19.86459	2	125
Size of wheat land	120	0.719025	0.3804686	0.083	2
DAP	120	19.04792	11.10229	1	50
Urea	120	14.22396	9.714435	1	50
Man days per tsimdi	120	24.38306	30.62058	0.6	216
Animal traction per tsimdi	120	3.603542	2.125563	0.625	10

Source: Own computation from survey data, 2011

On average, farmers used about 19 kilograms and 14 kilograms of DAP and Urea in producing wheat. All farmers in the sample are observed using both types of fertilizer inputs - the minimum being 1 kilogram and the maximum of 50 kilograms for both inputs. Per “tsimdi”, farmers allocated an average of 24 days and plowed the wheat farm for four times.

B. Poverty

Poverty is a concept of individual welfare having different arguments over its measurement. Either using of consumption or income as an indicator of welfare has been widely discussed in the literature. But most of the consensus on poverty (Ravallion, 1992; World Bank, 2005) shows that the use of consumption expenditure can have the power of reflecting the welfare of individuals rather than income. This study, therefore, prefers consumption to income in measuring household level poverty. However, measuring poverty by consumption expenditure could not show the intra-household variations on consumption level and calorie intake. To address it, the consumption per adult equivalent is calculated using the adult equivalent unit (AEU)⁷. This addresses the differences that might arise in consumption per capita across households due to household size and composition.

With regard to our measurement of poverty level, two types of poverty lines are used to address the number of households that live below the poverty line. Poverty line is the minimum level of standard of living below which survival is difficult. Both the national poverty line calculated by MoFED (2008) and the international standard are used for comparison with more focus given to the later. The international standard is US \$1.25/day⁸ which is approximately 7459.69 ETB in a yearly basis. However, the report on poverty dynamics of Ethiopia by MoFED (2008) calculated the national poverty line based on the 1995/96 national average constant prices of 1075 ETB per adult equivalent. This shows the international standard of US \$1.25/day is seven times higher than the average national poverty line.

⁷ AEU is the nutrition (calorie) based equivalence scale directly taken from Dercon and Krishnan (1998).

⁸ US \$1=16.35 ETB during data collection

Here, the international one is used for analysis purpose as it deems an absolute poverty comparison among individuals irrespective of the time or place, with or without some policy change, or within the relevant domain (Ravallion, 1992). Having decided the poverty line, a family of FGT poverty measurement is applied. The result shows that the incidence of poverty is 69.17 percent. This indicates a higher incidence as compared to the 39 percent national poverty incidence estimate of 2008 (IFAD, 2010; UNDP, 2010).

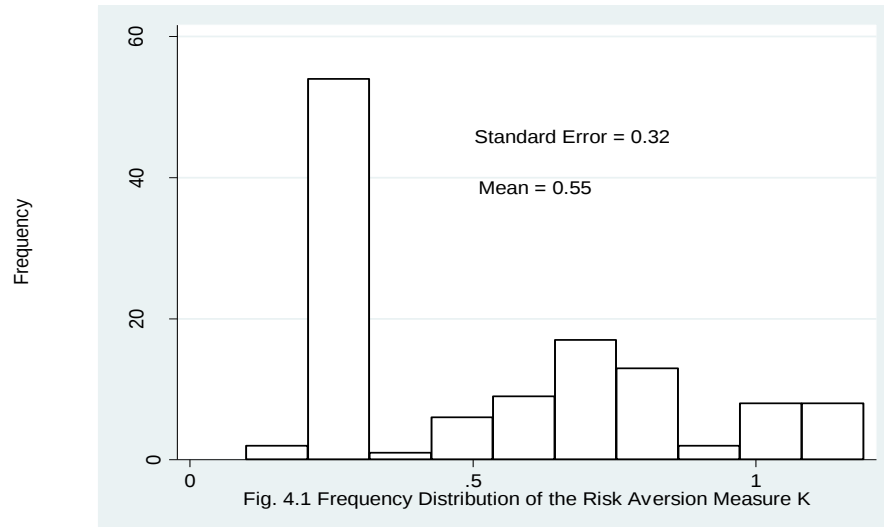
A regional poverty incidence report (MoFED, 2008) shows an in and out nature of poverty indices. While the incidence of poverty for rural Tigray was 57.9 percent in 1995/96, it increased to 61.6 percent during the 1999/2000. But the recent estimate of 2004/05 shows a rural poverty incidence of 51 percent in Tigray, which is higher than the overall level of poverty incidence in the region. Hence, the estimated incidence level of about 69.17 percent for Hawzen Woreda might be resulted from the high population density of 61.6 persons per square kilometer which is above the regional average of 55.1 (CSA, 2009). One possible implication is that the productivity of land may reduce with increasing population pressure. This may, in turn, expose many households in to poverty. Survey result revealed that per capita arable land in the Woreda is approximately 0.13 hectare – an amount less than the national estimate of 0.2 hectare (IFAD, 2010). The result, hence, shows consistency with the theory of diminishing marginal productivity of land. Coupled with the small farm size, the regional farm land has lost its fertility with over cultivation for centuries and low management. Moreover, the poor performance of rural markets and lack of rural infrastructure for the nation at large may prohibit farmers from selling their surplus products in other production deficit areas, holding other things constant.

The insensitivity of head count ratio to severity and depth, however, makes it less worthy for analysis purpose. Rather the squared poverty gap is a better measurement that eliminates the side effects of head count index. Using the squared poverty gap or the FGT measure of poverty, result shows that chronic poverty is about 21.86 percent. Unlike the head count index, the result from the FGT measure signifies that the Woreda's poverty level matches with the national chronic poverty of 22.8 percent (IFAD, 2010) and 27 percent (Dercon et al., 2007). However, the poverty gap shows that on average, 37.43 percent of the households consumption expenditure is far from the poverty line. Though the result seems a stringent compared to the national level, the comparison among regions with in the country indicates that Tigray has highest poverty gap and its squared (MoFED, 2008).

C. Risk

Farmers' risk was calculated from the estimated production function using marginal product together with the coefficient of variation and prices of both input and output. The risk parameter was used to classify farmers following the categorization of risk level by Moscardi and de Janvry (1977). Farmers are said to be low risk if $0 < K < 0.4$, risk neutral if $0.4 \leq K \leq 1.2$ and high risk or risk averse if $1.2 < K < 2$. The results show that all farmers lay either in the risk neutral or low risk group (see Fig. 4.1) with mean and variance of about 0.6 and 0.1.

This seems to be at odds with previous findings in the literature that reported that most farmers are risk averse (Moscardi and de Janvry, 1977; Aye & Oji, 2005; Olarinde et al., 2007). But Mahmud et al. (2009) has found that fertilizer has a risk reducing effect on the highlands of Ethiopia. This seems consistent with our finding that none of the farmers are risk averse.



Source: Own computation from survey data, 2011

Farmers are not risk averters towards the adoption of agricultural technology. The mean is not far from the median showing the result is not skewed more and the attitude is concentrated almost on risk lover and neutral groups. About 44 percent of the female headed and 49 percent of the male headed farmers are risk lovers showing that male headed are more risk lovers than their female counterparts (Table 4.2).

Table 4.2: Distribution of Risk Level by Sex

K	Sex (%)	
	Female	Male
$0 < K < 0.4$	8 (44.44)	49 (48.04)
$0.4 \leq K \leq 1.2$	10 (55.56)	53 (51.96)
$1.2 < K < 2$	0 (0)	0 (0)

Source: Own Computation from survey data, 2011

This result shows that female headed household has a fear to adopt modern agricultural inputs probably associated with the low level of education attained. While about 26 percent of the male

headed households have attained formal education, only 17 percent of the female headed households have a formal education regardless of the level of education (See Table 4.3).

Table 4.3: Distribution of Formal Education Attainment (in years of schooling) by Sex

Educational level of household head	Sex		Total
	Female	Male	
0	15	74	89
1	1	1	2
2	0	1	1
3	1	6	7
4	0	8	8
5	1	2	3
6	0	4	4
7	0	2	2
8	0	1	1
10	0	2	2
12	0	1	1
Total	18	102	120

Source: Own computation from survey data, 2011

4.2. Econometric Analysis

The production function for wheat yield is estimated using the most commonly used Cobb Douglas production function. After transforming the Cobb Douglas production function into linear function using logarithmic transformation mechanism, Ordinary Linear Regression is applied.

To take care of multicollinearity and heteroskedasticity problems, we tested the model for these purposes. Multicollinearity test result shows that the variance inflation factor for each predictor

variable is found less than 10 with a maximum of 9.60 (see Annex, 2). Despite of the fact that the two exogenous variables, DAP and Urea, are naturally collinear, dropping one of them to abolish the multicollinearity problem is not an end means. It has a consequence of model misspecification problem that is, “the remedy may be worse than the disease” (Gujarati, 2004: 366). In our case, since the VIF is not as high as 10, then multicollinearity is not a serious problem (Gujarati, 2004). Moreover, the problem of multicollinearity should not be considered as a serious issue while it “violates none of the assumption of a regression and its problem is not really well-defined” (Wooldridge, 2003: 95). Regarding heteroskedasticity, the problem is checked using the Breusch-Pagan test. Result shows that we fail to reject the null hypothesis of constant variance at all level of significance, thus, no evidence of heteroskedasticity (see Annex 3).

Moreover, we tested for model specification from an omitted variables” bias using the Ramsey RESET test. The null hypothesis of there is no omitted variable in the model is tested against the alternative. Evidence shows no rejection of the null hypothesis and thus, the model is correctly specified.

Result of the analysis shows that the model has an R-squared of 0.583. This indicates that about 58 percent of the variation in wheat yield is explained by the explanatory variables included in the model. The 0.000 p-value of the F-statistics revealed that, overall, the variables included in the production model are jointly significant in explaining the model. Therefore, the null hypothesis that joint coefficients are zero is rejected at 1 percent level of significance.

Of the commonly used fertilizers, DAP and Urea are the two most used inputs in Ethiopia generally and the sample site specifically. Referring to the empirical result from the production

function in Table 4.4, DAP was found to be a significant factor at 5 percent level of significance. This is consistent with the expectation that modern inputs raises agricultural yield considerably. A one percent increase in the input will result approximately in a 0.33 percent increase in yield, holding other things constant. Previous empirical findings acknowledged that fertilizer, an input most farming practitioners adopt to increase the mineral content of their farm, has a positive impact on yield (Aye and Oji, 2005; Moscardi and de Janvry, 1977).

Table 4.4: Determinants of Yield

Variable	Coefficient	Standard error
ln (quantity of wheat seed)	0.375***	0.111
ln (size of wheat land)	1.149***	0.298
ln (dap)	0.334**	0.165
ln (urea)	-0.162	0.157
ln (man days per Tsimdi)	-0.062	0.061
ln (animal traction per Tsimdi)	0.608**	0.291
Constant	2.426***	0.628
R ²	0.5831	
Adj R ²	0.5610	
F (6, 113)	26.34***	
No. of observations	120	
Dependent variable:	ln (yield)	

*** Significant at 1%

** Significant at 5%

* Significant at 10%

The other predictor variables, total land size allotted for wheat production and the quantity of wheat seed, are found significant at 1 percent. *Ceteris paribus*, a 1 percent increase in the quantity of wheat seed sown increases wheat output by about 0.37 percent. Likewise, output is expected to increase by 1.15 percent, *ceteris paribus*, when farmers bring an additional percent of land into wheat cultivation. Animal traction is also found to be a significant factor in explaining the variation in the yield at 5 percent. When a farmer increases his/her frequency of plowing the land by 1 percent, *ceteris paribus*, yield is expected to increase by 0.61 percent. All significant exogenous variables have their expected sign signifying. But comparing the contribution to yield, more than any other factor, land has the highest contribution. However, we find no evidence concerning the impact of man days per “tsimdi” and Urea.

In the previous part of the econometric analysis section, we present details about determinants of wheat output. Using the coefficient of DAP in the production function, the risk parameter is calculated. The consequent result is that farmers are either risk neutral or risk lovers. What determines the risk attitude of farmers is, in turn, empirically discussed below.

In doing so, Multivariate Linear Regression is applied. From this, the F-statistics of the model shows that the null hypotheses of the joint coefficients are zero is rejected at a 1 percent significance level. The model shows an R-squared of 0.451, revealing that about 45 percent of the variation in risk attitude is explained by the independent variables. Before going to interpretation of the results, we tested for the collinearity of exogenous variables. A result from VIF test indicates that each independent variable has less than 10 with a maximum of 2.24. Therefore, there is no evidence about the problem of multicollinearity in the model. In addition to this, we find no evidence about heteroskedasticity, as revealed from no rejection of the null hypothesis of constant variance (see Annexes 5 to 6).

Concerning the coefficient of exogenous variables, source of financing (*sfin*), a dummy variable, was significant at 5 percent. This suggests that, unlike farmers financing their fertilizer cost through credit, those who finance their expenditure from own sources are expected to increase their risk attitude by 0.10 units, ceteris paribus. The positive sign of this variable imply that with a subsistence living, farmers are not willing to spend extra money on modern inputs with unknown future returns. With inadequate income levels, rural households may prefer sustaining the lives of their families to investing on farm technologies. This is normally expected when the rate of returns across investment schemes are not certainly anticipated.

Table 4.5: Estimated Coefficients of Risk Determinants

Variable	Coefficient	Standard error
Sex	0.006	0.076
Household size	-0.017	0.014
Source of finance	0.104**	0.049
Farming experience	-0.003	0.002
ln (wheat farm/total farm size)	-0.220***	0.05
ln (no. of visit by extension workers)	0.056	0.041
ln (wheat income/total income)	-0.102***	0.032
Consumption per adult equivalent	-0.000	0.000
High yield variety	-0.258***	0.090
Educational level of household head	-0.000	0.011
Constant	0.722***	0.210
R ²	0.4513	
Adj R ²	0.4009	
F(10, 109)	8.96***	
No. of observations	120	
Dependent variable: K (Risk Parameter)		

*** Significant at 1% ** Significant at 5% * Significant at 10%

Theory suggests that the development and use of high yield variety crops enhance crop productivity and lowers the risk aversion attitude. To check its effect on risk aversion behavior of farmers, high yield variety (*hyv*) was introduced as dummy in to the model and found it is significant at 1% with an expected sign. This suggests that farmers are less risk averse if they combine high yield variety seeds with other technological inputs. Holding other things constant, the implication is that, farmers who use a high yield seed are expected to reduce their risk attitude by about 0.26 units compared to those who do not use.

The proportion of wheat farm allotted to total farm holding of a farmer (*lwfa*) is significant at 1% in line with the expected sign. Holding other things constant, allocating an additional land specifically into the production of wheat results in the reduction of risk attitude by about 22 percent. This is consistent with the findings of Olarinde et al. (2007) that high proportion of maize, in our case wheat, farm to total farm cultivated by farmers motivates farmers to take risk. Descriptive statistics show that the average proportion of wheat farm to total farm size is 0.31 “tsimdi”, while average total farm is 2.57 “tsimdi”. Therefore, risk can be minimized by allocating larger size of land towards wheat production.

Like the effect of the proportion of wheat farm to total farm holding, the proportion of wheat to total income show a 1 percent significant and negative relationship with risk. The implication is that increasing the proportion by one unit, ceteris paribus, reduces risk aversion by about 10.2 percent. This variable bears its expected sign.

However, there is no evidence that poverty has an effect on farmers’ risk attitude, hence, the adoption of agricultural technology. This is in contrast with the finding of Aye & Oji (2005) where poverty has positive significant effect on risk aversion. In the society, there is a belief that

poverty may occur only with the will of God based on their respect and doing for God. This may come from the strong belief on God and the persistence droughts occurred in different times due to shortage of rainfall associates with the annoy of God. It is highly believed that rainfall is a will of God. This is in consistent with a study by Nigist (2007). She conducted her study on Tigray farmers and found the annual mean rainfall has a positive significant effect on their risk attitude. This may help to suggest that modern inputs are not a cause for farmers' risk aversion attitude for fear of crop failure that leads to poverty but only the shortage of rainfall is the determinant. So, for fear that poverty may occur in the future due to crop failure as a result of use of modern agricultural inputs (fertilizer), is not cause for farmers to be risk averse.

CHAPTER FIVE

CONCLUSION AND POLICY IMPLICATIONS

5.1. Conclusion

Poverty is a serious problem throughout the world due to its multi facet effect on society. In most developing countries such as Ethiopia, poverty is still persistent and it is the main concern of policy makers. The causes for its persistence are various factors. However, the high dependence of the country's economy on agriculture, which is based on traditional farming, is expected to take a high share. This might be true that the rate of adoption for modern farming inputs by farmers is affected by different factors, in which poverty is hypothesized as one cause. That is, farmers are full of uncertainty for using modern inputs that would have the advantage of raising productivity and devise different mechanisms that reduce the uncertainty that would prevail in their future. One of it is the halt of using these technologies for fear that crop failure may occur that could affect their living. This may lead us to take a picture that farmers are risk averse for these technologies.

Given the above myopia that farmers are believed to have for new technologies, we used as a starting point to identify the risk attitude of farmers for these technologies and tried to link this attitude with the different socio economic variables that are possible to have significance associations or not. We followed Moscardi and de Janvry (1977) Safety First Model, where they used a production function to estimate the risk parameter using the elasticity coefficient obtained from the estimated production function for the input treated as modern input (i.e. fertilizer). Then, after estimation of each farmer's risk attitude, the multivariate regression analysis is taken

to show the effect of some socio economic variables, including poverty. The motto of this study is to determine the risk level of farmers' for adoption of fertilizer (here in our case, DAP) and the poverty level that exists in the sample area, measured by using the family of FGT. Next objective after the estimation of these two models is the determination of the possible effect of socio economic variables, including poverty on risk attitude.

The study used both descriptive and econometric approaches for analysis. Accordingly, the results reveal that:

- All farmers are not risk averters, rather 52.5 percent of them are risk neutral and the rest of them are risk lovers (i.e. 47.5 %). But none of them are risk averters for adopting fertilizer. However, male headed households are more risk lovers than female headed with a percentage of 48.04 and 44.44 respectively of the total risk lovers.
- The poverty index, using the international standard of poverty line US\$1.25 per day, shows that 69.17 percent of the total households live below this poverty line, which is higher than the IFAD (2010) national estimate of 39 percent. The land size, population density and the in and out nature of poverty may explain this incidence.
- Empirical findings on yield show that fertilizer, i.e. DAP has a positive effect on production of wheat. In addition to that, wheat plot size, number of repetitive plowing per "tsimdi", and quantity of seed affects yield positively. These variables are in line with their expected signs.
- Though poverty is high, the result shows that there is no evidence that poverty significantly affects of farmers' attitude towards risk. This is revealed by the multivariate estimation which passed through the test of Heteroskedasticity, multicollinearity and misspecification.

- Among the included exogenous variables, only the use of high yield seed, source of finance, proportion of wheat to total farm, and proportion of wheat to total income show that there is significant effect on risk. However, while the source of finance has a risk increasing effect, the remaining significant variables have a risk switching effect.

5.2. Policy implication

The above conclusion shows that some socio economic variables have an impact on risk attitude. Though poverty, the key variable in which the study stems, has no significant effect on risk attitude, other variables are found to significantly affect risk. Hence, based on the findings, we recommend that:

- On the production side, even if farm size is improbable to increase with rising population pressure, the improvement on farm quality may trigger high yield. Besides, the use of fertilizer in the right dosage specification would lead to increment of yield. This demands a support from concerned bodies to farmers and farmers should also be advised to plough repetitively before sowing.
- Regarding risk, it is highly recommended that while designing policies on diffusion of new technologies, it is better to consider some of the socio economic variables. Though farmers are not reluctant to adopt modern technologies, better policies should be designed that reduce risk such as complementary variables of fertilizer use in which enough water for crop production is one.
- The high incidence of the Woreda shows that there is a need to devise a developmental policy that creates both high employment and income. As seen from the result, the proportion of farm land of the Woreda is low as compared to the national level. With

increasing population density, the productivity of the land could decrease and employment opportunity could diminish if not vanish. So, appropriate policies should exist that increase employment opportunities and generate income. This can reduce the burden of agriculture.

- Finally there should be enough arrangements and provisions of high yield varieties. Opportunities should be created to farmers so as to finance their fertilizer expenditure. This is tied with the policy options for creating other means of financing such as expansion of credit schemes. In addition, the respective body for the supply of high yield seeds should focus in supplying on appropriate and timely basis. Great investment on research and development at emerging and diffusion of new high yield varieties should be encouraged. This helps to reduce the risk attitude for fertilizers that has a positive contribution on yield.

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Annexes

Annex 1: Questionnaire

Code number.....

Date of interview.....

Purpose: This questionnaire is used to gather data from farmers for MSc thesis entitled on “**Poverty and Farmers’ attitude towards risk: Evidence from Hawzen, Tigray, Ethiopia**”.

Nothing has the objective beyond this and the data is fully confidential for the purpose of this thesis only.

Thank you for your cooperation in advance!

Instruction: Every enumerator should follow the following instructions

- Introducing yourself and telling the respondent to introduce himself
- Before starting, inform the objective or purpose of the interview and come to consensus on every point
- Put “X” in the box
- Check that all questions are asked and responses are fully recorded accordingly

1. Address: Tabia _____ Kushet _____
2. Age _____ Sex _____
3. How many people are there in your household? Fill based on their sex, age and educational level

S. No.	Age	Sex	Relation with head (son, nephew or other)	Educational level	Total

4. For how many years you are engaged in farming? _____
5. Which category you are under?
 - I. Have formal education
 - II. Have non-formal education, such as church education
 - III. Illiterate

6. If your answer is number I, what is your last level grade you reached? _____
7. What is the highest educational level from the house hold members? _____
8. How much total cultivated land size do you have in “*tsimdi*”? _____
9. Of the total cultivated land that you have, how much is used for wheat production in “*tsimdi*” during the year of 2002? _____
10. Did the seed sow were high yield variety or local wheat seed?
 - a. Yes, HYV b. No HYV C. both
11. How much kilogram of wheat seed is planted in kilogram in “*tsimdi*”?
 - a. HYV _____
 - b. Local wheat seed _____
12. How much kilograms of wheat did you get from the wheat cultivation?
 - a. HYV _____
 - b. Local wheat _____
13. Did you use Fertilizer during sowing wheat? Yes ☐ No ☐
14. If yes,
 - i. How much kilogram of fertilizer is used for that plot?

DAP
UREA
 - ii. How much cost you each in Birr per quintal?

DAP
UREA

15. Do you get support from development agents (Extension workers) on the use or provision of fertilizer?

Yes ☐ No ☐

16. How many times the development agents visit your farm until you finish harvesting?

17. How many laborers do you employ in that wheat plot of land (regardless of paid or unpaid laborers)? _____

18. For how long hours did you stay working in that wheat plot per a day? _____

19. How many days you stayed working in that plot? _____

20. How many times you repetitively plowed with one tsimdi oxen? _____

21. Did you use herbicide for your wheat production? Yes No

i. If yes, how many liters of herbicide per” tsimdi”?

ii. If no, why?

22. Did you use insecticides for your wheat farm? Yes ☐ No ☐

i. If yes, how many liters of insecticides per” tsimdi”?

ii. If no, why?

23. Do you have another source of income? Yes ☐ No ☐

i. If yes, mention the type of activities according to their priority as source of income and total amount of income during a year

24. Is there any member who generates income from outside farming? If so how much Birr per month he/she earns? _____

25. Are there any cooperatives in your Tabia? Yes ☐ No ☐

a. If there, are you a member at least with one of them? Yes ☐ No ☐

26. What type of assets do you possess and how much?

Type of Asset		Total amount
Ox		
Cow		
Sheep/goat		
Hens		
Donkeys		
Horse/Mule		
Bee		
Others		

27. How much is your household total consumption expenditure on the following items on average?

average:

Expenditure on		Unit of measurement	Quantity
cereal	Tef	Quintal/ month	
	Wheat	Quintal/ month	
	Sorghum	Quintal/ month	
	Barely	Quintal/ month	
	Mixed	Quintal/ month	
	Dagusa	Quintal/ month	
Kerosene		Liter/week	
Sugar		Kg/week	
Coffee		Kg/week	
Shiro		Kg/month	
Vegetables and other		Cash/week	
Salt		Kg/month	
Edible Oil		Liter/month	
Wood		Donkey load/month	
Pepper (Berbere)		Kg/month	
Shoes	Plastic (kongo)	Pairs/year	
	Leather shoe	yearly expenditure individual's	
Clothes		yearly expenditure individual's	

28. Do your neighbors adopt modern agricultural inputs such as fertilizer?

Yes ☐ No ☐

29. What is the source of financing your fertilizer expenditure?

Own resource ☐

Credit ☐

Others ☐

30. Do you have access to near market for fertilizer? Yes ☐ No ☐

31. If yes, how much is far from home in kilometer? _____

32. Were you sick during the past three months? Yes ☐ No ☐

i. If yes, how many times _____

ii. How much Birr you spent for treatment during these months? _____

Thank you!

Annex 2: Test of Multicollinearity for Yield Estimation

Variable	VIF	1/VIF

ln (size of wheat land)	9.60	0.104127
ln (animal traction per Tsimdi)	8.07	0.123850
ln (dap)	4.98	0.200774
ln (urea)	4.59	0.217763
ln (quantity of wheat seed)	2.37	0.421903
ln (man days per Tsimdi)	1.04	0.957185

Mean VIF	5.11	

Conclusion: as to Gujarati, (2004) multicollinearity is a serious problem if the VIF a variable is higher than 10. But as we can see there is no a variable with VIF exceeding 10. Therefore, we find nothing that multicollinearity is a serious problem in the model.

Annex 3: Test of Heteroskedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of $\ln(\text{yield})$

$$\chi^2(1) = 0.86$$

$$\text{Prob} > \chi^2 = 0.3551$$

Conclusion: there is no evidence that rejects the null hypothesis that the error term has no constant variance. The null hypothesis, as can be seen from the p- value that it is failed to reject it. Therefore, heteroskedasticity is not a problem of the model.

Annex 4: Model specification

Ramsey RESET test using powers of the fitted values of $\ln y$

Ho: model has no omitted variables

$$F(3, 110) = 0.47$$

$$\text{Prob} > F = 0.7032$$

Conclusion: with the null hypothesis specifying there is no omitted variable or misspecification, the test result signifies that the null hypothesis is failed to reject at a probability level of 70.32 percent.

Annex 5: Test for Multicollinearity of the Risk Determinants

Variable	VIF	1/VIF

Consumption per Adult Equivalent	2.24	0.446207
Household size	1.86	0.537823
ln (wheat income/total income)	1.78	0.562264
Farming experience	1.70	0.587828
ln (wheat farm/total farm size)	1.68	0.593551
Educational level of household head	1.48	0.673527
Sex	1.46	0.686180
Source of finance	1.19	0.841098
High yield variety	1.12	0.889872
ln (No. of visit by extension workers)	1.06	0.941460

Mean VIF	1.56	

Having the VIF of a variable less than 10 do not indicate that multicollinearity is a serious problem. Therefore, being the maximum VIF of a variable is 1.76, multicollinearity is not a serious problem.

Annex 6: Test of Heteroskedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of k

$$\chi^2(1) = 1.51$$

$$\text{Prob} > \chi^2 = 0.2195$$

Conclusion: The null hypothesis is failed to reject at 1, 5 and 10 percents showing that there is constant variance.

Annex 7: Specification Test

Ramsey RESET test using powers of the fitted values of k

Ho: model has no omitted variables

$$F(3, 106) = 1.80$$

$$\text{Prob} > F = 0.1521$$

Conclusion: It fails to reject the null hypothesis at a probability level of 1, 5, and 10 percents implying that there is no misspecification or omitted variable and the alternate hypothesis of having omitted variable is rejected.

DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all sorts of materials used for this thesis have been duly acknowledged.

Declared by:

Name: _____

Signature: _____

Date: _____

Confirmed by Advisor:

Name: _____

Signature: _____

Date: _____

Place and Date of Submission: _____