Crop Choices and Land Productivity on Rented Land in Northern Ethiopian Highlands

Martin Morgan Mailosi

Norwegian University of Life Sciences
Department of Economics and Resource Management
Master Thesis 30 Credits 2011

Abstract

The study assesses the effect of risk aversion and crop choices on land productivity on rented land. The analysis uses panel household and farm-plot level data collected in Tigray, the northern part of Ethiopia (2006-2010) where drought is the most important risk affecting agricultural activities. We examined whether tenants' and landlords' risk aversion behaviours are revealed in their crop choices and whether these choices had effect on land productivity on rented land. The results show that both tenants and landlords are risk averse in our study area and tenants are dominating the decision on choice of crop to be grown on rented land. Using an ordered logit model on whether tenants choose more profitable and more risky crops on rented land, we found both tenants and landlords do not face trade-off between risk and profit by choosing profitable and less risky crop combination. Regression results for the effect of crop choices on land productivity found both more profitable and less risky crops positively affecting land productivity on rented land. Our finding is relevant for policy targeting rural households' poverty reduction and rural development.

Keywords: risk aversion, crop choices, land productivity, rented land, Tigray, Ethiopia

Acknowledgment

The following individuals deserve to be mentioned for making this thesis possible and helped in mainstreaming the ideas presented herein.

First and foremost, I am highly grateful for Professor Stein. T. Holden, my masters' supervisor for constant guidance, encouragements and critical academic advices. I have learnt a lot through our constant discussions and your useful comments throughout the process. I know that your joy is not in being thanked for what you have done but that you have done your work nicely and wonderfully.

Secondly, great thanks should be given for those who made the data collection for this thesis possible, in mind are our supervisors, Betty and Hossaena, our enumerators and data entry guys. To Betty Laggasse, your time and help has made me a guru in Stata and data analysis, I thank you so much.

The climax of group dynamics made the whole process of data collection, entry, cleaning and analysis exciting. I refuse to forget, high tensions, laughing moments and critical engagements with my fellow NOMA students which have made me a perfect economist. To Kondwani Nyirongo and Christine Kauma, I thank you both for making me feel good around you through out the process.

Above all special gratitude should go to the mother of my daughter, the rock of our family, the love of my life, my wife and friend Elizabeth Mailosi. You made great sacrifice than anybody else to let me be part of this experience and you have shared joys and frustrations in making this thesis possible. I am also indebted to our wonderful daughter *Prisca,* "Dad will not forget the songs you sang on the phone when the going got steeper."

Lastly, great credit should go to NOMA programme for according me an opportunity to engage in contemporary issues with some of the best institutions and lectures in the world. The legacy of the NOMA programme is seen around me every time I think of how much I have changed intellectually.

Table of Contents

List of Tables

List of Figures

List of Acronyms

FDRE -Federal Democratic Republic of Ethiopia.
TNRS -Tigray National Regional State

1.0: Introduction

Egalitarian land distribution characterizes the land distribution in Ethiopia, where land is in custody of the state and user rights are conferred to the people through government redistribution structure. The 1995 federal constitution (FDRE 1995) provides a market friendly legislation which permits short-term land renting and hiring of labour while prohibiting sales and mortgaging of land. Consistent with the national constitution, the regional state of Tigray in its official land proclamation (TNRS 1997) allows farmers to lease out not more than half of their allotted land for a limited period as an attempt to facilitate land market development, achieve agricultural productivity and sustained economic growth. Land rental market has played the role of enhancing allocative efficiency[1] of land in most parts of Sub Saharan Africa and enhanced agricultural productivity when other inputs markets are imperfect or missing (Benin et al. 2005; Holden et al.2009). Land rental market in Ethiopia is reported to have increased and received further boost in our study area, Tigray, through the successfully implemented low- cost land certification program. The certification stopped the frequent land redistributions and provided the households inheritable land user certificates which enhance land tenure security and thus investment incentives and land rental market participation (Deininger et al. 2008b; Holden et al. 2009; 2011). Success stories of the land certification program have been challenged for failure to accommodate emerging new households to access land through redistribution thereby making them susceptible to having no land. However, enhancement of land tenure through the certification program has given the new families alternative option to access land through the land rental market.

The land rental markets are active and dominated by sharecropping in our study area (Deininger et al. 2008b; Holden et al. 2009). The dominance of sharecropping has been linked to attempts by tenants and landlords to pool resources together in

[1] The land rental market facilitates transfer of land from inefficient landlords facing market imperfections in non-land factors to efficient tenants rich in non-land factors of production. (Benin et al. 2005).

order to balance the factor ratios needed for production across contracting partners for mutual benefits (Holden et al. 2009).

There are mixed evidences on efficiency of sharecropping tenancy with others suggesting policies such as land to tiller as source of tenure insecurity on the landlords' side resulting in marshallian inefficiency in those countries (Otsuka 2007). On the other hand, Sadoulet et al. (1997) and Kassie and Holden (2007:2008) tried to explain the existence of kinship ties between tenants and landlords as a mitigating strategy for moral hazard problems that characterize share tenancy arrangements. Sadoulet et al. (1997) found increased productivity on sharecropped land operated by kin of the landlords. The kin-contracts were not only successful as an attempt to operate in social circles to tackle the problem of market imperfections and high transaction costs but also was used by poor landlord as the form of "insurance policy" against consumption risk during times of crop failure.

On the contrary, efficiency of sharecropping arrangement in Ethiopia among kin was rejected by Kassie and Holden (2007; 2008) observing that non-kin sharecropped plots were more productive than kin operated sharecropped plots. The efficiency on the sharecropping contracts on no-kin sharecropped land was enhanced by landlord's ability to enforce tenant efficiency of land management through eviction threat (Kassie and Holden 2007).

Risk aversion has been found to be a basic characteristic of humans resulting in development of "survival algorithms" (Lipton 1968; Mosley and Verschool 2005). Low income, limited access to credit, no insurance market and thin or non-existent labour markets in developing countries have restricted poor rural households to protect themselves against and manage risk. On the contrary, households with ability to cushion themselves from risk take advantage of more profitable but risky opportunity than the poor whose ability to absorb or take the risk is limited (Eswaran and Kotwal 1990). The expected response of farm households to risk is not dependent on wealth only but also the imperfections in other asset markets that limit substitution across the types of wealth (Wik and Holden 1998). In our study area farming activities are dependent on traction power; hence oxen are

used as the proxy of wealth making farm households poor in oxen to rent out their land.

This study explores the linkage of risk in the sharecropping arrangement, crop choices and land productivity on rented land and has the following objectives 1. Assess whether tenants are less risk averse than landlords. Empirically we expect landlords who are poorer in non-land resources (oxen) to be more risk averse than tenants who are relatively wealthier. 2. Assess whether tenants and landlords bargaining power affect who chooses crops to be grown on rented plots. We expect tenants who are relatively richer in non-land resources to have more bargaining power on the choice of crop to be grown on rented plots. 3. Assess whether tenants' and landlords' risk aversion behaviours are revealed in their crop choices on rented plots. An extension from the first objective by hypothesizing that tenants have the ability to take more risk and take advantage of more profitable but risky opportunities unlike landlords in sharecropping contracts. 4. Assess whether crop choices by tenants and landlords affect land productivity on rented plots.

In our analysis, we found the level of risk aversion to be similar for landlords and tenants with mean risk aversion parameter being about 4.0 which is the scale of higher risk aversion (where rank of degree of risk aversion ranges form 1 representing least risk aversion to 5 representing most risk aversion). The finding was consistent with Binswanger (1980) who found wealth effects on risk aversion to be minimal in the rural villages of India and that risk aversion doesn't change much across the rural villages. The reason might be that risk aversion behaviour is not only the affected by wealth but other factors like climatic conditions that are prevalent in our study area.

The choice of crops in the sharecropping contract is hypothesized to depend on whether the contracting partners are risk averse or not. Choices of crops grown on rented plots are supposed to be attributed to risk preference of contracting partners' but recent literature suggest that the choices may also be tied to household characteristics. Dercon and Christiaensen (2007) found Ethiopian households inability to cope with ex post consumption risk as a reason for their

refusal to adopt fertilizers. Thus households who are unable to protect themselves from risk reveal their risk aversion behaviour by crop choices grown on their plots and used sharecropping as risk sharing arrangement.

In reverse-share-tenancy[2], which is the common sharecropping arrangement in our study area, the land moves to households relatively richer in non-land resources mostly oxen (Ghebru and Holden 2008). More asset rich households (tenants) are more able to take risk by choosing crops that are more profitable and more risky.

Most of the empirical evidences about risk aversion, poverty, crop choices and land productivity have not addressed the effects of risk preferences on crop choices and land productivity on rented land. Bendiera (2007) and Dubois (2002) tried to link crop choices to risk aversion and productivity on rented land in passing while emphasizing on other subject matter.

Bandiera (2007) while analysing the land tenure, investment incentives, and the choice of techniques from Nicaragua found that tenants choose less labour intensive but high marketed-input-intensive crops on rented plots than on owner operated plots. In the Philippines, landlords' choices of sharecropping contract were seen to be affected by soil quality characteristics where fertile plots had more incentive contracts than non fertile plots (Dubois, 2002).

In this thesis we build on the determinants of the crop choices and land productivity as explored above by assessing the risk aversion response of both tenants and landlords in sharecropping arrangement and how those affect the crop choices and land productivity on rented land. We use perceptions of profitability and riskiness of crops and risk aversion estimates of households to assess whether these affected crop choices of tenants and landlords in the sharecropping arrangements. The paper uses crop classification from Holden and Hagos (2002), where crops were ranked based on profitability and riskiness perceptions of farmers.

[2] A scenario where landlords are contextually described as poor in non-land resource (not land rich households) while tenants are described as asset rich landowners rather than landless or near-landless poor households (Ghebru and Holden 2008; Holden and Bezabih 2008)

The study intends to add to the existing literature on sharecropping arrangements and land productivity by assessing how risk aversion affects crop choices in the land rental market. We assume in this paper that the land rental markets are imperfect, which is realistic in developing countries and imply that production and consumption decisions are non-separable (Wik and Holden 1998).

The study used unbalanced panel plot data from Tigray in Ethiopia from 2006 and 2010 in order to increase our sample for analysis. The plot data was matched with the household level data to capture demographic characteristics of landlords and tenants

The paper organisation is as follows; literature review of risk aversion, crop choices and land productivity on rented land in Ethiopia and the rest of the world with their agrarian characteristics similar to that of the study area are presented in chapter 2. Chapter 3 includes discussion of the theoretical framework focusing on the risk aversion of households. Estimation methods (econometric model), methods of data collection and statistic description of the data are discussed in the chapter 4. Chapter 5 presents and discusses the results of the empirical findings of the study. Conclusions, limitation of the study and important policy implications closes the paper in chapter 6.

2.0: Literature Review

The emergence of land markets has implications on land use and addresses issues of poverty, equity and efficiency across African countries. In a continent characterised by growing population, soil degradation, technology stagnation and drought, land becomes the only resource accessible to the poor. In an attempt to solve the problem, there are effort by some countries on the continent to embrace new land reform as a way of ensuring equitable land distribution and tenure security as a poverty reduction strategy. Land reforms received the global boost by creation of the commission responsible for legal empowerment of the poor and expansion of the land reform projects funded by World Bank (WorldBank 2006).

There are however, mixed experiences on the success of land reform in Africa and their contribution in promoting poverty reduction and economic growth, given past experiences and the difficulties of designing and implementing these pro-poor land reforms. Examples of past land titling in Africa resulted in benefiting the wealthy and powerful at the expense of the poor and marginalized, owing to poor implementation, the high cost of obtaining titles in complex and often corrupt and inefficient bureaucracies, and limited or no formal recognition of customary land rights (Besley and Burgess 2000; Cotula et al. 2004; Deininger 2003).

Success stories of land reform were also reported in Africa. Increased land rental market activities were observed in our study area following land reform policy that gives property user rights of land to households by certification of rural land ownership titles (Holden et al. 2011).

2.1 Existence of sharecropping and productivity

Sharecropping arrangement is dominant contracts type in Northern Ethiopia and manifests itself differently than other sharecropping arrangements in Africa depending on dominance and dependency between the landlords and tenants. In Tigray, reverse-share-tenancy is practiced between households rich in land: labour or land: drought power ratio and households poor in land resource relative to their endowment in labour and oxen (Kassie and Holden 2007). The short term

transfer of land in form of sharecropping arrangement is reported to be increasing in our study area accounting to 88% of total temporary land transfers and 20% land operated by the tenants during the 1998 production season (Pender and Fafchamps 2006).

Practices and efficiency of sharecropping arrangement as a form of land rental market has been reported in Asia and Africa. In Ethiopia the dominant sharecropping contract involves sharing of factor of production (landlords and tenants provides land and labour respectively) and final crop output. However, variation in share of the factors of production by contracting partners defined alternative sharecropping arrangements and output share determination. In additional to land and labour, other factor of production like market purchased input determined the sharecropping contracts (Holden and Bezabih 2008; Pender and Fafchamps 2006)

Cheung (1968) reported sharecropping arrangement as the means of sharing production risk between the landlords and the tenants. Landlords use the contract as the form of perfect risk pooling and enhancing production efficiency, depending on the landlords' ability to enforce and monitor effort. There exist mixed evidences of share cropping tenancy, review of South and Southeast Asia case studies found significant Marshallian inefficiencies in the sharecropping arrangement as a result of land-to-the –tiller policies that created tenure insecurity (Otsuka 2007). Gevian and Ehui (1999), while measuring the productivity efficiency of alternative land rental contracts in mixed crop-livestock system in Ethiopia, found economic reasons for existence of the sharecropping arrangements and that share of output paid to the landowner was higher than the fixed land rental payment.

Studies that rejected occurrence of marshallian inefficiency in sharecropping contracts attributed the choice of contract to be sorely based on risk sharing and efficient contract enforcement and monitoring (Otsuka and Yahami 1988; Otsuka et al. 1992).

Pender and Fafchamp (2006), while assessing land lease market and agricultural efficiency in the Northern part of Ethiopia found that marshallian inefficiencies

were not existent on rented out plots. Similarly analysing the sharecropping efficiency in Ethiopia, Holden et.al (2002) found that barley yielded higher (51%) on rented land than owner operated land and attributed the increase to ability of the landlords to use of threat of eviction and kinship in the sharecropping contracts.

2.2 Crop choices and land productivity

Crop choices on owner operated land and rented land depends on both agro-ecological and economic factors. Pender et.al (2006) found rainfall pattern, temperature, market access, land quality, altitude, income strategy, land management practices and other policy relevant factors such as irrigation, technical assistance, education, and gender and tenure status to influence crop choices on land in East Africa Highlands. Better access to market in Kenya was driving preferences for crops choices by farmers noting that farm households close to urban centres choose cash crops unlike those far from urban centres who opt for food crops cereals like maize. Kruseman et al (2006) also found ***teff*** production (a common cash and food crop in the northern part of Ethiopia) common than maize crops in areas around urban markets. Using bio economic model Holden et.al (2003) found increased profitability on tree-planting activities close to roads and markets in the northern part of Ethiopia. Proximity to roads or markets provides incentives for income enhanced strategies which are consistent with better welfare outcomes. Market access was found to influence non-farm opportunity, intensification of use of fertilizer and other inputs and enhanced collective action towards land management (Bardhan 1993; Pender et al. 2006)

Population pressure was found to be driving land fragmentation which affects crop choices and land management strategies. Place and Otsuka (2000) found adoption of low input demanding crops and high practices of land conservation such as fallowing common in low populated areas. Contrary to the high populated areas greater use of fertilizer, low investment in land improvement practices and high adoption of other inputs associated with improved land value for crop production, high income and improved land quality were common in highly populated areas in Kenya and Ethiopia.

2.3 Land rental market, crop choices and risk aversion

In low income countries, farm investment decisions by farmers are made mindful of prevailing existing risk dominated environment. Binswanger (1980) found substantial variation in risk aversion across individuals within the villages in India but not so much variation in the mean levels of risk aversion across villages. He observed rural households with wealth to be moderately risk-averse with little variation according to personal characteristics. Slight reductions in risk resulting from wealth were observed but its effect was not significant statistically.

Risk aversion has been found to be basic stable characteristics of humans and found to alter behaviour that may seem sub-optimal at the fist glance. These are seen as" survival algorithms" (Lipton 1968; Rosenzweig and Binswanger 1993). Households' wealth was found to increase willingness to undertake activities and investments which are risky but have high expected returns (Eswaran and Kotwal 1990; Yesuf and Bluffstone 2009). In our study area land rental market is reported to have facilitated transferring of land from landlords poor in non-land resource to tenants rich in non-land resources like oxen. Women were found to dominate the sharecropping contracts because of their inability to use traction power due to restrictions by cultural belief and end up renting most of their agricultural land (Holden et al. 2011; Kassie and Holden 2007). Reverse-share-tenancy is predominant in Ethiopia enabling land to move to the wealthier tenants, whose willingness to undertake risk could be displayed in their choice of profitable but more risky crops.

Dubois (2002) while assessing land fertility and sharecropping in rural areas of the Philippines found profitability or riskiness of crop choices to be determined by the location of the land owner, finding the sugar (most profitable crop than corn) chosen by landlords close to sugar mills.

Similar studies found crop choices on rented land dependent on plot characteristics and land tenure periods. In Nicaragua, cassava and millet typically grown in low quality soils were found to be grown by both tenants and landlords who had low quality plots. Tenants in the long term contract were also likely to plant tree crops on rented land than their counterparts on short contract (Bandiera

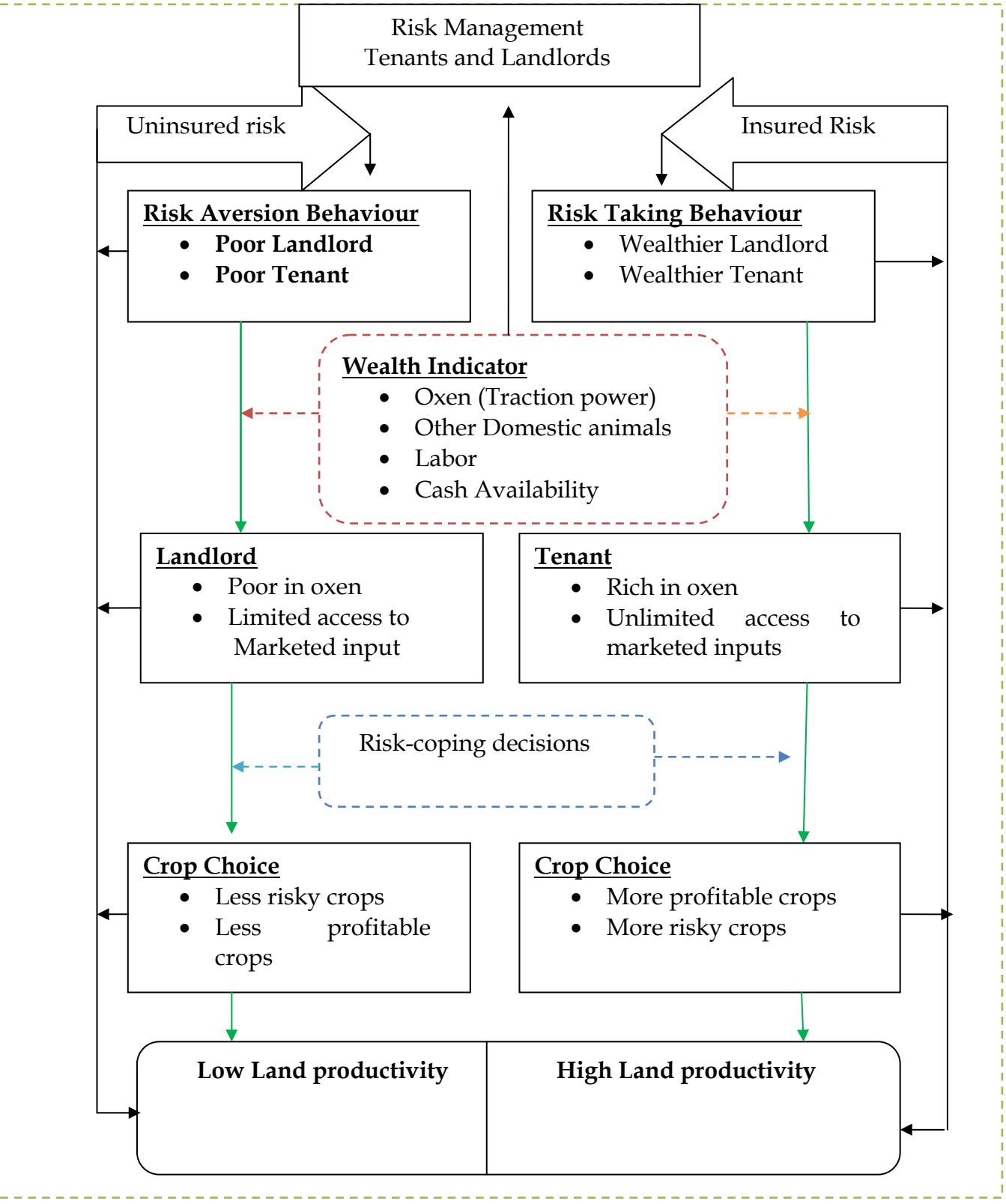
). However, similar studies failed to find the significant relationship between crop choice and soil quality or between crop choice and tenure status (Besley and Burgess 2000).

3.0: Theoretical Framework

This section outlines the theoretical framework for analysing the risk aversion behaviour of the tenants and landlords, its effect on crop choices and land productivity on rented land. Agricultural production systems in most low-income countries are characterised risky rain fed staple crops and livestock production. Such risks include but not limited to crop yield risks affected by drought, flooding, frost, war and crime, and animal risk due to diseases and changing output prices (Holden and Hagos (2002). Poor households respond to these risks by making sub-optimal investment decisions which limit them from exploiting investment choices promising high expected rate of return (Lipton 1968; Rosenzweig and Binswanger 1993). Low income and market imperfection for labour, insurance and credit disables the farm households to shift these risks to third party and insure their consumption risk. Risk aversion behaviours observed in households were not as a result of wealth only but also due to failure of the other markets limiting substitution across the type of wealth (Holden et al. 1998). Ability of farm households to protect themselves from risk enables them to take advantage of profitable but risky opportunities unlike the poor whose choices are limited to low-risk and low-return opportunities to secure themselves from risk. Rich farmers were found exhibiting low risk aversion in their investment and production activities unlike poor farmers who exhibited higher levels of risk aversion (Eswaran and Kotwal 1990). The observation were consistent with absolute risk aversion assumptions implying that as farm households become wealthier their risk aversion behaviour decreases (Yesuf and Bluffstone 2009).

In this thesis, we expend the theories above and study the risk aversion behaviour involving landlords and tenants in the land rental markets and how such affect crop choices and land productivity on rented land.

Figure1: Conceptual framework for risk aversion, crop choices and land productivity on rented plots.



Based on the literature review and the constructed conceptual framework, we use the risk aversion assumptions in assessing the behaviour of tenants and landlords

in the share cropping arrangement contract, their effect on crop choices and land productivity. In Ethiopian, tenants were found to be richer in non-land factors of production than landlords resulting in landlords renting out their land due to lack of oxen, which is an essential factor of production in Ethiopian agriculture (Holden et al. 2011). The wealthier tenants insure their consumption risk through their wealth and are able to undertake crop choices that are more profitable and more risky.

3.1: Measurement of risk aversion

In reference to Von Neuman-Morgenstern expected utility function, risk aversion in this thesis uses the commonly used risk aversion functions in understanding the crop choices and behaviour of tenants and landlords in the land rental market as follows; 1. Absolute risk aversion A(W),(Pratt 1964); 2. Relative risk aversion R(W) (Arrow 1971); and (3) partial risk aversion P(W0, Л) (Menezes and Hanson 1970; Zeckhauser and Keeler 1970).

$$A(W) = -\frac{U^{''}(W)}{U^{'}(W)} = \frac{-U^{''}(W_0)}{U^{'}(W_0)} = \frac{-U^{''}(Л)}{U^{'}(Л)}$$

$$R(W) = -W\frac{U^{''}(W)}{U^{'}(W)} = -WA(W)$$

$$P(W0, Л) = -Л\frac{U^{''}(W_0 + Л)}{U^{'}(W_0 + Л)} = ЛA(W_0 + Л)$$

Where W represents tenants/landlords wealth, $U^{'}$and $U^{''}$ represents first and second order derivatives of expected tenant /landlord utility, W_0 and $Л$ represents the initial wealth and stochastic income respectively. The risk aversion measures are related to each other at point where $W = W_0 + Л$ as in the equation below;

$$R(W) = W_0A(W) + P(W0, Л)$$

Different risk aversion measures are appropriate in different situations; in cases where income or gains are fixed and wealth is variable, absolute risk aversion measure becomes appropriate. The basic assumption holds in that wealth increases households willing to take more risky choices that promise high return. When the changes of both income and wealth are proportionally equal, relative aversion measure becomes appropriate. As hypothesized by Arrow(1971), the willingness of the individuals to accept a gamble decrease when both their wealth

and outcome of the gamble increase proportionally. In situation with initial wealth fixed and income varying, it is appropriate to use partial risk aversion measure.
As observed in this thesis, Ethiopian farm households are faced with both agricultural risk and constrained in access to credit and insurance markets limiting their ability to build wealth. Agricultural production also is characterized by traction power which is difficult to acquire by poor households hence assumption of absolute risk aversion holds in this case.

The thesis draws from above noted theories and conceptual framework in drawing and answering the hypothesises;

Hypothesis 1

- Tenants are less risk averse than landlords.

Binswanger (1980) revealed the role of wealth to reduce risk aversion in the rural households of India and found no variation of mean risk across the villages. Wik et.al (2004) found partial risk aversion reducing significantly as the wealth of rural household in Zambia increases. We hypothesize in this study that landlords who are poor in non-land factors of production make sub-optimal investment decisions resulting in unwillingness to undertake crop choice which are more risky but promises high profitability. This is contrary to the tenants who are rich in non-land factors of production (oxen) and have ability to secure themselves against risk and take advantage of more profitable but risky crop choices (Eswaran and Kotwal 1990).

Hypothesis 2:

In sharecropping arrangements tenants have higher bargaining power and decide the crop choice on the rented plots.

In sharecropping contracts crop choices are determined by contracting parterner who has more bargaining power than the other. Ghebru and Holden (2008) found tenants with more bargaining power in choosing land rental contracts than landlords since their richer in non-land resources. We also hypothisise that tenants who are richer in non-land resources will have higher bargaining power on the crop choice on rented land.

Hypothesis 3

- In sharecropping arrangements tenants choose more risky and profitable crops on rented land if they are allowed to make the crop choice decision.

Using the categories of crop based on their profitablity and riskiness by Holden and Hagos (2002), we hypothesize that tenants who are richer in non-land resource choose crops that are risky but promising higher profitability. We expand on crop choices on profitability and riskiness to assess if tenants plots are more productive than landlords plots which draws us to our last hypothesis.

Hypothesis 4

- Tenants' choice of more profitable and high risky crops increase land productivity on sharecropped plots.

Lipton (1968) found that rich rural households can secure themselves from risk and are more willing to undertake activities and investments that have higher expected return. We hypothesize in this study that more profitable and more risky crop choices result in increased land productivity. We assess whether the crop choices on the plots have effect on the productivity on both owner operated and rented land in sharecropping arrangement.

Table 1: The variables and their hypothesized relationship with crop choice and land productivity on rented land

Variable	**Measurement**	**Hypotheses (relationship with crop choices and productivity on rented plot)**
Sex of Household head	Dummy (1=female,0=male)	Male headed households choose more profitable crops than female headed households since they are generally wealthier than female headed household hence high productivity
Age of household head	continuous (years)	Aged household heads choose less risky crops to cushion their consumption needs than young headed household who can sell their labour in times of crop failure.
Literacy of household head	Dummy variable (1= literate,0= otherwise)	Education increases awareness. Thus illiterate household head are more willing to choose profitable crops due to more awareness of the benefits of taking such risk choices. Education may also enhance wealth which might reduce household risk aversion.
Farm size	Continuous (Tsindi)	Household with large farm size are willing to choose more risky and more profitable crop because of certainty of at least minimum return from the farm even in bad years as opposed to small farm size.
Oxen holding	Continuous (number)	Proxy for wealth. Hypothesised to increase tenants willingness to take more profitable and high risk crops due to its ability to cushion for crop loss in case of drought
Tropical Livestock Units	Continuous (number)	Proxy for wealth. Hypothesised to increase tenants willingness to take more profitable and high risk crops due to their ability to cushion for crop loss in case of drought

Risk aversion Parameter	Categorical (1-6 decreasing)	Measure of degree of aversion range from, 1= least risk averse to 6= most risk averse. Hypothesised to decrease as wealth of household increases.

** 1 Tsindi = 2500m^2**

4.0: Data and Methods

The thesis used both qualitative and quantitative methods to analyze the relationship between risk aversion between tenants and landlords and its effect on both the crop choices and land productivity on rented land. Key variables that are of interest to this study include production outputs per unit of land (total output – total inputs/ plot size), crop choices (classified by their profitability and riskiness), household characteristics, wealth of household (oxen and tropical livestock units), farm plot characteristics and risk parameter.

4.1: Methods of data collection

The study used the panel data covering a stratified random sample of 400 farm household from Tigray region in northern Ethiopia. The primary data comes from the household survey conducted in June 2010 as a follow up panel survey conducted from 1997/98, 2000/2001, 2002/03 and 2006/07. The author was involved as the supervisor during the data collection process of the last panel. The survey followed the same stratification and sampling that was done in the previous surveys which has data (household and plot level) collected from five administrative zone of Tigray region of Ethiopia. The sampling was conducted in two stages which included the stratified sampling of 16 communities (tabias) from the 11 districts of the administrative zones in the region followed by simple random sampling of 400 farm households (25 respondents from each of the 16 communities were considered for collection of both household and plot level information (Holden and Hagos 2002). The sub sample of 100 communities in the first stage sampling was based on the following characteristics that included irrigation projects, population density, geographical location and distant to market. However the 16 communities in the first stage were selected based on the same strata with the hope that the variation can improve the analysis on the important variables. The thesis also used the data from the Mahone which is the new site included in the sample to increase number of observations for analysis. In order to track our crop choice variable all participants of the rental markets who grew crops that were not in our classification were dropped making our number of observations smaller.

For the purpose of analysis, other observations involved in the land rental markets were dropped in order to maintain consistency with out dependent variables (rank of degree of riskiness and profitability). This reduced our observations used in our analysis to 1320 plots.

The study uses matched unbalanced data of participants in the land rental market across the two panels 2006 and 2010 to assess the trend of changes of chosen variables over time. Where some relevant variables were missing the study drop the data in that year to maintain the balance matched panel.

4.2: Estimation method

The descriptive statistics intends to give the general picture of chosen variables included in the analysis of risk aversion, crop choice and land productivity across tenants and landlords households while the quantitative analysis assesses the relationships between the risk aversion behavior, crop choices and land productivity.

Model 1: Assessment of risk aversion between landlords and tenants

In order to assess whether tenants are less risk averse than landlords, mean, frequencies and comparison statistics were used on hypothetical data about risk aversion responses by tenants and landlords. The household head was given an option to choose among crops with different risk portfolio between good and bad year. The hypothetical question used the risk preference between a crop which gives high return (20 quintal[3]) in good year but no return (0 quintal) in bad year with a crop giving comparatively less return (19.5 quintal) in good year and some return (2 quintal) in bad year. The preference for type of crop to plant was stopped at the minimum level of choice combination by the tenants and landlords. All the choices were assumed to have the bad year occurrence of one out of five years. The risk aversion categories were from one to six (with 1 representing less risk aversion and 6 represents high risk aversion) were used to assess the risk aversion level between tenants and landlords.

[3] One quintal is equal to 100kg

Model 2: Profitability and riskiness of crops

To assess whether risk aversion of tenants and landlords affect their crop choices, ordered logistic model was estimated. The applied ordered logistic models was applied to the two year plot-level panel data using crop profitability and crop riskiness categories as dependent variable as classified by Holden and Hagos (2002). The first model specifies the dependent variable "profitable crops choice" based on their profitability; 1) Barley (least profitable); 2) Maize (less profitable); 3) wheat (profitable); 4) teff (most profitable). We tested also the second model specification dependent variable "risky crops variable" based on the crop riskiness; 1) teff (least risky); 2) Wheat (low risk); 3) barley (riskier); 4) Maize (most risky); The crop choices categories used might have changed with time given that the classification was done in 1998 but we adopt the classification assuming that it is difficult to change tastes overtime. Teff is used as the base category in both equations to assess factors affecting choices of profitable and risky crops by both tenants and landlord. The reduced form of ordered probit model takes the following form:

$$Y_i = bo + b_1X_1 + b_1X_1 + b_2X_2 \ldots + U_{ij}$$

Where y_i is ordered crop choices based on profitability and riskiness, X_1 is gender of household sex, X_2 is literacy level of household head, X_3 is land characteristics (soil depth, soil quality and soil slope), $X_4$is household size X_5 is the oxen number (proxy for household wealth), X_6 tropical livestock units (proxy for household wealth), $X_7$is the risk aversion variable for tenants and Landlords, X_8, (dummy for tenants and landlords) ,B_0 is alternative specified constant and U_{ij} is the error term looking exclusively at attributes X_{ij}.

Model 3: Choice of crops and productivity on rented land

To estimate the relationship between the crop choices and land productivity on rented land. Net-crop revenue variable (output*price)-(input*price) per plot size of land will be used as a dependent variable in the regression model (OLS), which takes the following form;

$$y_i^* = \beta_0 + \beta_1 x_1 + \beta_2 z_1 + \beta_2 w_1 + \beta_3 c_1 + u_{ij}$$

Where, x_1 refers to a vector of household characteristics (gender of household head, literacy, family size), z_1 land characteristics (soil quality, soil depth and slope), w_1 represents the vector of household wealth (the area of land owned, oxen and tropical livestock units).

The crop choice variable used in the model as the independent variable is endogenous to production hence we used wide array of plot-level land quality characteristics to control for crop choices (Woodridge 2002). The net crop revenue (yield) used in the productivity model could not be measured directly as the prices for inputs were endogenous and could not be revealed easily. Instead, the values of total gross output minus marketed inputs (fertilizers) for each plot was used as the dependent variable.

In order to ensure the robustness of the models to heteroskedasticity and potential spatial autocorrelation, the models are estimated using robust standard errors.

Table 2: Description of explanatory variables for Ordinary Least Square (OLS) (Productivity)

Variable	**Description**	N	**Mean (SD)**
hhsex	Sex of household head (1=female; 0=male)	1320	0.24(.43)
hhage	Age of household head (number of years)	1320	54.39(13.7)
literacy	Literacy (1= literate, 0=illiterate)	1320	0.28 (.45)
oxcurrent	Oxen Holding (number of oxen)	1320	1.13(1.04)
Oxlu	Oxen livestock units	1320	0.78(0.72)
tlu	Total Tropical Livestock Units	1320	2.64(2.30)
risk	degree of risk aversion (where 1=risk lover and 6 is extreme risk averse)	1320	3.53(1.71)
distancetp	Distance to Plot (minutes)	1320	25.26(37.53)
rentinplot05	rented in plot (Tenant)	1320	0.092(0.29)
rentoutp05	rented out plot (Landlord)	1320	0.12(0.32)
landqual3	Soil depth = deep	1320	0.05(0.21
soiltyp1	Soil type: Baekel= Cambisol	1320	0.23 (0.23)
soiltyp2	Soil type: Walka =Vertisol	1320	0.29 (0.45)
slope1	Slope: flat very bottom	1320	1.79 (.84)
areaplanted	Area Planted (tsimdi)	1320	1.01(.87)
profcrop	Rank of crop profitability (1= teff; 2= Wheat; 3=Maize; 4= Burley)	1320	1.99(1.11)
riskcrop	Rank of crop riskiness (1= teff; 2= Wheat; 3=Maize; 4= Burley)	1320	1.93(1.02)

Note:* tsimdi is the area a pair of oxen can plough in a day and is approximately 0.25 hectares

**SD=Standard Deviation & N= No of observations.

Dependent variables

yield = Total net revenue (Price*total output-price* fertilizer)

logyield= log (Total net revenue (Price*total output-price* fertilizer)

Table3: Description of explanatory variables for maximum likelihood estimations (risky and profitable crops)

Variable	Description	N	Mean (SD)
hhsex	Sex of household head (1=female; 0=male)	1320	0.24(0.43)
hhage	Age of household head (number of years)	1320	54.39(13.7)
literacy	Literacy (1= literate, 0=illiterate)	1320	0.28 (0.45)
hhsize	Size of Household (number of people)	1320	5.45(2.24)
oxcurrent	Oxen Holding (number of oxen)	1320	1.13(1.04)
oxlu	Oxen livestock units	1320	0.78(0.72)
tlu	Tropical livestock units	1320	2.63(2.29)
risk	Degree of risk aversion (where 1=risk lover and 6= extreme risk averse)	1320	3.53(1.71)
distancetp	Distance to Plot (minutes)	1320	25.26(37.53)
rentinplot05	Rented in plot (Tenant)	1320	0.092(0.29)
rentoutp05	Rented out plot (Landlord)	1320	0.12(0.32)
soiltype1	Soil type (Baekel)	1320	0.23(0.42)
soiltype2	Soil type (Walka)	1320	0.27(0.84)
Slope1	Slope: flat very bottom	1320	0.49(0.49)
Slope2	Slope: Tedafat (foothill),	1320	0.24(0.42)
landqual3	Soil depth = deep	1320	.05(0.20)
areaplanted	Area Planted (tsindi)	1320	1.01(.87)
price	Price of the crops (ETB)	1320	5.4 (2.58)

ETB= Ethiopian Birr*SD=Standard Deviation & N= No of observations.***

Dependent variables

newprofcrop= Rank of crop profitability (1= Burley; 2= Maize; 3=Wheat; 4= Teff)

newriskcrop= Rank of crop riskiness (1= teff; 2= Wheat; 3=Burley; 4= Maize)

Table 4: Description of dependent variables for OLS and ordered logit Models

Variable	Description	N	Mean(SD)
yield2	yield per unit land(output*price -input*price)/plot size)	1320	1054.01(2220.42)
lnyield2	Log yield per unit land	1196	6.48(1.12)
new profcrop	Rank by degree of profitability (1= Barley, 2= Maize, 3=Wheat, 4= Teff), where 1= least profitable, 4 most profitable.	1320	3.01(1.11)
new risk crop	Rank by degree of riskiness (1=teff, 2= wheat, 3= barley, 4= maize), where 1=least risky, 4=most risky.	1320	1.93 (1.02)

**SD=Standard Deviation & N= No of observations.

Table 5: Degree of risk aversion in sharecropping arrangement

Degree of risk aversion	Frequency	percentage
risk lover	279	21.14
Neutral risk averse	71	5.38
Intermediate risk averse	287	21.74
Moderate risk averse	261	19.77
Severe risk averse	201	15.23
Extreme risk averse	221	16.74

4.3: Descriptive statistics

To be able to show how risk aversion and crop choice affect the productivity on rented land. The two year (2006 and 2010) household and farm plot level unbalanced panel was used. Unbalanced data was used for the need of a large sample for analytical purposes since the study used only sharecropping arrangement part of the rental market with our crop classification observations. Overall, most of our sample households were male headed comprising about 70% and the remaining 30% were female headed. From Table 6, most of the landlords were women 57.2% while on the contrary we found men dominating demand side of the land rental market 24.1 % as tenants as opposed to women 7.8%. This might be attributed to the fact that women who are mostly poor in non-land resources and barred by cultural norms to cultivate using traction power end up on the supply side of the land rental market (Holden et al. 2011; Kassie and Holden 2007) .On the other hand more landlords and tenants were able to read and/or write and the average age of both of them was around 50 years. Our literacy variable was a dummy variable which does not show the amount of schooling household heads did hence we are unable to find effect of the levels of education on most of our dependent variables. Generally more tenants (71.6%) were able to write or read than landlords (67.7%).

Oxen are the important part of the farming in Ethiopia as source of traction power. We found tenants oxen holding status to be higher on average (2.1) for tenants than landlords (0.2), far less than the minimum requirement of pair of oxen to fully engage in self-sufficient crop cultivation activity. This also reveals the role of oxen in both tenants and landlords side of the land rental market and confirms that land moves from landlords (poor in oxen holding) to tenants (rich in oxen holding) leading to the existence of reverse share-tenancy (Ghebru and Holden 2009).

Using farm plot characteristics in Table 3, we found mean area planted by both tenants and landlords involved in sharecropping arrangement to be 1.01 tsimdi with standard deviation of 0.87 from the mean, showing that sharecropped plots have not been spared from land fragmentation problems in our study area.

Analyzing the four crops chosen in this study, we found teff and wheat to be the most popular crops grown on plots of tenants and landlords and non-participants operated plots. In Graph 4, teff and wheat were also mostly chosen (70%) in each of the tenancy categories confirming the importance of such crops as staple food in our study area.

As can be seen from Table 4, our mean regressand (*yeild2*) used in regression model for productivity was 1054 kg per unit of land with a 2220 kg deviation from mean implying that there were huge variation in yield per unit area in sharecropping arrangement between tenants and landlords. Our dependent variables for ordered logit models had mean rank of profitability and riskiness of 3 and 2 respectively, implying that most of tenants and landlords choose most profitable (3) and less risk (2) crop choices.

Table 5: show the differences in degree of risk aversion in sharecropping arrangement. Using the degree of risk categories, 21% of risk lovers and intermediate risk averse households respectively were sharecroppers. The remaining participants were moderate, severe and extreme risk averse households.

In Figure 2 below, land productivity was found to be higher on plots operated by tenants than landlords. This might be due to the fact that most landlords do not have oxen and other non-land resources that are important in crop production. As observed above most of the landlords are women who are restricted by culture to use traction power and poor in non-land resources (Holden et al. 2011; Kassie and Holden 2007).

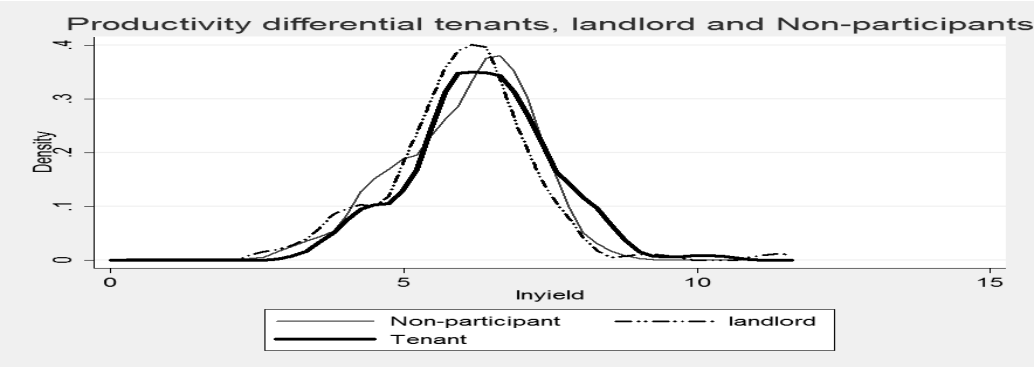


Figure 2: Kernel density graph for log of plot-level land productivity for tenants, landlords and non-participants plots.

Table 6: Summary of general household characteristics and market participation

Variable		**Non-participants**	**Landlords**	**Tenants**	**Overall**
Sex of head		N (%)	N (%)	N (%)	N (%)
	Female	149(27.3)	115(57.2)	13(7.8)	227(30.4)
	Male	395 (62.3)	86(13.6)	153(24.1)	634(69.6)
Age of head					
	Mean	54	56	50	54
	SD	14.3	15.7	12.7	14.5
Literacy:					
	Read/writ	390(71.7)	136(67.7)	120(72.3)	646(70.9)
	Others	154(29.3)	65(33.3)	46(27.7)	265(29.3)
Household size					
	Mean	5.3	3.9	6.2	5.2
	SD	2.3	2.3	2	2.4
Oxen Holding					
	Mean	1	0.2	2.1	1
	SD	0.9	0.55	0.91	1.02
Oxen family size ratio					
	Mean	0.97	0.07	0.39	0.2
	SD	0.24	0.27	0.29	0.28
Tropical livestock Units					
	Mean	2.3	1.2	3.9	2.4
	SD	1.9	1.8	2.7	2.2
Degree of risk aversion					
	Mean	3.5	3.4	3.4	3.4
	SD	1.7	1.8	1.8	1.8

** SD=Standard Deviation & N= No of observations.

5.0 Results and Discussion

We now turn to analyzing our hypotheses using both descriptive and econometric analysis. In analysing whether tenants were less risk averse that landlords, we found in Table 6 that tenants and landlords were equally risk averse with average risk aversion of 3.4 of risk aversion measurement. The mean average of degree of risk aversion of 3.4 was found when we used the rank of degree of risk aversion from least risk aversion to most risk aversion. We further categories the degree of risk aversion into two groups (risk lovers and risk averse) and see whether our results were sensitive to changes as seen in Table 7.

Table 7: Assessing whether tenants are risk lovers than landlord

Degree of risk	Tenant	Landlord	Total
Risk Lovers	138	223	361
Risk Averse	319	507	826
Total	457	730	1,187
Chi2=0.0164		P-Value = 0.898	

Table 7, compares summary statistics of whether tenants are risk lovers than landlords. Consistent with Table 6, most tenants (319 of 457) and landlords (507 of 730) were found to be risk averse. The Chi-square comparison test showed no significant and systematic differences in risk aversion between tenants and landlords. The possible explanation for this would be that mean risk aversion of rural households across the villages does not change much (Binswanger 1980). In addition, it might be the case that covariate risk (drought) common in our study area affects both tenants and landlords risk aversion behaviour equally.

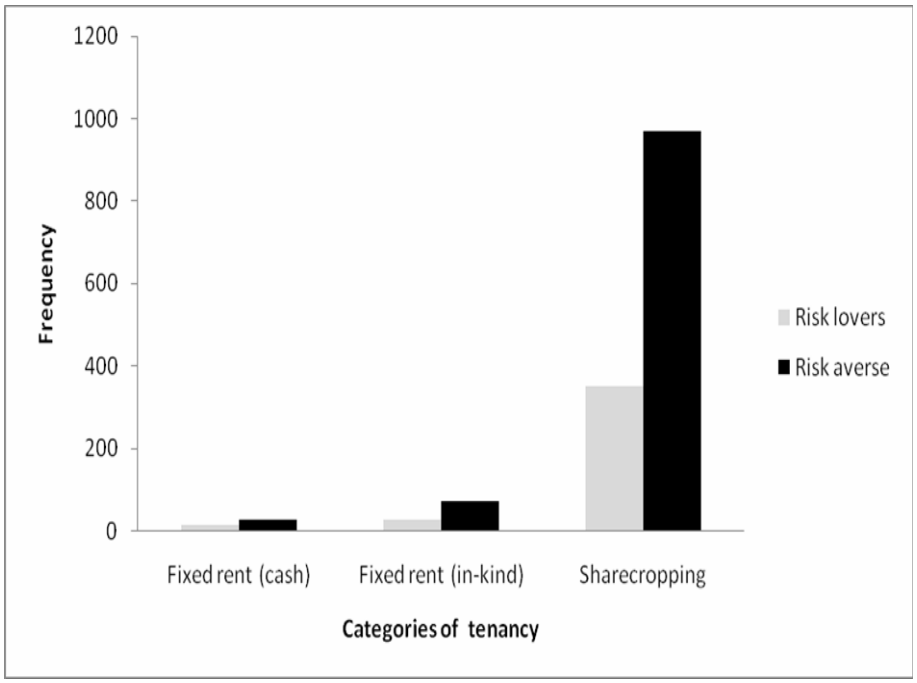


Figure 3: Tenancy category by risk aversion

Going further in understanding the risk aversion within and across tenancy categories, figure 3 shows us that we have more risk averse households than risk loving households in all tenancy categories. It can also be observed that sharecropping is most common type of contact for both risk loving and risk averse households. This might be due to the ability of sharecropping to distribute risk among the contracting partners.

Table 8: Who decides crop to be grown on sharecropped Land

Decision maker	Frequency (plots)	Percentages (%)
Tenant	43	3.5
Landlord	1,054	85.8
Both	131	10.67
Total	1,228	100
Chi2(3) = 29.3881		P-Value = 0.000

Table 8 summarizes statistics on decision power of tenants and landlords on crop choice in sharecropping arrangements. The chi-square comparison test shows a significant and systematic difference on who decides on choice of crop to be grown on sharecropped plot. Significantly larger proportion of sharecropped plots (86%) had crops chosen by tenants than it is for landlords (11%) while the

remaining plots had crops grown through negotiations between the contracting partners. The finding supports our second hypothesis that tenants choose crops on sharecropped plots. One possible explanation for this would be that in reverse tenancy, tenants are rich in non-land resources giving them higher bargaining power on choice of crop to be grown on rented plot unlike landlords.

Table 9: Model 1&2: Crop choices by Landlords and Tenants on rented Land

Variables	**Ordered logit**	**Ordered Logit**
Model 1	(Riskiness of crops)	Model2 (profitability of crop)
Household head sex (1=female, 0=male)	0.266**	-0.327**
	(0.13)	(0.13)
Household head age	0.012***	-0.015***
	(0.00)	(0.00)
Household head literacy	-0.195*	0.15
	(0.11)	(0.11)
Oxen livestock units	0.067	-0.138
	(0.13)	(0.13)
Tropical Livestock units	0.029	0.007
	(0.04)	(0.04)
Risk aversion Parameter	-0.035	0.029
	(0.03)	(0.03)
Tenant	-0.257*	0.259*
	(0.16)	(0.15)
Landlord	-0.302*	0.318*
	(0.16)	(0.16)
Soil type- Baekel	-0.035	0.018
	(0.14)	(0.14)
Soil type- Walka	0.001	-0.045
	(0.13)	(0.13)
Plot slope - flat	0.067	-0.12
	(0.34)	(0.32)
Plot slope- foothill	-0.05	-0.028
	(0.36)	(0.35)
Plot slope- midhill	0.003	-0.069
	(0.36)	(0.34)
Land quality- good	-0.152	0.161
	(0.14)	(0.14)
Plot size	-0.148**	0.133**
	(0.07)	(0.07)
Year 2010	-0.091	0.099
	(0.12)	(0.11)
Constant 1	0.208	-2.270****
	(0.46)	(0.45)
Constant 2	1.380***	-1.626****
	(0.47)	(0.45)
Constant 3	2.514****	-0.453
	(0.48)	(0.44)
Observations	1187	1187
Wald chi2	3117.00	32.80
Prob>chi2	0.01	0.00

R-squared	0.01	0.01
Log-likelihood value	-1449.75	-1450.48

Robust standard errors in Parenthesis
* significant at 10%; ** significant at 5%; *** significant at 1%

Dependents Variables

new profcrop: Rank by degree of profitability (1= Barley, 2= Maize, 3=Wheat, 4= Teff), where 1= least profitable, 4 most profitable.

new risk crop = Rank by degree of riskiness (1=teff, 2= wheat, 3= barley, 4= maize), where 1=least risky, 4=most risky.

We assessed tenants and landlords preference of type of crops to be grown on rented land and observed whether their crop choices revealed their risk preference. We hypothesized that tenants choose more profitable and more risky crops than landlords who choose less risky and least profitable crops. In answering this objective we tested different forms of ordered logistic and probit models with crop ranking (profitability and riskiness) as the dependent variables and found ordered logistic models best fit for the data. Our dependent variables (crop ranking) were risk preferences across villages. From the Table 9, the results in Model 1 indicate that the coefficient for both tenants and landlords are negative and significant at 90% confidence level. This suggests that larger increase in risk of crop reduces probability of both tenants and landlords in choosing that crop, *ceteris paribus*. Stated otherwise, the likelihood for tenants and landlords to choose risky crop on sharecropped plots reduces as the degree of riskiness of that crop choice increases. We found the likelihood slightly higher in landlords (30.2%) than tenants (25.7%), agreeing with Binswanger (1980) that risk aversion does not change much on average across rural villages.

According to model 2, the coefficient of both tenants and landlords were found to be statistically significant and positive at 90% confidence level. This suggests that the probability of both landlords and tenants to choose more profitable crops increases as the degree of profitability of that crop increases, *ceteris paribus.*

In our ranking of crops as profitable or risky crops we found the distribution of our crops to be almost similar. Teff was classified as most profitable and least risky crop; Wheat was more profitable and less risky crop; Maize was less

profitable and least risky crop while Barley was classified as least profitable and less risky crop.

From our analysis we find that crops that is more profitable and less risky (teff and wheat) are the mostly chosen on sharecropped plots. Contrary, we found maize and barley which are more risk averse and less profitable (Maize and Barley) not mostly choosen by both landlords and tenants. Our classification of crops identifies one crop as both profitable and risky which helps us to discuss our two specification hypothesis as one. Our models specification reveals that in sharecropping arrangements both tenants and landlords choose more profitable and less risky crops. This might be the case because such combination is optimal in our study area characterized by droughts and poverty. We therefore rejects our hypothesis that tenants choose more profitable and more risky crops than landlords who choose less risky and least profitable crops and found that both tenants and landlords in our study area choose more profitable and less risky crops.

Other variables which were significant in our likelihood estimation model were household head sex, household head age and area planted. We found that as the riskiness of crop increased tenants and landlords respond by decreasing area planted by 14.8% for that crop unlike for profitable crop which had increase in area of land by 13.3% as the profitability of land increased. This might be the case because of the crops that are more profitable are most used staple crops (Teff and Wheat) in our study area unlike the more risk crops (Maize and Barley).

5.4 Crop choices and Land productivity on both landlords and tenants operated land.

Crop choices by both tenants and landlords can have an effect on productivity on operated land. We tested if there were significant differences in productivity for both profitable (ranked by degree of profitability) and risky (ranked by degree of riskiness) crops. Figure 4 provides overview of crop productivity compared across the four categories of profitability.

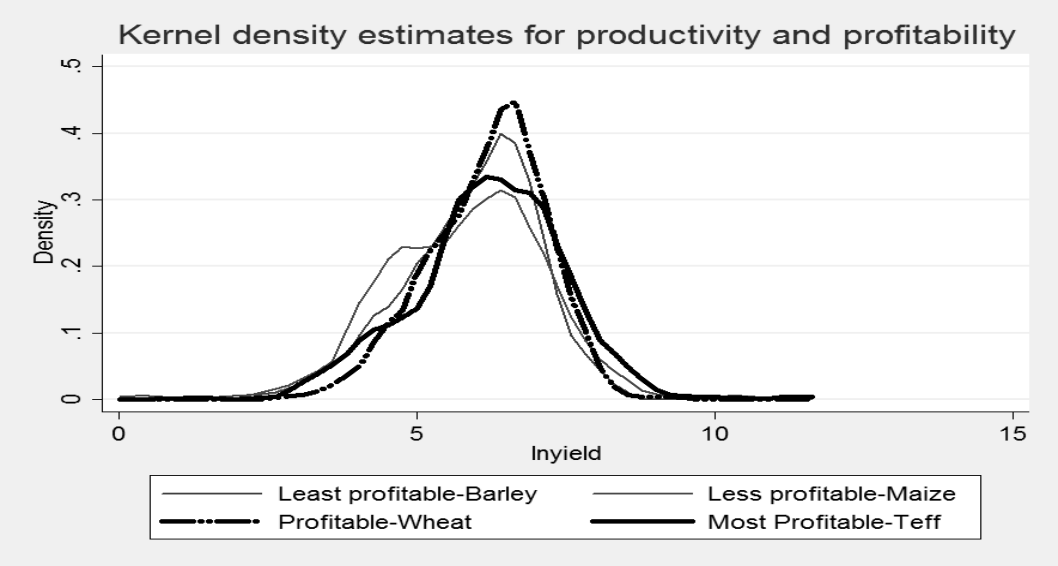


Figure 4; Kernel density graph on crop choices (profitability) and productivity

As can be observed from the figure 4, most profitable crop (teff) was the most productive crop followed by the profitable crops (wheat). These crops were also the least and less risky crops respectively. We observe that most profitable and less risky crops are more productive on sharecropped plots. In Table 8, we tried to look at mean yield per unit of land across each category of crop profitability ranking.

Table 10: Mean yield and variance of yield (per unit land)

Variable		**Sharecroppers**	**Non-participants**
Burley (least profitable)	Mean	858.53	812.53
	SD	2186.52	1612.08
Maize (less Profitable)	Mean	995.74	659.01
	SD	1404.61	1068.57
Wheat (Profitable)	Mean	1017.01	1020.32
	SD	1070.48	1197.80
Teff (More profitable	Mean	1162.56	1079.43
	SD	2812.57	2393.26

*SD = Standard Deviation from Mean

From the table, we found teff and wheat which are the most profitable and more profitable crops respectively to be productive in both sharecropping arrangement and owner operated plots. The deviation from the mean yield for teff was found to be bigger than other crops probably because teff is most used staple crop and grown by both rich and poor households.

To examine the actual effect of crop choices on land productivity, ordinarily least square (OLS) models were used with both yield (*yield2*) and log yield (*lnyield2*) as dependent variables. Log yield was used in attempt to normalize the yield distribution. In table 8, coefficient of teff which is least risky and most profitable crop (*profcrop1*) was positive and significant in all estimated models at 99% confidence level indicating that least risky and most profitable crops were more productive on both sharecroppers' plots and owner operated plots. The same observation was noted for wheat which was more profitable and less risky crop only in the log transformed model at 99% confidence interval. Comparing the productivity between the two crops we note that productivity is higher on teff planted plots (41%) than on wheat planted plots (25%). Our coefficient for maize crop which is more risky and least profitable was not significant in all model specifications. However, maize coefficient in all the estimated models gives insight on the relationship between productivity and less profitable crops and risky crops. Stated otherwise, the productivity of plot decreased (9%) when plots are grown with most risky and less profitable crop (maize).

Testing our hypothesis that most profitable and most risky crop are productive on rented land , we rejected the hypothesis and found that most profitable crops and least risky crops are productivity on both owner operated and rented land.

Kernel density analysis in figure 4 supports our parametric findings that more profitable and less risk crops are productive combination in our study area. In figures 4, we found land productivity to be higher for least and less risky crops (teff and wheat) which were positive and significant in our regression analysis and are most and more profitable crops respectively.

Other variables which were significant include oxen livestock units (*oxlu)*, current oxen holding (*oxcurrent*), tropical livestock units (*tlu*), plot slope- flat (*slope*1) risk parameter (*risk*), plot size (*areaplanted)*. The effect of oxen on land productivity was statistically significant at 10% in both models, implying the importance of oxen in crop cultivation activities in Ethiopia. The risk parameter was negative and significant in our log transformed yield model specification, implying that as more risk averse reduces productivity.

Assessing whether tenants land productivity was higher than landlords and owner operated land in the sharecropping arrangement. We found both landlords variable (*rentinplot05*) in log transformed model and tenants variable (*rentoutplot05*) in the yield model to be statistically significant at 10%. However, the coefficient of tenants was positive implying that tenants operated plots were productive as compared to landlord operated plots which had reduced productivity (26%). This might be the case because landlords are mostly women who are either poor in non-land resources or are barred by custom to use oxen (Holden and Ghebru 2008).

Table 11: crop choice and productivity

Variable	Yield per unit area	Log yield per unit area
	(Random effect)	(Random effect)
Household head sex (1=female, 1= male	-184.074	-0.073
	(172.51)	(0.09)
household head age	-1.399	0.003
	(5.08)	(0.00)
literacy of household head	-7.247	0.016
	(155.94)	(0.08)
household size	-2.516	0.00
	(33.99)	(0.02)
oxcurrent	-567.731****	-0.152***
	(129.72)	(0.06)
oxen livestock units	394.862**	0.160*
	(198.34)	(0.09)
Tropical livestock units	191.445****	0.064***
	(42.77)	(0.02)
Risk parameter	-37.169	-0.029*
	(36.35)	(0.02)
distance to plot	-1.633	0.00
	(1.58)	(0.00)
Tenants	362.042*	0.101
	(208.39)	(0.09)
Landlords	-6.464	-0.261**
	(228.45)	(0.1)
owner operated plots	-78.327	0.05
	(141.02)	(0.07)
Deep soil	51.31	0.04
	(112.46)	(0.05)
plot slope-flat	230.362**	0.015
	(110.74)	(0.05)
Baekel soils	104.053	0.072
	(136.65)	(0.06)
Walka soils	-100.836	-0.029
	(128.05)	(0.05)
Teff (more profitable)	377.353**	0.406****
	(153.22)	(0.07)
Wheat (profitable)	170.473	0.251****
	(165.74)	(0.07)
Maize (less profitable)	-160.909	-0.091
	(215.75)	(0.09)
Plot size	-461.689****	-0.389****

	(64.45)	(0.03)
manure	0.103*	0.000***
	(0.06)	(0.00)
urea	-8.797	0.00
	(10.31)	(0.00)
dap	2.661	-0.005
	(10.61)	(0.00)
Year	102.619	-0.011
	(124.34)	(0.06)
Constant	1431.563***	6.630****
	(476.22)	(0.24)
Observations	1818	1633
Wald chi2	111.98	254.61
Prob>chi2	0.00	0.00
R-squared	17.92	0.068

Robust standard errors in Parenthesis

* significant at 10%; ** significant at 5%; *** significant at 1%

Dependent Variables

Yeild2: (Income from production (Output*price of output- Input*price of inputs))/ plot size

lnyield = log of yield2

6.0: Conclusion and Policy Implications:

Taking advantage of unique data on risk aversion, crop choices and land productivity on rented land, our findings show that there are no systematic and significant differences in risk aversion between tenants and landlords in our study area. We found equal mean risk aversion of both tenants and landlords and confirm that in rural areas mean risk aversion of households across villages does not change so much. The results show important policy implication that assumption of differences in risk aversion between relatively rich tenants and poor landlords must not be used in designing and targeting village poverty alleviation and development programs aiming at improving village welfare.

We found systematic and significant differences between tenants and landlords when assessing who has the decision power on crops to be grown on rented land. We found that crop choice decision on sharecropped plots was dominated by tenants(86%) than landlords confirming that tenants who are relatively richer in non-land resource had more bargaining power on crop choices on rented land. Fear of landlord exploiting tenants through the choices of crops that were not profitable was dismissed as we found both tenants and landlord choosing profitable crops (staple crops) which are convenient for both partners.

Our decomposed analysis of whether tenants choose more profitable and more risk crops on rented plots, we found both tenants and landlords choosing profitable and less risky crops on sharecropped land. The empirical evidence implies that attempts to further improve productivity of most profitable and less risky crops has a directly enhancing effect on both owner operated plots and also direct impact on sharecropped plots.

We find that most profitable crop and less risky crops to be productivity enhancing unlike the more risky crops and less profitable crops. We found the combination of more profitable and less risky crops as the favourable combination for our study area which is characterised by drought and degraded soils.

References

Arrow, K., J. (1971). The Theory of Risk Aversion.

Bandiera, O. (2007). Land Tenure, Investment Incentives, and the Choice of Techniques: Evidence from Nicaragua. *The World Bank Economic Review*.

Bardhan, P. (1993). Symposium on Management of Local Commons. *The Journal of Economic Perspectives*, 7 (4): 87-92.

Benin, S., Ahmed, M., Pender, J. & Ehui, S. (2005). Development of Land Rental Markets and Agricultural Productivity Growth: The Case of Northern Ethiopia. *Journal of African Economies*, 14 (1): 21-54.

Besley, T. & Burgess, R. (2000). Land Reform, Poverty Reduction, and Growth: Evidence from India*. *Quarterly Journal of Economics*, 115 (2): 389-430.

Binswanger, H. P. (1980). Attitudes toward Risk: Experimental Measurement in Rural India. *American Journal of Agricultural Economics*, 62 (3): 395-407.

Cheung, S. N. S. (1968). Private Property Rights and Sharecropping. *The Journal of Political Economy*, 76 (6): 1107-1122.

Cotula, L., Toulmin, C. & Hesse, C. (2004). Land Tenure and Administration in Africa: Lessons of Experience and Emerging Issues:. London: International Institute for Environment and Development.

Deininger, K. (2003). Land Policies for Growth and Poverty Reduction. *A publication of the World Bank and Oxford University Press*, The World Bank.

Deininger, K., Ali, D. A. & Alemu, T. (2008b). Impact of Land Certification on Tenure Security, Investments and Land Markets: Evidence from Ethiopia. Washington, D.C, the World Bank.

Dercon, S. & Christiaensen, L. (2007). Consumption Risk, Technology Adoption and Poverty Traps: Evidence from Ethiopia. *World Bank Policy Research Working Paper 4257. Washington, D.C.*

Dubois, P. (2002). Moral Hazard, Land Fertility and Sharecropping in Rural Area of the Philippines. *Journal of Development Economics*, 68 (1): 35-64.

Eswaran, M. & Kotwal, A. (1990). Implications of Credit Constraints for Risk Behavior in Less Developed Economies. *Oxford Economic Papers*, 42(2): 550-60.

FDRE. (1995). Rural Land Administration Proclamation of the Federal Government of Ethiopia. ***Proclamation No.89/997***.

Gavian, S. & Ehui, S. (1999). Measuring the Production Efficiency of Alternative Land Tenure Contracts in a Mixed Crop-Livestock System in Ethiopia. *Agricultural Economics*, 20 (1): 37-49.

Ghebru, H. & Holden, S. (2008). Factor Market Imperfection and Rural Land Rental Markets in Northern Ethiopian Highlands. In Holden, S., Otsuka, K. & Place, F (eds) *The Emergency of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency*. Washington DC: Resource for the Future (RFF).

Holden, S., T., Shiferaw, B. & Wik, M. (1998). Poverty, Market Imperfections and Time Preferences: of Relevance for Environmental Policy? *Environment and Development Economics*, 3 (01): 105-130.

Holden, S., Bekele, S. & Pender, J. (2002). Market Imperfections and Land Productivity in the Ethiopian Highlands. *Agricultural Economics*, 52: 53-79.

Holden, S. & Hagos, F. (2002). Incentives for Conservation in Tigray, Ethiopia: Findings from a Household Survey: Department of Economics and Social Sciences, Agricultural University of Norway, unpublished

Holden, S., Benin, S., Shiferaw, B. & Pender, J. (2003). Tree Planting for Poverty Reduction in Less-Favoured Areas of the Ethiopian Highlands. Small-Scale Forestry, vol. 2: Springer Netherlands. 63-80 pp.

Holden, S. & Bezabih, M. (2008). Gender and Land Productivity on Rented Land in Ethiopia. In Holden, S., Otsuka, K. & Place, f. (eds) *The Emergency of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency*. Washington DC: Resource for the Future (RFF).

Holden, S., Deininger, K. & Ghebru, H. (2009). Impacts of Low - Cost Land Certification on Investment and Productivity. *American Journal of Agricultural Economics*, 91 (2).

Holden, S., Otsuka, K., Place, F. M. & Place, F. (2009). The Emergence of Land Markets in Africa: Assessing the Impacts on Poverty, Equity, and Efficiency. In: Resources for the Future.

Holden, S. T., Deininger, K. & Ghebru, H. (2011). Tenure Insecurity, Gender, Low-cost Land Certification and Land Rental Market Participation in Ethiopia. *Journal of Development Studies*, 47 (1): 31 - 47.

Kassie, M. & Holden, S. (2007). Sharecropping Efficiency in Ethiopia: Threats of Eviction and Kinship. *Agricultural Economics*, 37 (2-3).

Kassie, M. & Holden, S. (2008). Kinship, Tenure Insecurity, Input Use and Land Productivity. The Case of Sharecropping in Ethiopia. In Holden, S., Otsuka, K.

& Place, F (eds) *The Emergency of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency*. Washington DC: Resource for the Future (RFF).

Kruseman, G., Ruben, R. & Tesfay, G. (2006). Diversity and Development Domains in the Ethiopian highlands. *Agricultural Systems*, 88 (1): 75-91.

Lipton, M. (1968). The Theory of Optimizing Peasant. *Journal of Development Studies*, 4: 154-74.

Menezes, C. F. & Hanson, D. L. (1970). On the Theory of Risk Aversion. *International Economic Review*, 11 (3): 481-487.

Mosley, P. & Verschool, A. (1995). Risk Altitudes and Vicious Circle of Poverty. *The European Journal of Development Research*, 17(1): 55-88.

Otsuka, K. (2007). Efficiency and Equity Effect of Land Markets. In. Handbook for Agricultural Economics, Elsevier.

Otsuka, K. & Yahami, Y. (1988). Theories of Share Tenancy. *Econ.Dev.Cult*, Change 37: 32-68.

Otsuka, K., Chuma, H. & Hayami, Y. (1992). Land and Labor Contracts in Agrarian Economies: Theories and Facts. *Journal of Economic Literature*, 30 (4): 1965-2018.

Pender, J. & Fafchamps, M. (2006). Land Lease Markets and Agricultural Efficiency in Ethiopia. *Journal of African Economies*, 15 (2): 251-284.

Pender, J., Place, f. & Ehui, S. (eds). (2006). Strategies for Sustainable Land Management in East African Highlands; Conclusions and Implications, vol. 1. Washington, D.C: International Food Policy Research Institute. 377-415 pp.

Place, F. & Otsuka, K. (2000). Population Pressure, Land Tenure, and Tree Resource Management in Uganda. *Land Economics*, 76 (2): 233-251.

Pratt, J. W. (1964). Risk Aversion in the Small and in the Large. *Econometrica*, 32 (1/2): 122-136.

Rosenzweig, M. R. & Binswanger, H. P. (1993). Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments. *The Economic Journal*, 103 (416): 56-78.

Sadoulet, E., Janvry, A. d. & Fukui, S. (1997). The Meaning of Kinship in Sharecropping Contracts. *American Journal of Agricultural Economics*, 79 (2): 394-406.

TNRS. (1997). Regulations and Procedures for the Implementation of Rural Land Administration and Use Proclamation. *Negarit Gazetta of the Council of Tigray National Regional State*.

Wik, M. & Holden, S. (1998). Experimental Studies of Peasant's Attitudes towards Risk in Northern Zambia. *Department of Economics and Social Sciences, Agricultural University of Norway, Aas, Norway*, Discussion Paper D-14.

Wik, M., Kebede, T. A., Bergland, O. & Holden, S. T. (2004). On the Measurement of Risk Aversion from Experimental Data. *Applied Economics*, 36 (21): 2443 - 2451.

Wooldridge, J., M. (2002). Econometric Analysis of Cross Sectional and Panel Data: MIT Press, Cambridge, MA.

WorldBank. (2006). Land Policy and Administration. Washington, DC: World Bank.

Yesuf, M. & Bluffstone, R. A. (2009). Poverty, Risk Aversion, and Path Dependence in Low-Income Countries: Experimental Evidence from Ethiopia. *American Journal of Agricultural Economics, Vol. 91, Issue 4, pp. 1022-1037, November 2009*.

Zeckhauser, R. & Keeler, E. (1970). Another Type of Risk Aversion. *Econometrica*, 38 (5): 661-665.

Appendices

Appendix 1: Household Questionnaire

MASTERS PROGRAM: 2010 NOMA FELLOWS

NORWEGIAN UNIVERSITY OF LIFE SCIENCES

IN COLLABORATION WITH MEKELLE UNIVERSITY

HOUSEHOLD QUESTIONNAIRE

					The information collected will be used for research purposes. It will be treated as confidential and will not be used by tax authorities or others to assess the need for food aid or other assistances			
Zone								
Woreda								
Tabia								
Kushet								
Household ID								
Name of household head								
Distance to woreda town (walking minutes)								
Distance to local market (walking minutes)								

Distance to primary school (walking minutes)								
Distance to secondary school (walking minutes)								
Distance to all weather road (walking minutes)								
Distance to transportation service (walking minutes)								
Distance to health centre (walking minutes)								
Distance to grain mill								
Distance to nursery site								
Distance to protected water source(walking minutes)								
Distance to tap water(walking minutes)								
Enumerators:					Dates interviewed			
First interview:								
Second interview:								
Third interview:								
Data checked by		When	Status			Comments		
			ok	Correct	Return			
Data punched		When	Who			Comments		
Pages								

Farm household survey: Household characteristics							
Woreda:		Interviewer:		Household number:			
Tabia		Date of interview:					
Kushet		Household head name:					
Household composition in 2002 (E.C.)							
Household members		Religion:					
MNo:	Name	relationship	Sex	Age	Education	Skills	Occupation
1		Head					
2							
Codes:	Relation to household head: 1=wife, 2=child, 3=grand child, 4=brother, 5=sister, 6=hired labour						
	7=other, specify:						
	Sex: 1=female, 2=male. Age: Years. Skills: specify						
	Education: 0= illiterate, 1=read and write, 2= elementary, 3= church education, 4= secondary, 5=other, specify.						
	Occupation: 0=dependent, 1= student (in school), 2=watch after animals, 3=housewife, 4= farming						
	5=hired labourer, 6=off-farm activity, 7=Tabia/kushet official: specify, 8=other: specify.			PA/village official: specify			
	Presence: Months staying in the household during last 12 months						
Do any of the household members live outside the village this year (EC 1995)?							Yes
Name		Place	Purpose		Since	Coming back when	

					when		

HOUSEHOLD NAME:_____					HH id:_____					**Page 6**
Farm household survey: Livestock Production Activities										
Animal type	**Stock**	Stock	Stock	Born during	Died during	Slaughtered	Bought	Sold during	Months in	Milk per
	2 years ago	1 year ago	Current	EC 2001/02	EC 2001/02	EC 2001/02	EC 2001/02	EC 2001/02	milking (2001/02)	day (EC2001/02)
Cattle										
Milking cow										
Other cows										
Oxen										
Heifer										
Bulls										
Calves										
Sheep										
Goats										
Horses										
Mules										
Donkeys										
Camel										
Chicken										

Bee hives										
Source of cash to buy the livestock										
1	Sale of output				Other					
2	Remittance									
3	Credit									
4	Sale of food from FFW									
5	Sale of other livestock									

HOUSEHOLD NAME:_____	HH id:___			**Page 10**

Farm household survey: Preferences and Perceptions

If you have the choice between a crop which gives 20 qtl in a good year but no yield in a bad year, and

a crop which gives 19.5 qtl in a good year and 2 qtl in a bad year, which crop would you prefer to plant?

We assume a bad year occurs one out of 5 years (2 out of 10 years are bad)

Husband					**Wife**			
	Good year	Bad year	Choice			Good year	Bad year	Choice
Crop 1	20	0	1		Crop 1	20	0	1
Crop 2	19.5	2	2		Crop 2	19.5	2	2

If choice 2					If choice 2			
	Good year	Bad year	Choice			Good year	Bad year	Choice
Crop 2	19.5	2	1		Crop 2	19.5	2	1
Crop 3	18	4	2		Crop 3	18	4	2
If choice 2					If choice 2			
	Good year	Bad year	Choice			Good year	Bad year	Choice
Crop 3	18	4	1		Crop 3	18	4	1
Crop 4	16	6	2		Crop 4	16	6	2
If choice 2					If choice 2			
	Good year	Bad year	Choice			Good year	Bad year	Choice
Crop 4	16	6	1		Crop 4	16	6	1
Crop 5	13	8	2		Crop 5	13	8	2
If choice 2					If choice 2			
	Good year	Bad year	Choice			Good year	Bad year	Choice
Crop 5	13	8	1		Crop 5	13	8	1
Crop 6	9	9	2		Crop 6	9	9	2
Are there any changes in your strategy to cope with food insecurity as compared to 8-10 years ago?								Yes
If yes, explain why/how:								No

How strong is your social network (extended family) in terms of providing help in case	Very Strong
you face serious problems (e.g. drought, sickness, income failure)?	Medium
Explain:	Weak

Appendix 2: Plot-level Questionnaire

Plot Level Questionnaire 20010 Tigray Survey

Household Name:	Interviewer:	**GPS Coordinates for home of household:**	**Altitude (masl)**
Household Id. No.:	Date of Interview:	1.	
Kushet:	Tabia:	2.	

Does the household have a land certificate? 1=Yes 0= No If yes, **Year (EC) of receiving the certificate:**_____

Land certificate information (copy information from land certificate), If no, **why no certificate**? 1=Did not collect it, 2=No land at that time, 3=Too small land, 4=Land was not registered, 5=Tabia did not give me, 6=Lost it, 7=Other, specify

Registration number on certificate:_____

Full name (owner):_____Sex of owner: _____

Is owner current head of household? Yes No If no, relationship between listed owner and hhhead: HHhead is……

Family size when land was allocated:_____ The time when the last land allocation was made: _____ The number of plots allocated: _____

Plot No.	The name of the place where the plot is located	Distance (minutes)	Soil depth of the plot (Deep=1, medium=2, or shallow=3)	Plot size in Tsimdi	Measured plot size in Tsimdi	The plot is Adjacent to…..	GPS Coordinates	Altitude (Elevation)	Origin of plots	Who decide on plots	Who work on plots
1						E: _____ N: ___ W: _____ S: __					

Origin of plots: 1. Husband/Husband's family, 2. Wife's family, 3. Government, 4. Tabia, 5. other, specify….

Who decide on plots (make production and investment decisions): **1**.Husband/male head, **2.**Wife, **3.**Joint husband/wife, **4.**Female head, **5**.Son, **6.**Other, specify:

Who work on plots: **1.**Husband/male head, **2.** Whole family, **3.**Joint husband/wife, **4.**Female head, **5.**Wife, **6.**Son, **7.**Other, specify:

Cross/check information with plot level data from our earlier survey rounds:

Household Name:	Household Id. No.:	Interviewer:

Does the household have plots that are not listed on the certificate? Yes = 1 No = 0
If yes, list the plots

Plot No.	The name of the place where the plot is located	Distance (minutes)	Soil depth of the plot (Deep=1, medium=2, or shallow=3)	Plot size in Tsimdi	Measured plot size in Tsimdi	GPS Coordinates	Altitude (Elevation)	Origin of plots	Who decide on plots	Who work on plots

Origin of plots: 1. Husband/Husband's family, 2. Wife's family, 3. Government., 4. Tabia, 5. Other, specify….
Who decide on plots (make production and investment decisions): **1**.Husband/male head, **2.**Wife, **3.**Joint husband/wife, **4.**Female head, **5**.Son, **6.**Other, specify:
Who work on plots: **1.**Husband/male head, **2.** Whole family, **3.**Joint husband/wife, **4.**Female head, **5.**Wife, **6.**Son, **7.**Other, specify:

Cross/check information with plot level data from our earlier survey rounds:
NB! Fill plot number continuing from plot numbers on previous page and use carefully the same plot numbers and order of plots in the following pages.

Household Name:	Household Id. No.:	Interviewer:

Land rental and partners in rental market
Have you rented in or out land during the last year? Yes=1 No=0 If no, skip this page.
NB! Keep plot number the same as in land certificate and the following list of plots

Plot No.	Plot Name	Tenure status	Rented-in plot		Rented-out plot		Reasons for renting out	If the plot is transacted, details about rental partners				
			2000 1=yes 0=no	2001 1=yes 0=no	2000 1=yes 0=no	2001 1=yes 0=no		Name	Relationship	Kushet	How long has the contract partnership lasted?	Where rental partner lives

Tenure status: 1.Own land with certificate, 2.Own land without certificate, 3.Rented in, 4.Transferred, 5.Inherited, 6.Other,specify:
Reasons for renting out: 1= lack of labour, 2= lack of oxen, 3= unable to rent oxen, 4=lack of cash, 5= credit obligation, 6=other, specify…,
Relationship: 1=husband's close relative, 2=wife's close relative, 3=distant relative, 4=ex-husband/ex-wife, , 5= non-relative, 6=Son/Daughter, 7=other, specify,
Where rental partner lives: 1= within the kushet, 2= within the Tabia, 3= A closer Tabia, 3= distant Tabia, 4= other, specify.
How long: How many years has the contract partnership lasted?

Household Name:	Household Id. No.:	Interviewer:

Land characteristics

! Keep plot number the same as in land certificate and the following list of plots

Plot No.	Plot Name	Irrigated? 1=yes, 0=no	Soil Type	Soil Depth	Slope	Land quality	Weed infestation	Susceptibility to erosion	Degree of soil erosion /degradation
1									

Codes: a) **Soil type**: 1. Baekel, 2. Walka, 3. Hutsa, 4. Mekeyih, **Soil depth**: 1.Shallow, 2. Medium, 3. Deep,

Slope: 1. Meda, 2. Tedafat (foothill), 3. Daget (midhill), 4. Gedel (steep hill)

Land quality: 1. Poor, 2. Medium, 3. Good, **Weed infestation:** 1. High, 2. Medium, 3. Low

Susceptibility to erosion: 1. High, 2. Medium, 3. Low, 4. None

Degree of degradation: 1. Highly degraded, 2. Degraded, 3. Moderately degraded, 4. No degradation

Number of Visits to Plot (May 2001 – May 2002)

Plot No.	Plot Name	Land preparation		Planting		Manuring/ Fertilization		Weeding		Inspecting/ (scaring birds)		Harvesting		Threshing		If landlord, monitoring visit		Total No. of visits	No. of Sole visits
		No.	Who	No.	Who	No.	Who	No.	Who	No.	Who	No.	Who	No.	Who	No.	Who		

No: Number of Visits

Who: Persons visited the plot: 1= Husband, 2= Wife/female head, 3= Husband and wife, 4= Husband and Son, 5= others

Land market participation

Fill in if household has participated in the land rental market (including sharecropping in or out) during the last year.

! Keep plot number the same as in land certificate and the following list of plots

Household No.:										Interviewer:								
HH name										Data of Interview:								
Kushet:										Woreda:								
Tabia:										Zone:						**Who decides**		
2006 plot		Land rental markets								Byproducts, who get them?			Responsibilities			Contract	Crop	Share
no	Plot Name	Contract	Type	Duration	If duration>3 yrs, specify	Payment	Advance payment	Paid when	Cost-sharing arrangement	Crop residues	Manure	Grazing	New SWC	Maintain SWC	Pay land tax	type	choice	rate/Rent

Contract: 1. Fixed rent (cash), 2. Fixed rent (Kind), 3. Sharecropping (output only), 4. Cost sharing, 5. Output sharing after deduction of (cash) input co
6. Other, specify: **Type: 1.** Oral without witness, 2. Oral with witness, 3. Written and unreported. 4. Written and reported to Tabia.

Household Name:	Household Id. No.:	Interviewer:

Crop production and input use

Plot no.	Sub-plot	Sea-son	Plot Name	Crop grown	Area planted	crop output Kg	Seeds		Manure in Kg	Urea in Kg	Dap in Kg	*Herb and pesticide Birr*	Number of labor man days					**Oxen**
							Type	Kg					Plow-ing	Weed-ing	Harvest- ing	Thresh-ing	hired labor	
1																		
	Season: 1=Meher (rainy season, 2=Dry season 1 (irrigated land), 3=Dry season 2 (irrigated land) **Crops grown**: C1. Barley, C2. Wheat, C3. Teff, C4. Maize, C5. Millet, C6. Sorghum, C7. Field pea, C8. Bean, C9. Linseed, C10. Lentil, C11. Hanfets Vegetables: V1. Onion, V2. Potato, V3. Tomato, V4. Letus, V5. Cabbage, V6. Carrot, V7. Pepper, V8. Others Perennials:P1. Orange, P2. Banana, P3. Eucalyptus. P4. Guava, P5. Papaya, P6. Coffee, P7. Others, Specify…….. Seed type: 1. Improved, 2. Local, 3. Others, specify **Oxen**: 1. Own oxen, 2. Shared oxen, 3. Oxen exchange with labour, 4. Borrowed oxen, 5. Rented oxen for cash, 6. Other, specify:																	