Essays on Contracts, Risk Coping and Technology Adoption in Ethiopia

Essays om kontrakter for risikohåndtering og teknologiopptak i Etiopia

Philosophiae Doctor (PhD) Thesis

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Ås 2010

Thesis number: 2010: 18

ISSN: 1503-1667

ISBN: 978-82-575-0893-7

ACKNOWLEDGEMENT

I would like to express my gratitude to all those who gave me the possibility to complete this PhD study without whom its completion would not have been possible. First and foremost, I am deeply indebted to my main supervisor Ragnar A. Øygard whose help, stimulating suggestions and encouragement helped me in all the time of research for and writing of this dissertation. He has provided me the freedom to pursue and explore new topics of my own interest.

My co-supervisor, Stein T.Holden was the first who inspired me to pursue my PhD study at the Department of Economics and Resource Management, Norwegian University of Life Sciences (UMB). His door has been open for discussions. I am grateful to Stein for his guidance and encouragement throughout my study period. I would like to thank the academic and administrative staffs of the department for the friendly environment and stimulating discussions. I thank Arild Angelsen for his technical comments. We had a wonderful interaction especially with my office neighbor, Stig Danielsen (IT), his help has been numerous. I would like to thank Reidun Aasheim for her administraive support and guides throughout the study period. I thank Carl Brønn (UMB) and Karen (Equinox, USA) for English style and grammar, correcting both and offering suggestions for improvement, each in one of my papers.

The Norwegian Government PhD Quota Scholarship program is gratefully acknowledged for providing such opportunity. I am thankful to the Research Education Committee (FUFU) for among other things providing financial support to present some of my papers

in this dissertation at international conferences. I also acknowledge the financial support of Goteborg University, Environmental Economics Units, Sweden for PhD course works in spring 2005. My friends, Hussein Hamda and Jema Haji made my PhD course works more interesting in Uppsala University, Sweden in spring 2004.

The Southern Agricultural Research Institute, Ethiopia provided logistical support during my field research in *Wolaita* and *Sidama* Zones. I want to thank many colleagues in the institute without their help the two years intensive field work may not have been accomplished. Especially I am obliged to thank Daniel Dauro , Agedew Bekele, Genene Tegaye, Zerihun Yemataw, Waga Mazengia, Demise Zewdu, Yehiyese Rezene and Fiseha Negash. Special thanks go to the enumerators, drivers and farmers. I would like also to thank Ethiopian Students and community in Ås for their lovely culture of cooperation and brother-sisterhood relationship. My friend Borgar Auslund has been instrumental for the off campus interactions and family support.

Last but not least, my wife Sinework Geberemariam and my sons, Fitsum and Yesha deserve special thanks for their patient, love and generosity. I have no words to express, there presence with me in Ås helped a lot to work hard even in a very difficult conditions. All my relatives in Ethiopia (mother, sisters and brothers) highly encouraged me. Especially, my sister Lemlem and my brothers, Ameha and Ayele played key roles in many aspects.

Ås, May 2010
Million Tadesse

In memory of my father, Tadesse Aytenfisu Desta

Contents

Abstract

This dissertation consists of an introduction and four independent papers. The first two papers examine land and livestock rental contractual arrangements. The first paper provides detailed analysis of cost sharing contract choices in share cropping contracts and shows that such arrangements are rational adjustments to the missing credit and insurance markets. Building on the idea of land rental contracts, the second paper provides an empirical evidence for the existence of livestock contract choices in an agrarian economy for the first time. In the third paper, I estimate the role of *ex-ante* and *ex-post* risk coping strategies of households'on fertilizer adoption. The final paper examines households' soil conservation technology adoption behavior. Hence, this dissertation aims at providing empirical evidence on applied contracts in land and livestock, the effect of informal risk coping strategies on fertilizer use, household soil conservation technology adoption behavior in southern highlands of Ethiopia. We used an original data set (cross-sectional and panel) to answer the research questions and test alternative hypotheses. The first two papers use same data set with additional survey round for the second paper that makes panel data. Paper 3 and paper 4 utilize data collected in 2000. The findings from this dissertation provide new insights into applied contracts in land and livestock. While the literature in land rental contract choices is abundent, no previous study examine the contribution of livestock contract choices in agrarian economy. The diversity of livestock contract choices identified in this study is refutation of the claim that livestock rental contracts are impossible (Binswanger and Rosenzweig, 1986). We showed that contracts are found to be an important household adaptation to risk and resource sharing strategies of the poor in Ethiopia. We find that tenants are relatively poor in livestock rental contracts but they are rich in land rental contracts compared to their counterpart.

Abstract

Denne avhandlingen består av en introduksjon og fire uavhengige artikler. De to første artiklene omhandler uformelle kontrakter i landbruket. Den første artikkelen gir en detaljert analyse av valg av kontrakter for kostnadsdeling i leilendingskontrakter og viser at slike arrangementer er rasjonelle tilpassinger til manglende kreditt- og forsikringsmarkeder. Artikkel to bygger på teorier fra leilendingskontrakter i analyse av leiekontrakter for husdyr, og viser hvordan leiekontrakter for husdyr kan eksistere. Den tredje artikkelen analyseres hvordan ex-ante og ex-post strategier for risikohåndtering påvirker husholdenes bruk av kunstgjødsel.I den siste artikkelen undersøkes husholdenes valg av teknologi for jordkonservering. Denne avhandlingen gir empiri og analyse av kontrakter for leie av jord og husdyr, effekten på gjødselbruk av uformelle tiltak for risikohåndtering, husholdenes adopsjon av jordbevaringsteknologi i høylandet i Sør-Etiopia. Vi har samlet og anvendt et unikt datasett (tverrsnitt og panel) for å svare på våre problemstillinger og teste alternative hypoteser. De to første artiklene bruker samme datasett, men artikkel 2 bruker en ekstra runde med datainnsamling, slik at artikkelen kan bruke panel data metoder. Artikkel 3 og 4 anvender data samlet inn i 2000. Avhandlingen viser at kontraktene er en viktig tiltak for husholdning tilpasning til risiko og ressursdelingsstrategier for de fattige i Etiopia.

Introduction

Essays on Contracts, Risk Coping and Technology Adoption in Ethiopia

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1. Introduction

1.1. Background

Roughly 80 percent of all people in Ethiopia are engaged in smallholder, rural, rainfed agriculture. Given the disproportionate numbers of Ethiopians involved in this sector, it is unsurprising that agriculture accounts for nearly half of the country's GDP and 60 percent of its export (CIA, 2008). To date land improving technologies such as improved seed, fertilizer, improved agronomic practices and natural conservation measures are not widely adopted in Ethiopia. One potential factor for the low adoption of agricultural technologies in Ethiopia is the risk associated with the use of improved technologies when harvests fail (Dercon and Christiaensen, 2007). Serious challenges contributing to the country's poverty include climate stress, weak markets, rapid urbanization, underdeveloped transport and communications networks, civil and international conflict, and inadequate and meager social services (such as education, health, water, and sanitation). Access to reliable rural financial services is the major constraint to the sustained increase in agricultural production and productivity in Ethiopia (Admassie *et al*.,2005). In this regard, provision of improved rural financial services (credit and insurance), investment in small and medium irrigation projects and agricultural research are essential getting the agricultural sector moving in Ethiopia. The overall objective of

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this dissertation is to provide empirical evidence on contract choices in land and livestock and examine the role of land and non-land resources (livestock, labor, off-farm wages (saftey nets), access to credit and other socio-economic factors) on household technology adoption behavior in southern highlands of Ethiopia.

1.2.Defining poverty in Ethiopia

Although the definition and measurement of poverty[2] may vary from study to study, for our purpose, poverty may be defined as a condition in which families live with unacceptably high risks with few tools to manage those risks. The term "unacceptable risk" describes the likelihood of an event whose probability of occurrence and consequences are so high. Tadesse and Victor (2009) indicate that poverty may:

- *Increases the severity of risks*: A small earthquake in poor countries kills many more than in rich countries due to impoverished communities' inadequate access to safe housing.
- *Increases the probability of risks*: The poor have a harder time protecting themselves. For instance, the inability to purchase a mosquito net increases the risk of contracting malaria.
- *Decreases coping capacity*: The poor have few assets to serve as a cushion. Risk can be a source of persistent poverty as it leads households on the edge of survival to seek to choose low risk but low return activities (Rosenzweig and Binswanger,1993).
- *Decreases awareness of financial tools*: Low levels of education and access to public services mean many poor people are unaware of financial tools.

[2] See Angelsen & Wunder (2006) for non-monetary definition of poverty.

- *Decreases access to financial tools*: Financial providers believe that the poor do not constitute a profitable market, and therefore do little to try to reach them.

Shimeles's (2005) study shows that it was easier for rural households to exit poverty as well as to re-enter it. Earlier study by Dercon (2002) indicates that during bad harvest season about 60 percent of the population in Ethiopia could be poor. Although the statistics differ from study to study, it is clear across the board that poverty is pervasive and severe in many parts of Ethiopia.

2. The overall conceptual framework

In this section, I present a simple framework relating household risk coping and resource sharing strategies at household, community and national level specific to Ethiopia. For the purpose of presenation, I start with the general literature relating farm household production decisions under unceratinity and the relevant risk coping strategies of households in low-income countries in the absence of credit market (insurance) with some additional evidence from Ethiopia. In this regard, farm household models that take into account the risk and poverty situations of households may be relevant. However, the objective in this section is not to develop models relating these but rather to explain the reality in a simple framework taking into account the behaviour of smallholder farmers and the nonmarket institutions that exist in the study areas (Figure 1). The dominancy of sharecroping and livestock rental contracts is of particular relevance to show how households in Ethiopia be able to utilize these informal risk coping and resource sharing strategies as second best optimal strategies.

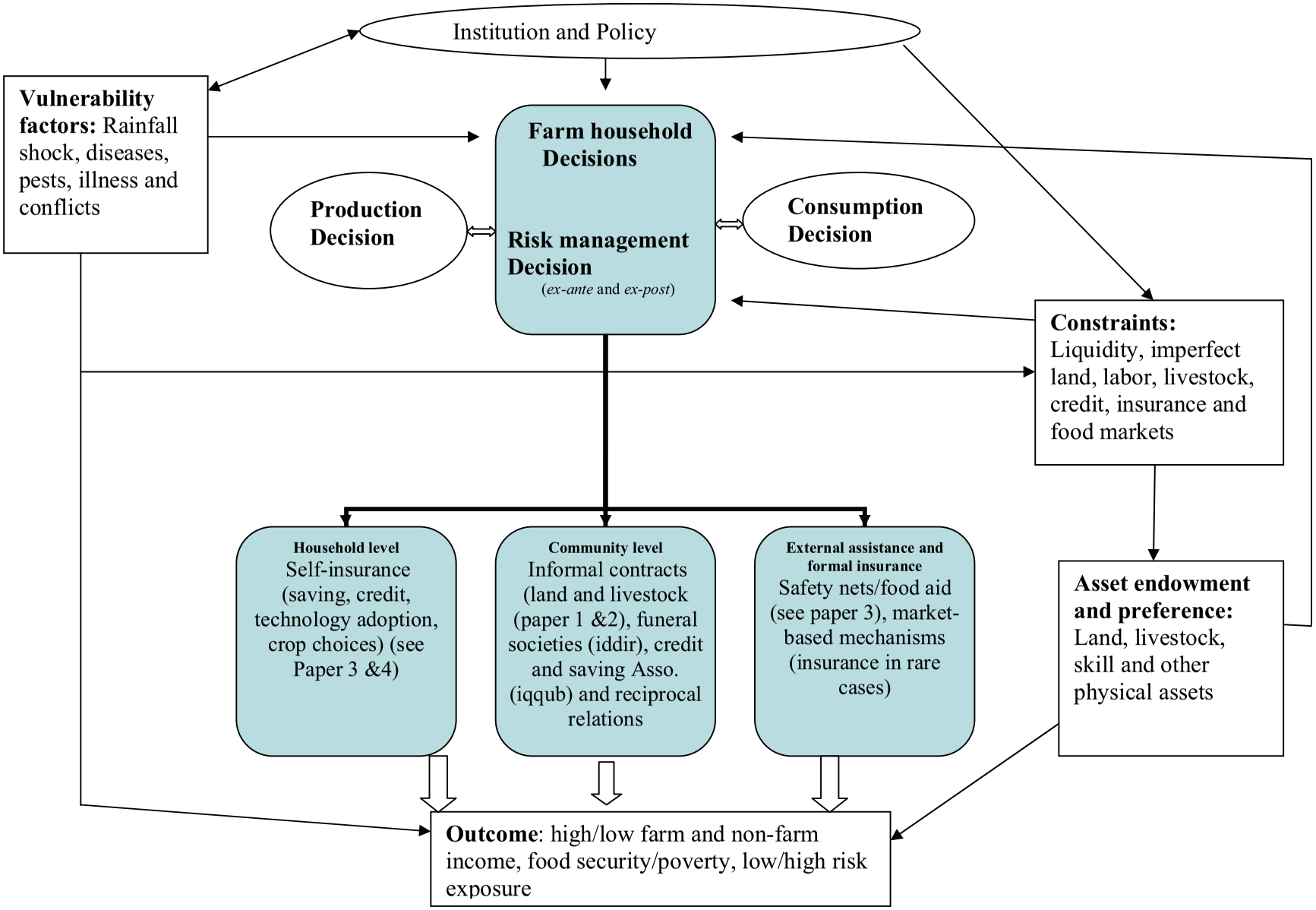

Figure 1: A conceptual framework for farm household decisions under uncertainty

In many developing countries, extreme poverty pushes farm households to avoid activities that entail significant risk, even though the income gains might be larger than for a less risky choices. This inability to manage risk and accumulate and retain wealth is sometimes referred to as the "the poverty trap'' (Dercon, 2002). When you are poor, you may not use your own resources as efficiently as the rich. That means being poor contributes to deviations in production behavior of farm households from the full and effcient production framework (Eswaran and Kotwal,1986).

In the context of imperfect credit market, (Eswaran and Kotwal,1986) developed a model that shows the possibility that land rich farmer can easily aquire fertilizer and other assets such as land and labor to make sure that inputs are used as efficient as possible. Contrary to this, the land poor farm household will end up using their land and non-land resources less effciently. A follow up study by Eswaran and Kotwal (1989) also shows that asset poor farm households can not enter into high risk activity because they do not own enough assets (and they do not have access to credit) to cope with downside risk. As a result, to reduce their income risk, poor households may enter into low-risk, low return activities. This indicates that farm households in risky envoronment make production decsions by adopting income reducing activities and became more conservative in technology adoption.

Morduch (1995) presents evidence that households whose consumption levels are close to subsistence (and which are therefore highly vulnerable to income shocks) devote a larger share of land to safer, traditional varieties such as rice and castor than to riskier, high-yielding varieties. Similarily, households in our study area use various means to

cope with risks such as crop diversifiaction, relaince on drought tolerant crops such as *enset* (false banana) and other root crops, reducing consumption, looking for help from friends, relatives, government assistance and participation in various community based informal risk management strategies (e.g. share cropping, livestock sharing, rotating saving and credit scheme, funeral societies (*iddir*), etc).

The importance of risk management through income source diversification is emphasized by Rosenzweig and Stark (1989), who find that households with high farm profit volatility are more likely to have a household member engaged in steady wage employment. For instance, during famine or when crop harvest fails, households in many parts of Ethiopia still participate in fireword collection, making charcoal by clearing natural forests, consume wild fruits, leaf and out migrate for immediate survival especially when government assistance is delayed due to problems related to roads, communication, storage, and lack of food aid reserve at federal level and other factors.

We may classify, households risk coping strategies[3] as *ex-ante* or *ex-post* measures. The former are strategies that take place before the occurrence of a random shock while the later takes place after a shock has occurred (Fafchamps, 2003).Typical *ex-post* informal income-smoothing mechanisms may include the sale of assets, such as land or livestock (Rosenzweig and Wolpin,1993), or the reallocation of labor resources to off-farm labor activities. For instance, Gadgil *et al*.(2002) argues that southern Indian farmers who

[3] For simplicity, I used the term coping strategy both for *ex-ante* and *ex-post* actions. Otherwise, what is more appropriate may be to define the *ex-ante* action as risk reduction strategy and the *ex-post* as risk coping startegy.

expect poor monsoon rains can quickly shift from 100 percent on-farm labor activities to mainly off-farm activities.

In rural Ethiopia, participation in off-farm activities are often limited (Dercon,2002) except in areas where there is an established link with off-farm labor markets (e.g. migrating to large scale sugar cane/coffee/tea/cotton plantation sites). However, in drought periods, the Ethiopian government has a productive safety net program for households affected by seasonal rainfall fluctuations. These households are allowed to participate in small scale Employment Generation Schems (EGS)[4] where by a farmer in his/her community can get low wage off-farm income often in kind (3 kg of wheat and 120gm of cooking oil per mandays). Those who are not allowed to participate or self select not to partcipate (because of the minimum wage) are households having relatively better assets such as land[5] (for renting out), livestock (for sale or renting out), perennial crops (coffee or *enset* (false banana)).

Livestock are an important production input (the only source of traction power), source of food and cash reserves in this region and many parts of rural Ethiopia. Their role for rental purpose (in addition to the sale value) provides a unique opportunity for households to relax their cash needs and escape poverty (Tadesse and Holden, 2010). A

[4] EGS via constructing soil conservation measures, rural road and other community works are commonly practiced.

[5] Land is state property and can not be sold but household can rent in/out in the form of sharecropping or fixed rent contracts as they have user right. We see the double role of livestock (sale and rental value) in rural Ethiopia unlike the case of land which is only used for renal purpose under the current land tenure policy. In Paper 2 we examine livestock rental contract choices for the first time in agrarian economy.

study in Bangladish, Ethiopia and Malawi show that higher future probability of disasters increases the likelihood of holding more livestock relative to land, *ex-ante* (Yamauchi *et al*., 2009). This shows the *ex-ante* risk reduction role of livestock. However, livestock may also serve as an *ex-post* risk coping strategy provided that livestock markets are functional after the shock. However, livestock market may not be functional in many low income countries following this period.

The risk-sharing role of share tenancy contract is central to the economics of land rental contract choices (Otsuka, 2007; Ackeberg and Botticini, 2002). Our own empirical investigation in paper 1 and paper 2 also support the risk sharing predictions in shaping contract choices. For instance, in paper 1, in the purest risk sharing arrangement, the landlord provides all of the inputs while the tenant provides all of the labour. The total output is shared equally; in this way, if a crop fails, the landlord mainly loses the cost of the inputs and the tenant loses only the value of the contributed labour. As such, they share rewards and risks jointly.

Generally, without sufficient coping strategies, poor households in many developing countries can find themselves locked into a cycle of poverty by staying in low-risk, low-yield economic activities in order to reduce their exposure to extreme shock. Alternatively, they may take out emergency loans, default on borrowed funds, and sell productive assets like livestock. If liquidation takes place at a time when others are also trying to liquidate, assets may have to be sold at fire sale prices.

2.1. Risks and coping strategies: Ethiopian evidence

Drought is the number one risk not only for rural Ethiopians, but also for the country overall, as evidenced by the fact that the country's macro-economic growth closely mirrors increases and decreases in precipitation (Figure 2). However, this does not mean other risks such as health, accidents, conflicts and unemployment less important for the poor in Ethiopia. For most, having enough food means less of the other risks such as health, conflict for resources and unemployment. A recent study by Yamauchi *et al*. (2009) finds that in Ethiopia and Malawi, exposure to high frequent droughts reduces schooling investments,with a very high negative effect for children having low nutritional status.

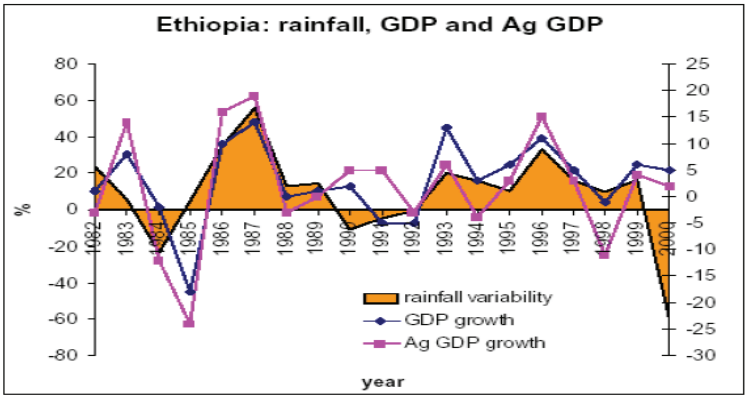

Figure 2: Rainfall and GDP growth in Ethiopia, Source: IGAD, 2008

To mitigate and deal with risks, Ethiopians rely on three categories of risk management strategies: self-insurance, community based risk management arrangements, and external assistance (see figure 1 in previous section). Below I will briefly discuss household and community level risk and resource sharing arrangements in Ethiopia. Finally, the role of Ethiopian government and external assistance in agricultural production risk management is discussed. This is because understanding the existing risk management strategies

at various levels will help to know their effectiveness and limitations to design a better social protection program for the poor in Ethiopia.

2.1.1. Self-insurance[6] in the form of saving

Coming in many different forms, self-insurance entails the retention of risk, meaning that any loss is absorbed and "compensated" by one's own assets (e.g. savings and current or future income). Saving is an *ex-post* response to insure consumption over time. It is the most common form of self-insurance and effective method for coping with the majority of economic shocks (Manje and Churchill, 2002). It is adaptable to any kind of unforeseen event and can be drawn upon quickly.

The advantage of cash savings is liquidity when there is no time to sell in-kind assets or when they fetch a low price. Livestock have the potential advantages of producing off-spring (and more income and savings). The livestock rental arrangments explored in this dissertation is evidence for the existence of alternative asset accumulation mechanisims when markets for credit are missing. The rental contracts also avoid the problem of assest indivisibility (lumpiness) pecular to livestock. In addition, the arrangment also enable the poor to invest their labor in livestock upkeep and use animal products from the rented in cow (if not offsprings) in case of shock to smooth consumption.

Despite the benefits of cash savings, Ethiopia has a relatively low rate of overall savings, precautionary or otherwise. From the poor's point of view, the disadvantage of precautionary savings is that it takes a lot of time to build substantial reserves, and shocks

[6] Technology adoption is another important self-insurance mechanisim. We will see the behaviour of smallholder farmers in technolgy adoption in paper 3 and 4.

frequently come before reserves are sufficient.They also require sacrifices in consumption, and for those living on a few dollars a day, saving is a challenge (Tadesse and Victor, 2009).

Nonetheless, empirical evidence shows that even the very poor can save. Admassie *et al*. (2005) found that the average amount of savings in poor rural Ethiopia ranges from ETB 1,000–2,000 (a little more than USD $100–200) per year. While more and more Ethiopians are beginning to save through formal financial institutions, most still stash them insecurely in a box at home. Saving at home allows households to avoid tax duties and bureaucratic paperwork involved in formal deposits or withdrawals. Further, many deposit-taking institutions require photo identification, an initial deposit, and some degree of literacy are no minor obstacles for the poor. Finally, lack of awareness and low interest rates on capital deposited availability contribute to the low rate of participation in formal savings programs (Admassie *et al*., 2005). Another important saving method in Ethiopia is *iqqub*, an informal rotating savings and credit association whereby members can access their contributed money when their turn comes up. This allows to relax capital contraints in case of unforesen events or invest in a new production/consumption activity.

Credit

Credit serves as an insurance substitute when market opportunities for risk sharing are limited (Besley, 1995). The author argues that pure credit arrangement, rather than a contract with contingencies is likely to be less optimal in risky environments. This indicates the role of informal contractual arrangements to cope with economic shocks in risky environments. Credit markets are significant to the discussion of insurable risks mainly in two ways (Tadesse and Victor, 2009):

Reducing vulnerability ex-ante: Economic shocks are easier to weather when one is wealthier. This is because credit, used wisely, can help build wealth .

Coping with shocks ex-post: Once a shock occurs, credit can be used to fund necessary and wise consumption, such as emergency medical care or food. It is not always obvious how the poor will repay their loans if they do not even have enough income for normal consumption in the first place; however, sometimes a basic level of consumption (e.g. minimum caloric intake) is necessary before any productive activities can become possible.

2.1.2. Community based risk management arrangements[7]

"When spiders' webs unite, they can tie up a lion."

In Amharic "Dire bi'yabere anbessa yasere."

—Ethiopian Proverb

Community based risk management arrangments are more relevant to cope with idiosyncartic (uncorrelated) shocks but are likey to fail in the face of correlated shocks unless household has systems to transfer the risk outside of their community/village (Battamishra and Barrett, 2010 in press). The importance of extra-regional risk sharing systems are found in literature, including, credit and transfers between distant relatives, (Rosenzweig,1988) and (Miller and Paulson, 2000); migration and marriages (Rosenzweig and Stark ,1989) and ethnic networks (Deaton and Grimard,1992).

A recent study in Tanzania by De Weerdt and Dercon (2006) find that risk sharing among households such as gift-giving and credit without interest from social networks-

[7] Paper 1 and paper 2 provide empirical evidence on land and livestock contractual issues as part community level risk managemnt and resource sharing arrangements in Ethiopia.

found to be the most important strategy for coping with shocks. Although past studies find some degree of risk sharing and thus of insurance against weather, use of such systems is not so widespread as to cover all households, nor do they come even close to providing a fully efficient insurance mechanism (Battamishra and Barrett, 2010 in press). Most households are therefore still left with no insurance against correlated risks, the main source of which is weather.

Ethiopians in both urban and rural areas enjoy a rich tradition of informal community risk and resource sharing mechanisms based on principles of social solidarity. The most common community-based risk management arrangements in Ethiopia include *iddir* (burial societies operating through membership dues to cover funeral costs when a person in a member's family dies), sharecropping, livestock sharing, and agricultural and financial cooperatives.

Our own empirical results from paper 1 (share cropping contracts) also indicate that landlord provides interest free inputs to tenants with financial problems. In livestock sharing contracts a severely cash constrained livestook tenant form contracts with rich livestock lords residing either in distant area or with in the same community. This allows the poor to have access for animal products such as butter, millk, cheese and manure for crop production which would have been difficult to get them without the contract. Similarily, the rich also get offsprings (prodcutive asset). This allows the livestock lord to store assets (livestock) in productive form as livestock reproduce.

Livestock sharing/rental contracts are common beyond the southeastern highlands (*Wolaita* and *Sidama* zones) as well in other forms. In pastoral areas, a household that has suffered a loss negatively affecting its access to milk and butter can borrow a cow from very close friends or relatives under an arrangement called *dabare*; after the family has had time to recover, the affected household is required to return the cow .

Pastoralist areas also count on their strong social linkages and relationships during social and economic crisis, through a system called *buusaa gonofaa.* Under the arrangement, fellow community and clan members contribute food and up to 10 heads of cattle per individual following a loss of livestock. For households that have lost all of their livestock, they can expect to receive from their clan as many heads of cattle as they had before; however, those who have lost animals as the result of mismanagement or negligence may receive only a few.

Iddir[8]

Primarily designed to deal with the financial burden of burial, as mentioned earlier represents a considerable and necessary expense due to its important cultural and religious significance (Mariam, 2003). *Iddir* members are required to pay fixed monthly contributions (often a few birr per month) to cover expenses when a member or a member's family member dies. Well-defined rules and obligations that are often recorded in writing and codified through mutually agreed regulations and accounting. Ability to

[8] Voluntarily registered under the Ministry of Justice and Internal Affairs , *iddir* have legal status in Ethiopia. It is distributed both in rural and urban areas across the country except in Tigray and some pastoral regions. Usually *iddir* members are often neigbours but there is no restriction if one wants to join an *iddir* group outside of his location/community as long as the transaction cost is low.

attract different socioeconomic groups with restrictions based on ethnicity or religion relatively rare in practice.

While most *iddir* only focus on compensating loss associated with death, some provide cash transfers or loans for other risks including illness, property damage including fire, death of livestock, and crop failure (Dercon, 2008). Other *iddir* have moved beyond their roots as funeral societies and begun to offer loans to construct homes, host weddings, and cover health benefits. In Mariam's (2003) study, about 20 percent of *iddir* provided help for health-related problems including obtaining loans to cover all medical costs.

2.1.3 External assistance

Finally, to manage risks, Ethiopians also turn to external assistance from institutions that are headquartered or supported by funds outside the area of intervention. *Ex-ante* assistance covers a very wide range of initiatives including micro-entrepreneur income generation, savings and credit-led schemes, environmental rehabilitation, agricultural productivity enhancements, and other development projects. *Ex-post* support focuses on interventions like cash and grain transfers in response to emergencies that affect very large numbers of people at once (e.g. drought, flooding, ethnic conflict, and cross-border war). Experience in many developing countries shows that risk management specific to weather shocks has generally focused on providing resources for *ex-post* relief operations to cope with shocks rather than on making dedicated resources available *ex- ante*. Often, due to delays in declaring emergencies and mobilizing and then distributing resources, relief often takes significant time to arrive and, indeed, can arrive too late.

A. Emergency and food relief

From 1993 until the spring of 2008, the Ethiopian federal government devoted two agencies to emergency relief, both housed in the Ministry of Agriculture and Rural Development. Until recently, the federal Disaster Prevention & Preparedness Agency (DPPA) was responsible for managing response to acute emergencies in coordination with other government ministries, the United Nations (UN), NGOs, and other donors. The DPPA oversaw the early warning system, development of appeals to the UN, and coordination of on-the-ground response; it also liaised with relief-oriented NGOs. To accomplish this work, the DPPA established various coordination forums, working groups, and task forces to handle various components of emergency response and preparedness.

The Food Security Office, a second emergency relief agency, managed the still active Productive Safety Net Program (PSNP) which targets chronic food insecurity through a combination of cash and food transfers that aim to ensure asset creation by poor households. The PSNP was established partly in response to fears that Ethiopians had developed a dependency on food aid; the program also aims to mitigate the unpredictability and lack of timely assistance from the international donor community.

B. Financial Sector Development

Also notable is the government's Financial Sector Capacity Building Project backed by the World Bank, which aims among other things to "help ensure better access to finance for all". Among the project goals are to strengthen national financial sector infrastructure (including strengthening insurance regulation and supervision), and to develop new financial products (including agricultural risk insurance). Currently, in terms of

government-backed or required insurance, a very small handful of Ethiopians enjoy access to disability benefits, maternity leave, and pension payments.

The Ethiopian Commodity Exchange (ECX) is one last recent professional individuals and government initiative worth mentioning. The ECX aims to fill a gap in the country's price risk management for agricultural commodities. Farmers in countries with developed financial markets can hedge against price swings up and down through futures and options contracts, traded on an exchange. Established in April 2008, the ECX will carry similar services, albeit on a limited basis, working through a system of exchange warehouses where farmers will be able to store their crops until they think selling conditions are favorable. As proof of deposit, farmers will receive a receipt that can be sold on the commodities exchange. If successful, the ECX could create critical opportunities to stabilize prices for agricultural producers (and large buyers as well) (Tadesse and Victor, 2009).

2.2. The Region studied, data and methodology

The Southern Nations, Nationalities and Peoples Region (SNNP) is one of the nine administrative regions[9] in Ethiopia.Unlike the other major regions (Amhara, Oromia and Tigray), SNNP is relatively less studied. Hence, this study believed to bridge this research gap and provide useful information for researchers and policy makers. For the purpose of our study, two administrative zones, *Wolaita* and *Sidama* were selected based on different criteria such as time and budget, production potential of each zones and our own earlier experience to the farming systems of these zones. These two zones are diverse in terms agro ecology, ethnicity, market and exposure to improved technologies.

[9] See administrative map of Ethiopia on page 42.

This study covers four peasant associations[10] in *Wolaita* and two in *Sidama z*ones. Within each peasant associations, households are sampled randomly from different agro ecologies to ensure representativeness of the study. However, depending on the research questions in each paper, our sampling procedure may vary from paper to paper within the general framework of capturing representative households for a particular research question under consideration.

This dissertation uses both household and plot level data collected by trained enumerators who are graduates from agricultural colleges and researchers and technical assistants at regional research centers (Awassa and Areka, Ethiopia[11]) under the supervision of the author of this dissertation. From September to December 2005, we collected household and plot level data (with last 12 months recall) in *Wolaita* and *Sidama* zones, Ethiopia. The *Wolaita* zone sample was built considering our previous data collected in 2000 on 120 sample households in *Gununo* area, *Wolaita* zone but additional districts (*Weredas*) and peasant associations were included for a better representation and the need to answer additional research questions.

Paper 1 uses the data collected in 2005 from *Wolaita* and *Sidama* zones, on 278 households and 3088 plot level observations. In paper 2, we added one additional survey in 2007 on the 278 households that makes a total of 556 households,balanced panel data. In our 2007 survey,we also interviwed[12] land and livestock rental partners who may or

[10] The smallest administration unit.

[11] The two major agricultural research centers under the Southern Agricultural Research Institute, Ethiopia.

[12] See appendix B.

not be part of the original sample to make the data suitable for econometric analysis (i.e.control the problem of endogenous matching between contract partners in livestock share contracts). The 2005 and 2007 data collection were conducted both at plot and household levels (Appendix A and B). Paper 3 and paper 4 use the data collected in 2000 on 120 households. In addition to the detailed quantitative survey, we also applied participatory rural appraisal techniques to get more qualitative information that are often important in supporting the quantitative data. We also undertake detailed review of existing literature under Ethiopian context and globally in each of the papers for a more rigorous investigation.

2.3. Research questions and linking the four papers together

In this dissertation, I attempt to answer key research questions believed to have impact for households living in a state of recurrent drought, poverty and food insecurity. The dissertation deals with informal contractual arrangements and their role in risk and resource sharing, and the role of informal risk coping strategies of smallholders in improved agricultural technology adoption. Broadly , I ask two questions:

1. What determines the participation and choice of contractual arrangements in land and livestock rental markets and their impact on poverty.
2. What role do the existing informal risk coping strategies of smallholders (i.e. reliance on livestock wealth, crop- diversification, land and non-land resources and safety nets[13]) play on fertilizer and structural soil conservation technology adoption?

[13] In paper 3, I examine the role of small scale Employment Generation Scheme (EGS) of the Ethiopian government on household fertilizer adoption.

The four papers in this dissertation consider farm households production bevaiour in risky environment and examine the role of contracts, land and non-land assets, credit and public works on technology adoption, poverty and input use efficiency using a rich data set collected for these purpose. These has been systematically shown in figure 1 of the conceptual framework (page 5). In areas where both credit and insurance markets are poorly developed, contracts are formed mainly to deal with risks and share resources which would have been difficult to acquire individually especially when assets are indivisible such as livestock. At household level, farmers use various self-insurance mechanisms such as technology adoption, plot and crop diversification,opt for low-risk, low return production choices (i.e. avoid exposure to risk) and use of precautionary savings among other strategies.

Paper 2 in this dissertation is built on the idea of share cropping contracts in paper 1, and brings the issue of livestock contract choices in an agrarian economy for the first time. In paper 1, it is shown that the land rental markets in Ethiopia are characterized by poor landlords and rich tenants. However, the livestock rental market (paper 2) is characterized by poor livestock tenants[14] and rich livestock lords. As a result, the poor tenants get access to productive assets (livestock) that could help relax constraints imposed by capital. In paper 3 and paper 4, the role of land and non-land resources (livestock, labor, low-wage off-farm income (saftey nets), access to credit) on household technology adoption behavior are examined. These helps to understand, how the existing resources and arrangements affect households' production and consumption decision in risky environment.

[14] Refer paper 2 for the formal definition of tenants and livestock lords in livestock rental contracts.

In terms of theoretical foundations, paper 1 and paper 2 use the theories in land rental contract choices taking into account the existing land and livestock contracts identified in this study and the behaviour of farm households in southern highlands of Ethiopia. Paper 3 and paper 4 are based on farm household production models/theories and investigate how the land and non-land resources and existing institutions affect farm household technology adoption behavior.

The emprical methods (econometric strategy) adopted in this dissertation are based on the underlying theories and hypotheses formulated in each of the papers. Qualitative response econometric models (for cross-sectional and panel data) such as (logit, probit and tobit), truncated regression, Generalized Linear Latent and Mixed Models (GLLAMMs)), instrumental varaibles and treatment effect models are applied. In either of the papers, one or more of these models are specified to test our hypotheses. Econometric problems such as endogeneity, multicollineiarity and sample selection issues are controlled and discussed in each of the papers to make sure that results are consistent across models.

3. This Dissertation

3.1.Key findings and contribution of the dissertation

Paper 1

Title: Contract choices and poverty in southern highlands of Ethiopia[15]

Objective

1. To investigate the variations in cost-sharing sharecropping arrangements and factors explaining them.

[15] Chapter 8 of the book, *The emergence of land markets in Africa. Impacts on poverty, equity and efficiency*, pp. 159-178. In Hoden, S.T., Otsuka, K. and Place, F.M. (eds) (2009). RFF press, Washington, D.C.

Based on the land rental contract choices identified in this study (see details in Table 1 of paper 1), the characterstics of households in this farming systems and the literature in land rental contracts (Hayami and Otsuka, 1993; Allen and Lueck, 2003), we developed a theoretical model for economies characterized by imperfect markets for land, credit, insurance and labor. We assume that households that are potential participants in land rental markets as landlords or tenants have a preference ranking among the contracts that are available to them and that the actual contract choice is a result of this preference ranking.

Not all of these arrangements involve risk sharing (as opposed to resource sharing), but a few do. Under Contract $Y_{6,}$ the tenant bears the cost of 100 percent of the inputs and gets 100 percent of the outputs, covering the cost of land through a fixed (cash) rental payment that is not revised upward or downward to reflect the success of the harvest. Contracts $Y_{2\ to\ 5,}$ fall somewhere in between the two ends of this spectrum.

When choices are ordered, the most common econometric estimation method is an ordered probit model. However, since we have multiple plot level observations for each households, calls for methods that enble to capture unobserved plot level hetergoeneity and adjust for within cluster correlation. Particularly the availability of multiple plots per households requires the use of panel data econometric methods for the above ordered contract choices. Hence, a Generalized Linear Latent and Mixed Models (GLLAMMs) (Rabe_Hesketh *et al*., 2004), is specified to test our hypotheses from both sides of the rental market (tenant and landlord sides). We confirmed the suitability of GLLAMM model against the standard ordered probit model using log likelihood ratio test statistics.

Plot level data is collected from southern highlands Ethiopia between september to december 2005. Six peasant associations (PA) were chosen to represent various agro-climatic zones in each zones. Input use and output values and other relevant varaibles were collected (for each cropping seasons (*meher* and *belg*) from 278 households and 3088 plots. We used trained enumerators for data collection with day to day supervision by the author of this dissertation.

The findings from paper 1 indicates that the diversity of land rental contracts in the region reflects rational adjustments in the environment of rural economies characterized by market imperfections in land, labor, credit and insurance markets. Particularly, we find that access to credit has a positive effect influencing poor tenant's land rental contract choices. This result is similar to the findings by Laffont and Matoussi (1995) that tenant's share of output positively influence his /her working capital. Thus, the contracts are induced to facilitate efficient use and allocation of land and non-land resources. Hence, a land tenure policy that favor tenure security and long term land rental contracts should be encouraged to reduce the transaction costs and enhance efficiency of land rental markets in the area.

An important contribution from paper 1 is that although the literature in land rental contract choices is rich, we have not come across any empirical studies examining variations in cost-sharing arrangements and factors explaining them.In addition, we applied an advanced econometric estimation methods (GLLAMM) to controll household level heterogeneities taking into account multiple plots per househoold as panel which is difficult to estimate using the standard ordered probit model specification.

Paper 2

Title: Livestock rental contracts, incentives and impact on poverty: Panel data evidence from southern highlands of Ethiopia[16]

Objective

1. To examine the most common forms of livestock rental contracts, factors determining household participation, the choices of contracts and the impact of participation on poverty
2. To test the claim that livestock contractual agreement is impossible (Binswanger and Rosenzweig, 1986)

We developed theoretical models based on the literature in land rental contracts choices, (Allen and Lueck, 2003; Hayami and Otsuka, 1993; Tadesse *et al*., 2009; Tikabo and Holden,2004), considering input and output sharing rules for an indivisible asset (livestock). The available livestock sharing/rental contract choices identified through our two-rounds household survey are presented (see details in Table 1 of paper 2). The livestock contract arrangements described entail arrangements slightly different from one another, but they all involve varying degrees of risk and benefit sharing. Types 2 and 3 are attractive in reducing the concentration of risk and investment inherent in each head of shared livestock. In contrast, type 1 contracts essentially represent a livestock purchase-on-credit plan with interest payments charged in-kind. Subtle variations of type 1 contracts involve more risk sharing.

[16] Earlier version of this paper was presented at the Nordic Development Economics Association annual conference in June 2008. Stockholm University, Sweden.

The advantage of type 1 contract (also called *Harra*) from the perspective of very poor households is that it requires no up-front investment costs and the risk of animal death is carried by the livestock lord but the tenant has no right to get offspring. Hence, livestock tenants who can afford to do so prefer to enter into contracts by sharing equally in the initial purchase costs and risk. In the long-run, this allows them to enjoy equal rights to all the benefits of the animal, particularly the offspring. Because healthy cattle reproduce, they are a particularly attractive investment with an added "profit function" built in. Under *Harra,* the keeper loses this profit mechanism, making it difficult to graduate to a contract with better benefits.

We used household panel data collected in 2005 and 2007 from, *Wolaita* and *Sidama* zones, of the southern highlands of Ethiopia. A total of 278 and 318 households in 2005 and 2007, respectively were interviewed. Balanced panel data were developed by dropping some of the households from the 2007 survey. Under close supervision, graduates from agricultural colleges worked to collect detailed data on inputs and outputs, expenditures, credit use, and livestock sharing arrangements. Although most past studies in contract choices ignored collecting information from matched contract partners, this study included information from matched contract partners in each contract.This helps to control for unobserved household level heterogeneity between contracting parties.

The fact that we have repeated household level observations calls for the use of panel data econometric methods (Baltagi, 2003; Hsiao, 1986; Wooldridge, 2002; 2005). To assess factors associated with participation and contract choice, participation selection models were run to also control for possible selection on unobservable related to

participation in the livestock rental market for livestock lords and livestock tenants separately using maximum likelihood selection models (Heckprob in STATA). In addition, treatment effect models for the impact of participation on the welfare of livestock lords and tenants, separately were implemented as endogenous treatment models on the same sample of households that satisfied common support in the propensity score matching.

This paper contributes to theory and empirical findings in area of applied contracts in agriculture that have to date been dominated by the studies of land rental contracts choices.We showed that the observed livestock sharing/rental contracts have the potential to benefit poor households that have had severe cash constraints. The findings from participation selection models indicate that livestock lords are more likely to rent out animals the more animals they have, the more *enset* stocks they have (wealth variable) and the less male and female labor they have per unit of land. Tenants' participation in livestock rental markets is mainly explained by the possible fragmentations of the rental markets and factors related to access to their labor endowments. Livestock tenants with better access to credit are more likely to form contracts that allows to share more benefits (favourable contracts such as type 2 and 3) than those without access to credit. The diversity of livestock contract choices identified in this study is refutation of the claim that livestock rental contracts are impossible (Binswanger and Rosenzweig, 1986). Controlling possible endogeneity of treatments, we found that access to livestock contracts have a positive welfare effect for livestock tenants. Both risk sharing motives and liquidity constraints imposed by the indivisible nature of livestock investment are key factors determining the choice of livestock contracts. We conclude, such rental

arrangements enable households to allocate production factors (land and livestock) more efficiently. Introduction of measures that enhance a more equitable livestock distribution that take into account the fuller advantage of the potential livestock-land synergies could be one possible policy interventions.

Paper 3

Title: Risk coping strategies, public works and fertilizer use in southern highlands of Ethiopia

Risk, credit constraints and limited access to information are the leading factors why improved technology has failed to diffuse in low income countries (Feder *et al*., 1985). Past studies from a range of countries indicate that a low level of modern input use may be related to risk aversion on the part of smallholder farmers (Antle, 1983; Binswanger, 1981; Feder *et al*., 1985; Moscardi and de Janvry, 1977; Shively, 1999; Yesuf, 2004). In order to cope with risks, the poor in many developing countries use various strategies such as crop diversification, reducing consumption, liquidating assets, adopt better soil conservation measures (e.g. soil and stone bunds), seed and fertilizer and rely on external assistance or out migration for better off-farm jobs. The risk coping strategies could be either *ex-ante* or *ex-post* measures. Strategies such as crop diversification, liquidating assets (livestock), participation in land and livestock contracts, reliance on external assistance (participation in small scale Employment Generation Schemes (EGS)) and adopting technologies that conserve soil moisture/ enhance soil fertility are some of the strategies used by smallholder farmers in our study areas.

Objective

1. To test the role of *ex-ante* and *ex-post* risk coping strategies of resource poor farmers on fertilizer use.

Relatively little is known at present about farmers who use modern varieties and fertilizer in the poorest countries (Doss, 2006). Towards this end, this paper provides detailed information about households' technology adoption behavior and their resource basis in one of the most densely populated regions of southern highlands of Ethiopia. Availabilty of cross-sectional micro level data provide important descriptive information about improved technology adoption by resource poor farmers (Doss, 2006). A simple theoretical framework was formulated to motivate the econometric analysis.

A two-part model, originally developed by Cragg (1971) is applied. This method is intensively used in consumer demand literature (Atkinson *et al*., 1984; Garcia and Labeaga, 1996). It is also applied in technology adoption studies in agriculture (Coady, 1995; Croppenstedt *et al*., 2003; Ghadim *et al*., 1999). Other econometric methods for handling the problem of endogeneity and sample selection bias are also considered. Results that are robust across the various models are discussed.

A random sample of 120 households proportional to the size of total population was interviewed from six villages during october-december 2000. This is a unique data set collected when the country has been affected by severe drought (as shown in Figure 2 earlier). Data collectors were trained on the contents of a questionnaire and a pre-test of the questionnaire was also conducted by the author of this paper. On the basis of the pre-test, some modifications were made to the questionnaire. This study was conducted in the southern highlands of Ethiopia, namely *Gununo* area of *Wolaita* zone.

The findings from this study have policy relevance for Ethiopia and other low income countries with similar conditions. It is shown that the existing risk coping strategies of the poor (e.g. reliance on livestock wealth and participation in small scale income generation scheme, EGS) have a positive effect on fertilizer adoption. As expected, households who are relatively wealthy (more livestock per unit of land) are less likely to participate in low-wage income sources (EGS). However, one has to interpreate this result with care. Although I attempt to control the problem of self-selection, the low participation of the relatively wealthy households could still be either due to self-selection (because the wage is so low) or targeting by the village committee members.

Based on past studies in low income countries including Ethiopia (Dercon, 2002; Battamishra and Barrett, 2010 in press), the existing informal risk coping strategies while effective for counterbalancing the consequences of events affecting only some members of the community, they often fails in the face of mass (covariate) risks, e.g. when the whole village is affected by drought or malaria epidemics. Hence, there is a need for better risk management for the poor in low income countries. At the same time, the existing informal risk coping strategies has to be strengthen because of their relevance in reducing shocks at household and possibily at community level through the extended social networks that exist in land and livestock contracts.

Paper 4

Title: Factors influencing adoption of soil conservation measures in southern Ethiopia: The case of *Gununo* area[17]

The adoption of improved production technique is a key determinant of agricultural productivity, diversification and economic growth in developing countries. Identifying the factors that hinder the adoption of new production techniques is therefore essential to design policies to reduce poverty and promote growth in developing economies. Households adopt techniques that conserve soil moisture for better yield and smooth their consumption across periods. However, investment in soil conservation technologies often requires considerable inputs (e.g. labor, opportunity cost of land allocated for the structures, and other negative effects of the technology) and sacrifice in current consumption. For households living at susbsistence level, investment in soil conservation technology is often difficult without assistance from governemnt or in the form of collective action.

In early 1980's with the help of international soil conservation research centers in collaboration with the Ethiopian government, soil conservation technologies have been introduced in different parts of Ethiopia on selected demonstration sites. The current study area, *Gununo* is among those sites. Then farmers in *Gununo* area were able to learn, adopt or reject the technologies at hand based on their own conditions. Hence, gathering information (factors) that contribute for the low/high adoption of soil conservation technologies is of particulr importance for countries like Ethiopia where the rate of soil erosion is too high.

[17] Published in Journal of ARD.

Objective

1. To identify the principal factors that affect the adoption of soil conservation technologies (soil bunds and *fanyajuu*[18]).
2. To examine the relative importance of each factors influencing farmers' soil conservation adoption decisions.

The theoretical model used in this paper is based on the literature in adoption studies in developing countries (Feder *et al*., 1985). Households improved technology adoption decisions are influenced by several factors (Feder *et al*., 1985). Doss (2006) shows that three factors are important for farmers not adopting improved technologies. First, farmers may not be aware of the technologies or the benefits that those technologies would provide. Second, the technologies may not be available at the time they would be needed or not available at all. Third, the technologies may not be profitable, given the complex set of decisions households are making on how to allocate land and labor across agricultural and non agricultural activities. Based on these literature and knowledge of the farming systems in this particular area, alternative hypotheses were formulated for empirical investigation.

Researchers often use qualitative response models such as logit or probit in technology adoption studies. In this study, a binomial logit model was specified. This is because the binomial logit model is simpler to estimate and interpret results (Aldrich and Nelson, 1990).

[18] A terracing process whereby a trench is excavated to form an embarkment on the upper side by throwing the excavated soil uphill whereas soil bunds are constructed by digging a ditch and throwing the soil downhill.

A random sample of 120 households was selected for this study. However, the study sites were selected using purposive sampling technique. This study was conducted in *Gununo* area across six villages by trained enumerators and the author of this dissertation. In addition to the formal survey questionnaire, we used informal interview checklists to gather qualitative information.

One of the key results from this study is that farmers' perception of soil erosion problem has a positive impact influencing the adoption of soil conservation technologies. Those who perceive soil erosion as an important problem are more likely to adopt physical soil conservation technologies than those who do not perceive soil erosion as a problem. Other factors such as household labor endowments, wealth status, farm size and the characterstics of the technology itself have significant effect influencing household soil conservation adoption in line with previous studies in other parts of Ethiopia (Shiferaw and Holden, 1998).

In the past, technology adoption studies in Ethiopia and elsewhere has given more emphasis on crop and livestock technologies. Only few and area specific studies have been conducted to identify factors influnceing smallholder structural soil conservation technology adoption particularily in Ethiopia. Hence, this study was conducted in view of bridging this gap. The findings from this paper suggest the need to increase farmers awareness of soil erosion problem demonstrating the gains and risk reduction role of improved soil conservation technologies. In addition, the fact that households' have their own traditional means of conserving their farm lands, introduction of new soil

conservation technology should consider the already existing indigenous land management practices.

Overall contribution of the dissertation

This dissertation consists of an introduction and four independent papers in the field of applied development economics. The empirical results from this dissertation adds to our understanding of applied contracts, smallholders risk coping strategies and household technology adoption decisions under risky environment. These are of interest for researchers, policy makers, private sectors and the public. The contract choice models developed in paper 1 and paper 2 will be applicable for researchers working with large panel data set. In paper 1, we showed that diversity in cost sharing contracts under share cropping arrangments are rational adjustments to the missing credit and insurance markets. Paper 2 is the first empirical paper that shows the existence of livestock rental contracts in agrarian economy. The findings from paper 2 refute the the claim that moral hazard makes livestock contracting impossible (Binswanger and Rosenzweig, 1986). In addition, controlling the endogeneity of treatments in treatment effect models, we find the positive welfare effects of livestock rental contracts for livestock tenants.

The findings from paper 3 help inform policy makers and public with respect to the positive impact of the current risk coping strategies of smallholders on chemical fertilizer adoption and consequently on crop productivity. It is shown that the use of two-part model is more relevant for empirical studies of similar kind. Paper 4 adds to earlier empirical studies in Ethiopia examining the factors influnecing the adoption of soil conservation technologies. Hence, the econometric results from paper 4 inform researchers and policy makers to design sustainable land management options via

combining farmers' indigenous soil conservation practices in the region and other similar areas.

Conclusion and future research

The dominancy of sharecropping contractual arrangements in many developing countries is considered as an optimal response for the missing or imperfect credit and insurance markets (Ackerberg and Botticini, 2002; Otsuka, 2007; Besley, 1995). The findings from this dissertation also provide new insights into this argument considering the existence of diverse forms of contracts in land and livestock in Ethiopia. These arrangements are important for risk and resource sharing in areas where insurance and credit markets are poorly developed.These informal risk coping strategies while effective for counterbalancing the consequences of events affecting only some members of the community, they may not be efficient in terms of protecting households from correlated risks such as drought (Dercon, 2002; Battamishra and Barrett, 2010 in press). Furthermore, these arrangements frequently come at a very high cost (both in cash outlays and opportunity costs) and partial or total irreversibility. A more quantitaive analysis on the effectiveness of household risk coping strategies requires detailed panel data (Dercon, 2002). But one has to note that the contribution of this the existing informal risk coping strategies sholuld not be undermined considering the volume of risks (uncorrelated risks) households in low income countries currently facing (Battamishra and Barrett, 2010 in press). Hence, policies that strengthen these informal institutions should be promoted. Alternatively introduction of a less expensive micro-insurance scheme for the poor in Ethiopia (Tadesse and Victor, 2009) and other low income countries may be promoted.Therefore, finding cost effective and sustainable risk

management strategies for households in low income countries should be the concern of future research.

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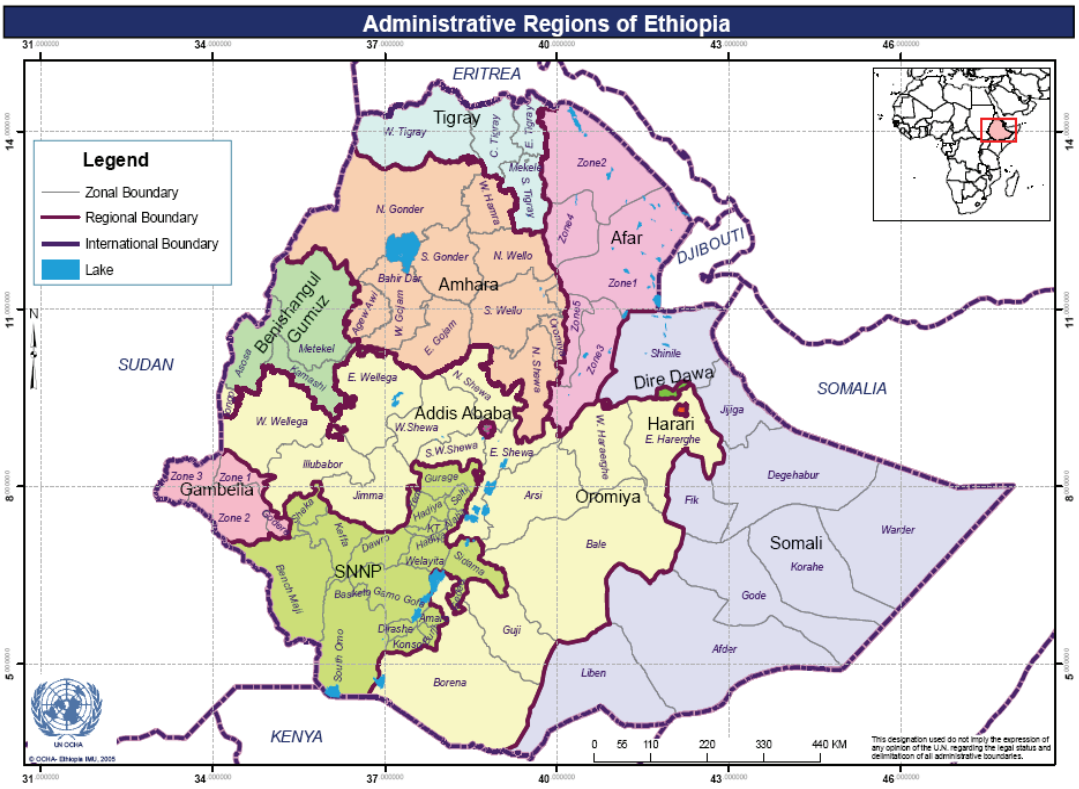
Map: Administrative Regions of Ethiopia



Note: *Currently, Ethiopia has nine administrative regions*: Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, SNNP, and Tigray *Two chartered cities:* Addis Ababa and Dire Dawa. Our study zones (*Wolaita* and *Sidama*) are located within the SNNP.

Paper I

CHAPTER 8

Contract Choice and Poverty in Southern Highlands of Ethiopia

Million Tadesse, Stein Holden, and Ragnar Øygard

Sharecropping is a land lease contract in which a tenant and a landlord share the final output as compensation for the labor supplied by the tenant and the land supplied by the landlord. In addition to labor and land, farmers in many rural areas form informal cost-sharing contracts for market-purchased inputs. The fact that land is state-owned property under the current Ethiopian constitution implies that land acquisition is via membership in a particular peasant association (PA), allowing only parental transfer of user rights to the heirs and participation in land rental markets (sharecropping and fixed rent contracts), while formal land sales are prohibited. The 1974 Ethiopian land reform implied a radical redistribution of land from feudal landlords to all community members. Land was then allocated based on household size. Land renting as well as hiring of labor was prohibited, whereas frequent land redistributions were implemented to maintain the egalitarian land distribution and allocate land to new households. With the change in government in 1991, a more market-friendly policy was introduced and short-term land renting was again allowed. Despite the policy barriers related to access and transfers of land, Ethiopian farmers have a long history of renting land through sharecropping and fixed rent contracts. This has continued even after the egalitarian land distribution was introduced. Our study revealed a particularly rich variation in cost-sharing sharecropping arrangements in southern Ethiopia, yet there have been no studies trying to explain the rationale of this variation within and across local communities. This is what we try to do in this chapter.

In other parts of the world there have been many studies and researchers trying to explain the rationale of sharecropping and to assess its efficiency implications (Marshall 1890; Cheung 1968, Cheung 1969; Stiglitz 1974; Shaban 1987; Hayami and Otsuka 1993b). Various authors have provided alternative theoretical explanations for the existence of alternative contracts. Screening models (Hallagan 1978; Allen 1982; Shetty 1988) assumed that landlords have no information on the ability of tenants and that they use self-selection

among contractual options as a device to prevent tenants from defaulting on rent payments. However, the assumption of nonobservable tenant quality may be unrealistic when landlords and tenants live together in the same community and can obtain knowledge on ability and land quality through direct observation (Bardhan 1984; Singh 1989; Hayami and Otsuka 1993b). Braverman and Stiglitz (1986) argued that cost sharing applies only to inputs that can be monitored and enforced by the landlord at low cost. If so, there is no incentive issue regarding the application of such inputs. Hayami and Otsuka (1993b) therefore suggested that inputs supplied under cost sharing can be regarded as *de facto* production loans. However, as shown by Kassie and Holden (2007) and in Chapter 10, tenants may have an incentive to use more fertilizer on their rented-in land in order to increase the probability of contract renewal.

Bell and Zusman (1976) and Zusman and Bell (1989) formulated the problem of contract choice in a bargaining framework where they argued that optimal contracts are result of the relative bargaining power of the contracting parties. Sadoulet et al. (2001) argued that contracts take the form of resource pooling, which compensates for idiosyncratic market failures to which the parties are subjected. Tikabo and Holden (2003) proposed a model where contract choice—including cost sharing, pure output sharing, and fixed rent contracts as the options—was endogenous. Imperfections in credit and insurance markets caused contract choice to be driven by risk aversion and liquidity scarcity. Cost-sharing contracts were therefore to be preferred by relatively cash-rich and less risk-averse landlords and by more cash-poor and risk-averse tenants.

Empirical studies investigating contract choices include Dubois (2002), who found that fixed rent contracts were preferred to sharecropping for the most fertile plots in the Philippines, but the latter is preferred when crops-enhancing land overuse, such as maize, are grown. In a study in Tunisia, Laffont and Matoussi (1995) found that a tenant's share of output is directly related to his or her working capital but inversely related to that of the landlord, which is in line with the capital constraint and resource-pooling hypothesis. Tikabo and Holden (2003) found that poor landlords and wealthy tenants were attracted to each other through a preference for fixed rent contracts, whereas less poor landlords and poorer tenants were attracted to each other through a preference for cost-sharing contracts. The intermediate wealth stage on both sides provides a preference for pure sharecropping contracts. Negative correlation between wealth and capital shortage, and between wealth and risk aversion, could possibly explain this variation in contracts.

We have not come across any empirical studies of variation in cost-sharing arrangements and factors explaining them. Our study is therefore unique, but we can build on the reviewed theoretical literature to assess alternative hypotheses to explain the observed variation in contracts in southern Ethiopia. In this chapter we develop a general theoretical model facilitating the testing

of a number of hypotheses of why a diversity of cost-sharing contracts coexist within the same communities and across neighboring communities. We assess whether resource pooling or relative bargaining power can explain the variation, or whether the variation is primarily an adjustment to differences in soil quality across rented plots. With resource pooling, the wealthier landlords would provide more inputs costs, but if wealth and bargaining power are positively correlated, wealthy landlords would cover less of the input costs. With resource pooling, poorer tenants would also get more input costs covered by their landlords, whereas under the bargaining model, assuming that wealth and bargaining power are positively correlated, poorer tenants would have to cover more of the input costs.

Land Rental Contracts in Southern Ethiopia

The land rental contracts identified in our study areas are presented in Table 8-1. As can be seen from the table, we identified six different contract types. It was surprising, however, that output sharing was fixed at 50:50, since output shares are found to vary in other parts of Ethiopia. The fact that insurance

TABLE 8-1 Input cost sharing rules under crop-sharing and cash rent contracts in *Wolaita* and *Sidama* Zones, Ethiopia

Contracts (y^n_{obs})	*Description of each land rental contracts*	*Frequency*	*Percent*
y_1	Landlord covers all input costs* and output is shared equally	18	2
y_2	Landlord covers all input costs but it is subtracted first before output is shared equally	53	6
y_3	Equal input cost share and equal output share	430	49
y_4	Tenant covers all input costs but it is subtracted first before output is shared equally	225	25
y_5	Tenant covers all input costs and output is shared equally	47	5
y_6	Fixed rent contract, tenant covers 100% of input costs and gets 100% of output	112	13
	Total	885	100

Note: Tenant preference ordering: $Y_1^t > Y_2^t > Y_3^t > Y_4^t > Y_5^t$ and landlord preference ordering: $Y_5^l > Y_4^l > Y_3^l > Y_2^l > Y_1^l$. It is only under distress rental condition that Y_6^l is preferred over the rest of the contracts by landlords. Observations are at plot level for each contract type for unmatched tenant and landlord households.

*Landlords contribute labor on rented out plots only in rare cases, except during harvesting. Otherwise, labor input is exclusively supplied by the tenant. Hence, our definition of input costs does not include labor and land.

or credit markets are imperfect in our study area may cause land rental markets to serve as a substitute to smooth consumption and mobilize resources as needed.

In Table 8-1 we have ranked the land rental contracts in terms of how favorable they are to the tenants, with the most favorable contract ranked first and assuming the opposite rank applies for the landlord. As marginal return to the tenant's work effort is 50% of marginal yield for all contracts, the work incentive provided by the contracts is the same in all cases, except for the fixed rent contract.

The tenants' expected return and utility from contracts decreases as we move from Y_1 to Y_5 but increases for the landlord as one moves from Y_1 to Y_5 (see Table 8-1). This is because contracts, all else being equal, at the top are less expensive for the tenant but more expensive for the landlord. In contract Y_1 the landlord covers all the cash input costs. In contract Y_2 the landlord covers all the up-front financial costs of the inputs but is compensated after harvest when the costs are shared equally (without interest).

Contract Y_3 implies equal sharing of financial expenses for cash inputs. Contract Y_4 implies that the tenant covers the up-front financial expenses for cash inputs but is compensated after harvest by equal sharing of the costs (without interest). Contract Y_5 implies that the tenant carries all the cash input costs without compensation other than through equal sharing of the output, like in all the previous contracts. This is the standard pure sharecropping contract. Contract Y_6 is the fixed rent contract. The return to this contract and its ranking relative to the other contracts depends on the rental rate. Land rental market participation under cash rent is often an indication of financial distress by the landlord rather than a pure demand and supply-driven market condition. Those landlords who are really constrained by cash (liquid assets) for the purchase of inputs, or for meeting consumption demands such as expenses on school fees, social ceremonies, and medical treatment, may rent out their plots on cash rental basis. This will then be their most preferred contract, given their very high subjective discount rate. The average cash rental price in the study area was about 1,312 Ethiopian birr/hectare/year (1US$ = 8.8 bBirr), whereas the share of landlords' average net return from sharecropping contracts was 3,301 birr/hectare/year. The difference in mean returns between sharecropping and fixed rent contracts is statistically significant $t = 3.2064$; $p = 0.000$. In order to assess landlords' time preferences, we computed the discount rate at mean values of fixed rate and sharecropping contracts returns, assuming that the whole difference is due to discounting of future income. The result indicated that a landlord who prefers fixed rent contract from sharecropping has a discrete time discount rate of at least 150%. This must be seen as an upper bound on the discount rate because risk sharing is also implicit in the sharecropping contract. High discount rates have also been found for poor households elsewhere in Ethiopia and in other countries (Holden et al. 1998).

As can be seen from Table 8-1, the equal input cost sharing contract, Y_3, is the most common contract in our study area (49% of contracts), followed by Y_4 (25% of contracts) and Y_6, the fixed-rent contract (13% of contracts). The contract Y_2, where the landlord advances for cash inputs but gets refunding at the time of harvest, before the remaining output is shared equally, and Y_5, where the tenant pays for all inputs without compensation, and output is shared equally at harvest are about equally rare (6% and 5% of the contracts, respectively). Finally, the Y_1 contract, where the landlord pays all the inputs without compensation at harvest while output is shared equally, is a rare contract that we found in only 2% of the cases.

A Model of Land Rental Contract Choice

We assume that there exists a set, S, of available contracts in an area. The size of the set is likely to increase with an expansion of the area, meaning that the set of contracts may be smaller in a sub-area, like a village, as compared to a district or region; therefore, the set of contracts in a village, $s^v \in S$. Furthermore, the set of available contracts to a specific household, h, in the village v may only be a subset of the village set of contracts, $s^{vh} \in s^v$. For households that are rationed out of the land rental market, $s^{vh} = \varnothing$. Contract characteristics are also likely to be affected by basic agroecological characteristics that affect the types of crops that can be grown, the profitability, and the risk. Specific plots that are offered in the rental market may therefore have a subset of contract alternatives that is a sub-set of the types of contracts available within a village, $s^p \in s^v$. The specific contracts available for a specific plot of a specific household in a specific village may be denoted $s^{vhp} \in s^{vh} \in s^v$, indicating also that contract choice may be a function of plot, household, and village characteristics.

We assume that households that are potential participants in the land rental market as landlords or as tenants have a preference ranking among the contracts that are available to them and that actual contract choice is a result of this preference ranking. However, landlords and tenants who agree on a contract may have conflicting interests with respect to contract choice, and the actual agreed contract may therefore depend on their bargaining power and be the best outcome of available choices. This will be the best offer from the contracting partner or possibly several potential contract partners. The actual observed contracts of landlords and tenants are a result of their constrained optimization. Thus, contract choice is likely to be a function of the characteristics of the landlords and tenants, the village characteristics, the agroecological and specific farm plot characteristics, and the market's characteristics.

$$Y_{obs}^{n} = Y_{obs}^{n}\left(z^{t}, z^{l}, z^{p}, z^{v}, p^{m}\right),$$

where Y^n_{obs} is observed contract choice of tenant (when $n = t$) and landlord (when $n = l$). z^t is tenant household characteristics, z^l is contract partner-landlord household characteristics, z^p is the plot and agroecologal characteristics, z^v are the village characteristics, and p^m is a vector of prices and market characteristics.

We develop the model for economies characterized by imperfect markets for land, labor, credit, and insurance. We assume that there is production risk but markets for cash inputs (fertilizer and seed) and outputs exist. Households are generally poor, face subsistence constraints, and have small farm sizes. Their endowments of nonland assets determine their relative poverty and their decisions on whether to participate in the land rental market or not. Households with more nonland resources relative to land are more likely to rent in land, whereas households with few nonland resources are more likely to rent out land. This is based on the assumption that transaction costs in the land rental market tend to be lower than in nonland factor markets (Tikabo et al. 2008; Holden and Ghebru 2006; Chapter 4). We will now introduce a number of hypotheses that may possibly explain observed contract choices of landlords and tenants:

H1. Bargaining Power Hypothesis

Observed contract choice depends on the relative bargaining power of landlords and tenants. Landlords and tenants with more bargaining power obtain better contracts than landlords and tenants with lower bargaining power.

Assumption: Landlords and tenants with more wealth have more bargaining power than landlords and tenants with less wealth.

Testable implication: More wealthy landlords and tenants achieve more favorable land contracts.

H2. Resource-Pooling Hypothesis

This is the altruistic or more equal sharing of benefits model. Landlords and tenants with more resources contribute more of their resources and therefore accept less favorable contracts.

Assumption: Altruism and/or Pareto-efficiency gains can explain this behavior.

Testable implications: Altruism may be associated with kinship contracts. Pareto-efficiency gains may be investigated through assessment of production efficiency in alternative contracts.

H3. Land Quality-Adjusted Contracts Hypothesis

Contract choice reflects differences in land quality. For good quality land the implicit rent will be higher (i.e., the tenant covers more of the input costs).

Assumption: Land quality is observable to both parties.

Testable implication: Observable land quality characteristics are positively related to the rank obtained by landlords, implying that the tenant has to cover more of the input costs on better quality land.

H4. Duration-Adjusted Contracts Hypothesis

More long-term contracts are preferred by tenants and they are willing to cover more of the input costs for long-term contracts.

Testable implication: Longer-term contracts are associated with tenants covering more and landlords less of the cash input costs.

H5. Distress Rental Hypothesis

Landlords facing emergencies rent out their land on fixed-rent basis due to lack of alternative sources of cash.

Assumption: Poor landlords lack access to credit and are cash-constrained.

Testable implication: Landlords renting out land on fixed-rent contracts are particularly poor. Rent paid in fixed-rent contracts is low compared to return from sharecropping contracts.

H6. Spatial Variation Hypotheses

There is not one rental market for land, but due to the spatial distribution and immobility of land and the spatial dispersion of potential landlords and tenants, land rental markets are fragmented. Variation in contracts reflects local differences in demand for and supply of rental land.

Testable implication: Location (village) dummies will explain the variation in land rental contracts.

H7. Reputation and Trust Hypothesis

Well-established tenants and landlords obtain more favorable contracts than new entrants in the market and entrants with poor reputation and low trust.

Testable implication: Assess whether landlords and tenants that emphasize reputation and trust when selecting partners have given their partners more favorable contracts.

An Application to Southern Ethiopia

We will apply this theoretical framework to a case study in southern Ethiopia. Our data allow us to observe the range of contracts in a larger area containing variation in agroecological and market characteristics, variation in farm and household characteristics within villages, the actual contracts of individual tenant and landlord households, and the plots that are transacted. While we observed the set of contracts in Table 8-1, here they are formulated mathematically as seen from the tenant households' perspective:

$$S^{tp} = \left\{ \begin{array}{ll} \alpha\rho^t \sum_p \theta_p F_p^t\left(A_{rp1}^l, L_{rp1}^t, X_{rp1}^l\right) - \omega^t \sum_p L_{rp1}^t & :Y_1^t \\ \alpha\rho^t [\sum_p \theta_p F_p^t\left(A_{rp2}^l, L_{rp2}^t, X_{rp2}^l\right) - p_x \sum_p X_{rp2}^l] - \omega^t \sum_p L_{rp2}^t & :Y_2^t \\ \alpha\rho^t \sum_p \theta_p F_p^t\left(A_{rp3}^l, L_{rp3}^t, X_{rp3}^{lt}\right) - p_x \sum_p \gamma_p X_{rp3}^{lt} - \omega^t \sum_p L_{rp3}^t & :Y_3^t \\ \alpha[\rho^t \sum_p \theta_p F_p^t(A_{rp4}^l, L_{rp4}^t, X_{rp4}^t) - p_x \sum_p X_{rp4}^t] - \omega^t \sum_p L_{rp4}^t & :Y_4^t \\ \quad \alpha\rho^t \sum_p \theta_p F_p^t(A_{rp5}^l, L_{rp5}^t, X_{rp5}^t) - p_x \sum_p X_{rp5}^t - \omega^t \sum_p L_{rp5}^t & :Y_5^t \\ \rho^t \sum_p \theta_p F_p^t(A_{rp6}^l, L_{rp6}^t, X_{rp6}^t) - p_x \sum_p X_{rp6}^t - \tau_p A_{rp6}^t - \omega^t \sum_p L_{rp6}^t & :Y_6^t \end{array} \right\} \quad (8.1)$$

where $\rho^t = 1/1+\delta^t$ is the subjective discount factor, α is the output share (= 0.5), F_p^t denotes plot level concave production function that preserves the usual properties $F_p^{'t} > 0$ and $F_p^{''t} < 0$ and with positive cross-partial derivatives. Plot level output is a function of area, A_r, labor input per plot supplied by the tenant, L_{rp}^t, and purchased inputs, X_{rp}^l, either supplied (contributed) by the tenant (if superscript t), by landlord (if superscript l) or by both parties (if superscript lt), while subscripts 1, 2, 3, . . . ,6 denote available contract choices, Y_j^t ranging from 1 to 6. Output price is normalized to 1 and tenant's shadow wage rate, ω^t, and input price, p_x, are assumed constant across contracts. In addition, γ_p indicates input cost share of the tenant under equal cost-share contract choices ($\alpha = \gamma_p = 0.5$). The term τ_p denotes the fixed payment for cash rented plot, p.

The mirror image of this set of contracts as seen from the landlord is as follows:

$$S^{lp} = \begin{cases} (1-\alpha)\rho^l \sum_p \theta_p F_p^l(A^l_{rp1}, L^t_{rp1}, X^l_{rp1}) - p_x \sum_p X^l_{rp1} & : Y_1^l \\ (1-\alpha)[\rho^l \sum_p \theta_p F_p^l(A^l_{rp2}, L^t_{rp2}, X^l_{rp2}) - p_x \sum_p X^l_{rp2}] & : Y_2^l \\ (1-\alpha)\rho^l \sum_p \theta_p F_p^l(A^l_{rp3}, L^t_{rp3}, X^{lt}_{rp3}) - (1-\gamma_p) p_x \sum_p X^{lt}_{rp3} & : Y_3^l \\ (1-\alpha)\rho^l \sum_p [\theta_p F_p^l(A^l_{rp4}, L^t_{rp4}, X^t_{rp4}) - p_x \sum_p X^t_{rp4}] & : Y_4^l \\ (1-\alpha)\rho^l \sum_p \theta_p F_p^l(A^l_{rp5}, L^t_{rp5}, X^t_{rp5}) & : Y_5^l \\ \tau_p A_{rp6} & : Y_6^l \end{cases} \quad (8.2)$$

where $(1 - \alpha)$ and $(1 - \gamma_p)$ are the landlord's output and input shares, respectively with all other terms defined as before. Based on these sets we can now look at contract choice for individual tenants and landlords who are not likely to be able to choose among the full set of contract alternatives listed above.

Tenant Model

A typical tenant in our study area cultivates own plots, A_o and applies labor and purchased inputs, L_o and X_o, respectively, on own plots in addition to the available contract choices under the set s^{vt}. Hence, we can specify the tenant's discounted expected net income, denoted by $y_j^{\,t}$, from own plots and from the set of contract choices ranging from 1, 2, 3 . . . 6 in $\{s^{vtp}\}$, as:

$$y_j^t = \underbrace{\rho^t \sum_p \theta F_p^{\,t}(A^t_{op}, L^t_{op}, X^t_{op})}_{\text{Income from own plots, where subscript } p \text{ is plots}} - \underbrace{\sum_p \left(p_x X^t_{op} + \omega^t L^t_{op}\right)}_{\text{Cost of inputs on own plots}} + \underbrace{\arg\max\{s^{vtp}\}}_{\text{Choice of best available contract}}$$

$$= \rho^t \sum_p \theta F_p^{\,t}(A^t_{op}, L^t_{op}, X^t_{op}) - \sum_p \left(p_x X^t_{op} + \omega^t L^t_{op}\right) + \pi\left\{Y^t_{obs}\left(z^t, z^l, z^p, z^v, p^m\right)\right\} \quad (8.3)$$

The expression $\sum_p \left(p_x X^t_{op} + \omega^t L^t_{op}\right)$ denotes the sum of input costs on own plots for purchased inputs and labor. The tenant's expected return from alternative contracts has the following preference ordering: $Y_1^t > Y_2^t > Y_3^t > Y_4^t > Y_5^t$. For a severely cash-constrained tenant the last contract, Y_6^t, will be the least preferred, while its rank is undetermined and depends on the rental price, relative risk of alternative contracts, the (subjective) discount rate and risk aversion of the tenant, in other cases. Based on this we are able to estimate a "reduced form" of the observed contract choices of tenants as an ordered rank model as follows:

$$Y^t_{obs} = Y^t_{obs}\left(A^t, L^t, z^t, z^l, z^p, z^v, p^m\right) \quad (8.4)$$

Since we do not have paired observations we assume that $z^l = z^l(z^v)$.

Landlord Model

A landlord in our setting usually cultivates own plots ($A_o - A_r$) in addition to the plot currently leased out, either in the form of sharecropping or cash rent contracts. He or she lives in the same village as the tenant, or may in some cases reside in a neighboring village. The landlord's discounted expected net income, denoted by y_j^l, from own plots and from the choices of the best available contract, for each contract choice is specified as:

$$y_j^l = \underbrace{\rho^l \sum_p \theta F_p^{\,l}(A_{op}^l, L_{op}^l, X_{op}^l)}_{\substack{\text{Income from own plots, where subscript} \\ p \text{ is plots}}} - \underbrace{\sum_p \left(p_x X_{op}^l + \omega^l L_{op}^l\right)}_{\text{Cost of inputs on own plots}} + \underbrace{\arg\max\left\{s^{vlp}\right\}}_{\text{Choice of best available contract}} \tag{8.5}$$

$$= \rho^l \sum_p \theta F_p^{\,l}(A_{op}^t, L_{op}^l, X_{op}^l) - \sum_p \left(p_x X_{op}^l + \omega^l L_{op}^l\right) + \pi\left\{Y_{obs}^l\left(z^l, z^t, z^p, z^v, p^m\right)\right\}$$

The expression

$$\sum_p \left(p_x X_{op}^l + \omega^l L_{op}^l\right)$$

denotes the landlord's total costs (purchased inputs and labor) on own plots. Assuming that a cash rental contract is practiced only under distress condition (indication of the landlord's weak financial position), contracts have the following preference ordering: $Y_6^l > Y_5^l > Y_4^l > Y_3^l > Y_2^l > Y_1^l$. Other landlords not in a distress situation are likely to rank the fixed-rent contract lower. Based on this we may estimate the "reduced form" ordered response model for actual observed contacts of landlords as follows;

$$Y_{obs}^l = Y_{obs}^l\left(A^l, L^l, z^l, z^t, z^p, z^v, p^m\right) \tag{8.6}$$

allowing us to test our hypotheses, assuming that $z^t = z^t(z^v)$, since we do not have data on both landlord and household characteristics for each contract.

Econometric Specification and Estimation Issues

Ordered probit models were used in the econometric analysis. In order to capture unobserved household heterogeneity (such as tenant and landlord unobserved behaviour), and also to adjust for within-cluster correlation, GLLAMM models (with 16 points of integration using ordinary quadrature points), following Rabe-Hesketh et al. (2004) were estimated. A two-level random inter-

cept model taking only one plot specific explanatory variable, x_{pk} for simplicity, can be specified as:

$$y_p^h = \eta_0^h + \beta_1 x_p^h + \varepsilon_p^h \tag{8.7}$$

where p denotes plots as level-1 units and households, h, as level-2 units, η_0^h are household-specific intercepts, β_1 is a regression coefficient, and ε_p^h is a plot level residual term. The η_0^h intercepts may be expressed as:

$$\eta_0^h = \gamma_0^0 + \zeta_0^h \tag{8.8}$$

where γ_0^0 is the mean intercept and ζ_0^h is the deviation of the household-specific intercept η_0^h from the mean. Let $\theta \equiv \text{var}(\varepsilon_p^h)$ and $\psi \equiv \text{var}(\zeta_0^h)$. We assume household level clusters are independent and

$$\begin{aligned}
&\varepsilon_p^h \mid x_p^h \quad N(0,\theta),\\
&\text{Cov}(\varepsilon_p^h, \varepsilon_{p'}^h) = 0,\ p \neq p'\\
&\zeta_0^h \mid x_p^h \quad N(0,\theta),\\
&\text{Cov}(\zeta_0^h, \varepsilon_{p'}^h) = 0
\end{aligned}$$

The reduced form of the model is obtained by substituting equation (8.8) into equation (8.7) (Rabe-Hesketh et al. 2004):

$$y_p^h = \gamma_0^0 + \zeta_0^h + \beta_1 x_p^h + \varepsilon_p^h \tag{8.9}$$

The log likelihood-ratio test statistics favored GLLAMM models against the standard ordered probit models for both tenant and landlord sub-samples (1% level of significance), as zero variance restrictions were strongly rejected. This indicates that the two-level random intercept GLLAMM models are more suitable in analyzing the dataset and are therefore used in our subsequent discussion. Standard errors are also corrected for heteroskedasticity using the Huber/White/Sandwich estimator. One of the limitations of our analysis is that we do not have matched data for landlords and tenants. We therefore have to assess the contracts of landlords and tenants separately, causing possible omitted variable bias due to correlation of landlords' and tenants' characteristics. However, the use of the two-level random intercept model in GLLAMM (household being level 2 and plot being level 1) helps to control the unobserved heterogeneity of the overall responses of contract choices.

Instead of a constant term, the vector of explanatory variables includes threshold parameters (κ_0 to κ_6) that determine the six outcomes for observed responses.

$$Y_{obs}^{n} = \begin{cases} \overbrace{1 \Rightarrow Y_1}^{\text{Choices, } Y} & \text{if } \kappa_0 = -\infty \le Y_j^* < \kappa_1 \\ 2 \Rightarrow Y_2 & \text{if } \kappa_1 \le Y_j^* < \kappa_2 \\ 3 \Rightarrow Y_3 & \text{if } \kappa_2 \le Y_j^* < \kappa_3 \\ 4 \Rightarrow Y_4 & \text{if } \kappa_3 \le Y_j^* < \kappa_4 \\ 5 \Rightarrow Y_5 & \text{if } \kappa_4 \le Y_j^* < \kappa_5 \\ 6 \Rightarrow Y_6 & \text{if } \kappa_5 \le Y_j^* < \kappa_6 = \infty \quad \text{where } Y_j^* \text{ is unobserved contracts.} \end{cases} \tag{8.10}$$

And can be estimated as

$$y_j^* = x'\beta + \varepsilon$$

Since the rank of the fixed-rent contract is not obvious and may vary with the discount rate (and risk preferences) of landlords and tenants, we have chosen to run the models with and without including the fixed-rent contracts (Table 8-5, shown later). We use this as a robustness test of the results as well and interpret results conservatively by saying that a hypothesis is supported only when the results are significant and in favor of the hypothesis in both model specifications.

Data

The dataset used for this study is based on data collected from southern highlands Ethiopia from September to December 2005. Six peasant associations (PA) were chosen to represent various agroclimatic zones in Wollaita and Sidama zones of the southern highlands of Ethiopia. The districts that are used in the present study are *Bolososore* and *Kindokoysha* in Wollaita zone and *Wondo Genet* area in Sidama zone. A total of 36 villages were included and households were randomly sampled from each village. Trained enumerators (who have diplomas and are qualified in agricultural sciences) were used to collect both farm plot and household level information under strict supervision by the first author of this chapter (Tadesse). Input use and outputs for the two rainy seasons (*meher* and *belg*) were collected from 278 households and 3,088 plots. Variable definitions and descriptive statistics of explanatory variables are presented in Tables 8-2, 8-3, and 8-4 for tenants and landlords.

As can been seen in Table 8-3, there are statistically significant differences between tenants and landlords for key wealth indicator variables. We found that tenants have significantly higher income, per capita farm size and male work force, contrary to other parts of the world where landlords are often richer than tenants. In addition, we also found that tenants are significantly younger, have smaller family size and lower dependency ratio compared to landlords. We also tested for significant correlation between contract choice

TABLE 8-2 Variables Used in the Models with Summary Statistics

		Tenants		*Landlords*	
Variables	*Description*	*Mean*	*SD*	*Mean*	*SD*
Dependent variable	Ordered responses for contract choice Y_j^n (j= 1, 2,3 . . . 6) and n = t or l				
Age	Age of household head in years	44	11.77	49	13.99
Sex	Sex of household head: 1 = male; 0 = female			0.82	0.38
Femaleworkf	Number of female work force per household	1.68	0.95	2.0	1.1
Maleworkf	Number of male work force per household	2.12	1.44	1.94	1.30
Cwratio	Consumer-worker ratio	0.89	0.56	0.92	0.74
Plotdist	Plot distance in meters	959	1317	394	1520
Farm size	Average farm size, ha	0.63	0.52	0.58	0.42
Pcfarmsz	Household's total farm size (sq. meters) divided by total family size	932	722	833	552
PA	5 dummy variables for 6 peasant associations				
Tlu	Tropical Livestock Unit excluding oxen units	1.61	1.1	1.59	1.04
Oxtlu	Oxen Tropical Livestock Unit	0.52	0.71	0.65	0.78
Durdum2	= 1 if contract duration ≥ 12 months but < 36 months ; = 0 if not	0.05	0.21	0.02	0.15
Durdum3	= 1 if contract duration ≥ 36 months ; = 0 if not	0.13	0.34	0.14	0.34
Plotsucero	Plot exposure to erosion: 1 = high, 2 = medium, 3 = less, 4 = no				
Soildpth	2 dummy variables for 3 soil depth categories: 1= shallow, 2= medium; 3 = deep				
Reputation	If reputation is main criteria for partner selection: 1 = yes; 0 = no	0.14	0.31	0.10	0.28
Trust	If trust is main criteria for partner selection: 1 = yes; 0 = no	0.24	0.43	0.19	0.39
Accaltpart	Access to alternative partners: 1 = yes; 0 = no	0.40	0.48	0.35	0.48
Acccredit	= 1 if household has access to credit (applied and obtained credit); 0 if not	0.17	0.33	0.13	0.34
Iftenusec1	If you want, can you rent out your land on cash basis without PA approval? 1 = yes; 0 = no			0.49	0.01

and categorical variables using χ^2 test statistics (see the test results in Table 8-4). We see that access to credit, access to alternative partners, and reputation were significantly correlated with tenants' contract choice. However, credit access was not significantly correlated with contract choice for landlords.

TABLE 8-3 Mean comparison tests across major wealth indicator variables by household type

Continuous variables	*Tenant Mean(SD)*	*Landlord Mean(SD)*	*Mean Diff. (t-value)*
Income from crop and livestock per family size	666.1(512)	532.6(329)	133.5 *** (t = 6.78)
Per capita farm size (Sq. meters) (PCFARMSZ)	932.02(722)	832.8(552)	99.1 *** (t = 3.37)
Family size	7.06(2.47)	7.24(2.23)	–0.18* (t = –1.65)
Consumer worker ratio (CWRATIO)	0.89(0.56)	0.92(0.74)	–0.03 (t = –0.92)
Female workforce (FEMALEWRKF)	1.68(0.94)	2.01(1.1)	–0.33*** (t = –6.93)
Male workforce (MALEWRKF)	2.12(1.44)	1.94(1.29)	0.18*** (t = 2.88)
Livestock ownership (TLU) excluding oxen	1.61(1.03)	1.59(1.04)	0.019 (t = 0.42)
Age of household head	43.9(11)	48.4(14)	–4.5*** (t = –7.66)

Note: ***, **, * significance at 1, 5 and 10 percent level, respectively.

TABLE 8-4 Tests for significant correlation between contract choice and categorical variables

	Variations across contracts by household type	
Discrete variables	*Tenant (Overall χ^2-test)*	*Landlord (Overall χ^2-test)*
Access to credit (ACCCREDIT)	32.54***	6.44
Access to alternative partner (ACCALPART)	42.14***	28.10***
Trust	9.96*	16.3***
Reputation	29.69***	9.10
Being male headed household (SEX2)	12.12*	33.69***
Freedom to rent out plots without PA approval (IFTENSEC1)	7.51	11.43*

Note: ***, **, * significance at 1, 5 and 10 percent level, respectively.

Results and Discussion

We present the results of our analysis of determinants of land rental contract choice from ordered probit models with household random intercepts (using the GLLAMM procedure in STATA) in Table 8-5 with models for tenants (M_1 and M_3) and landlord (M_2 and M_4)with and without the fixed-rent contracts. Robust standard errors for clustered data are reported in all the models. The Huber/White/Sandwich estimator of the covariance matrix of parameter estimates is used. We present the results with a focus on our main testable hypotheses in chronological order.

H1. Bargaining Power Hypothesis

If this hypothesis is correct, landlords and tenants with more bargaining power should obtain better contracts than landlords and tenants with lower bargaining power. If bargaining power and wealth are positively correlated (our assumption), more wealthy landlords and tenants should achieve more favo-

TABLE 8-5 Determinants of land rental (cost sharing) contract choices, southern Ethiopia

	With Fixed Rent Contract		*Without Fixed Rent Contract*	
	Tenant ($M_{1)}$	*Landlord ($M_{2)}$*	*Tenant ($M_{3)}$*	*Landlord ($M_{4)}$*
	b/(se)	*b/(se)*	*b/(se)*	*b/(se)*
Fixed part				
Age	–0.046*	0.102***	–0.075**	0.019**
	(0.025)	(0.030)	(0.032)	(0.008)
Femalewrkf	–0.347	0.665	–1.185***	–0.275*
	(0.333)	(0.492)	(0.408)	(0.150)
Malewrkf	0.591***	1.085**	1.469***	0.052
	(0.177)	(0.431)	(0.377)	(0.131)
Cwratio	–1.689***	2.716***	–0.564	0.846***
	(0.351)	(0.589)	(0.619)	(0.260)
Plotdista	0.000***	0.000	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Pcfarmsz	0.002***	0.003***	0.000*	0.000
	(0.000)	(0.001)	(0.000)	(0.000)
PA2	4.428***	3.662***	3.451***	–1.325***
	(0.630)	(0.939)	(0.553)	(0.369)
PA3	–0.290	–0.026	–2.556***	–2.765***
	(0.421)	(1.143)	(0.708)	(0.414)
PA4	–1.318**	–0.330	–0.790	–0.401
	(0.559)	(1.740)	(0.665)	(0.471)
PA5	–1.109	–4.476***	0.510	–0.913
	(0.863)	(1.262)	(1.436)	(0.632)

(Continued)

TABLE 8-5 *(Continued)*

	With Fixed Rent Contract		*Without Fixed Rent Contract*	
	Tenant ($M_{1)}$	*Landlord ($M_{2)}$*	*Tenant ($M_{3)}$*	*Landlord ($M_{4)}$*
	b/(se)	*b/(se)*	*b/(se)*	*b/(se)*
PA6	0.755	1.994***	1.160**	0.233
	(0.796)	(0.763)	(0.525)	(0.484)
Tlu	–0.150*	0.616***	–0.011	0.185
	(0.084)	(0.217)	(0.095)	(0.123)
Oxtlu	–0.127	–0.035	–0.267**	0.113
	(0.133)	(0.167)	(0.111)	(0.131)
Durdum2	3.351***	–1.583	2.438**	0.052
	(0.560)	(1.480)	(1.010)	(0.388)
Durdum3	1.673**	8.163***	–0.928***	0.252
	(0.703)	(2.692)	(0.302)	(0.255)
Plotsucero2	–1.279**	0.358	0.169	–0.658*
	(0.606)	(0.755)	(0.419)	(0.376)
Plotsucero3	–2.405***	–2.237**	–2.015**	–1.567***
	(0.522)	(0.932)	(0.941)	(0.395)
Plotsucero4	1.724***	5.055***	–0.509	–1.612***
	(0.551)	(1.299)	(0.595)	(0.512)
Soildpth2	0.994***	1.180***	0.966**	0.700***
	(0.353)	(0.397)	(0.482)	(0.219)
Soildpth3	3.314***	2.549***	5.973***	1.672***
	(1.050)	(0.695)	(1.496)	(0.454)
Reputation	–1.101	–0.018	–2.301*	1.387*
	(0.860)	(2.285)	(1.259)	(0.731)
Trust	–0.063	–5.136***	0.497	0.928**
	(0.592)	(1.483)	(0.608)	(0.455)
Accaltpart	0.770	1.935*	–0.052	–0.373
	(0.906)	(1.151)	(0.417)	(0.418)
Acccredit	0.732***	–0.769	–1.124*	0.031
	(0.219)	(0.827)	(0.600)	(0.430)
Sex2		–1.277		0.480*
		(0.868)		(0.285)
Iftensec1		–4.400***		–0.302
		(1.131)		(0.246)
Random part				
Variance(cov)				
HH level	14.22(6.1)	9.21(2.69)	13.90(2.03)	8.79(2.56)
N (level 1,plots)	333	254	303	231
N (level 2, HHID)	62	70	62	70
Log likelihood	–209.26	–157.53	–110.79	–125.25

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors for household (HH) level clustered data are reported. The variance of HH level RE is 14.22 with SE 6.1 for M1 and so on.

rable contracts. However, we see from Table 8-5 that there is little support for this hypothesis. Perhaps this is because landlords in the area tend to be poorer than tenants and are often female-headed households. This may imply that their bargaining power is relatively weak. Also, we could not find any strong evidence of contract choices depending on tenants' bargaining power.

H2. Resource-Pooling Hypothesis

This is the altruistic or more equal sharing of benefits model. The results in Table 8-5 provide some support for the resource-pooling hypothesis on the landlord side (M_2 and M_4) because tenants covered more of the input costs for landlords with high dependency ratios (cw-ratio was significant and positive at 1% level in both models). On the tenant side (M_1 and M_3) we also found support for the resource-pooling hypothesis since tenants with more male work force (significant at 1% level in both models) and larger farm size (significant at 1 and 10% levels) were correlated with tenants covering more of the input costs. This may also be in line with landlords screening and selecting tenants with more resources.

H3. Land Quality-Adjusted Contracts Hypothesis

According to this hypothesis, tenants who rent in good quality land cover more of the input costs. The results for soil depth were highly significant in both models for landlords as well as for tenants (significant at 1% levels for both soil depth variables in all but one model, where the level of significance was at 5% level) and with positive signs related to the deeper and more fertile soils. This is very strong support for the hypothesis that contracts are adjusted for land quality such that tenants have to pay more of the inputs when they rent in better quality land. The results for the other land quality-related variable, plot exposure to erosion, were more mixed.

H4. Duration-Adjusted Contracts Hypothesis

The results in Table 8-5 revealed that tenants were having contracts that required them to cover significantly (at 1 and 5% levels) more of the input costs when contracts were for more than one year and up to three years (durdum2), but the results were mixed when the contracts were for more than three years (durdum3), as compared to annual contracts. It appears that fixed-rent contracts were associated with contracts longer than three years as the durdum3 variable switched from positive and significant (at 5% level) to negative and significant (at 1% level) when the fixed rent contracts were taken out.

H5. Distress Rental Hypothesis

The analytical results in Table 8-5 provide little evidence of this hypothesis as access to credit was insignificant in both landlord models.

H6. Spatial Variation Hypothesis

Consistent with this hypothesis arguing that land rental markets are fragmented, we found that several peasant association (PA) dummy variables were significant in the alternative specification of tenant and landlord models in Table 8-5 and three of the PA dummies were significant in the landlord model. These results, however, were not robust when we compared models with and without fixed-rent contracts, pointing at spatial discrepancies in the role of fixed-rent contracts. These are signs of poor integration of land rental markets but this could possibly also be explained by other unobserved village characteristics. As a further visualization of the variation of contracts across PAs, we present the distribution of contracts for each of the six PAs in Table 8-6.

The results from the overall χ^2 tests showed significant contract variations within PAs vs. across PAs, except in PA5 (due to few observations there). This result also supports our hypothesis (i.e., land rental markets in the study area are fragmented).

H7. Reputation and Trust Hypothesis

We found that young tenants were significantly more likely to have contracts where they had to cover more of the input costs (significant at 10 and 5%

TABLE 8-6 Distribution of contracts across the six peasant associations

Contract choices	*Peasant Associations (PAs)*						*Total*
	PA1	*PA2*	*PA3*	*PA4*	*PA5*	*PA6*	
Y1	0	0	12	6	0	0	18
Y2	14	19	11	3	0	6	53
Y3	126	118	109	35	14	28	430
Y4	91	58	44	11	6	15	225
Y5	0	24	3	8	0	12	47
Y6	19	60	19	8	0	6	112
Total	250	279	198	71	20	67	885
$\chi^2_{(5)}$	49.46***	49.03***	32.44***	24.31***	7.42	25.94***	

Note: As can be seen from Table 6, except in PA5 land rental contracts vary with in and across Peasant Associations at 1 percent level of significance. Plot level observations are reported for each contract type across PAs.

levels). So if young age is a sign of limited reputation, and trust has to be earned over time, this result may be in support of this hypothesis. We also had information from landlords and tenants on whether they paid attention to reputation and/or trust when they selected their contract partners. However, when we tried to use this information in the analysis we found no robust evidence in support of the hypothesis. Some of the variables included in the analysis require more cautious interpretation. These include the age of head of household in the landlord model, access to alternative partners (accaltpart), and a variable capturing the landlords' perceived freedom to rent out land (iftensec1) on cash basis without informing the local administration. Only the first of these three was significant and consistent (at 1 and 5% levels). Old age of landlords was associated with tenants covering more of the input costs. This could be in line with our resource-pooling hypothesis as old age may be a sign of lower capacity to cover cash input costs. Therefore the cost may be covered by the (younger) tenants who also may be relatives. It could, however, also be in line with the bargaining power hypothesis if old age is associated with more bargaining power.

Conclusions

In this chapter we have examined diverse forms of input cost-sharing land rental contracts in the southern highlands of Ethiopia and alternative hypotheses that could possibly explain this contract diversity. First, we found that tenants were richer than landlords in terms of income per capita, the endowment of male labour force, and land per capita, while landlords had significantly larger family size and female work force and with an older head of household. We tested the alternative hypotheses regarding the variations in land rental contracts after controlling for household level unobserved heterogeneity using household random intercept models using farm plot panel data with multiple plots per household covering two rainy seasons.

The analysis gave little support to the bargaining power hypothesis on the landlord side. On the other hand, more wealthy tenants were found to be associated with contracts in which they covered more of the cash inputs, in line with the resource-pooling hypothesis. This may also imply that more resource-poor tenants are rationed out of the market like that found by Holden and Ghebru (2006) and Chapter 4 in northern Ethiopia. Landlord households with higher dependency ratio and with older household head also had tenants to cover more of the cash input costs, also in line with the resource-pooling hypothesis.

Furthermore, we found evidence on land quality adjustment in contracts as tenants covered significantly more of the cash inputs if they rented land of better land quality in terms of deeper soils. We also found some evidence of tenants covering more inputs when contracts were for more than one year.

There was also significant spatial variation in the composition of contracts indicating possibly the fragmented nature and poor geographical integration of land rental markets.

We may therefore conclude that the diversity of land rental contracts largely reflects rational adjustments in the environment of rural economies characterized by market imperfections in land, labor, credit and insurance markets, variation in household resource endowments, and land quality. This implies that in general a variety of land rental contracts observed in the southern Highlands of Ethiopia are induced to facilitate efficient use and allocation of land and nonland resources. Furthermore, they are found to be conducive to equity. Thus, land tenure policies that favor tenure security and longer-term contracts should be encouraged, as they are likely to reduce the transaction costs and enhance the efficiency of the land rental market. Allowing more long-term land rental contracts may facilitate a more dynamic off-farm sector as an alternative source of employment and income.

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Paper II

LIVESTOCK RENTAL CONTRACTS, INCENTIVES AND IMPACT ON POVERTY: PANEL DATA EVIDENCE FROM ETHIOPIA[1]

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Abstract

Using household panel data from southern Ethiopia, this study examines the determinants of livestock rental contract choices and their impact on poverty. We found that livestock rental contracts help parties overcome capital constraints and the lumpiness of livestock investments in an area with high production risk, capital constraints and imperfect inter-temporal markets. More credit constrained livestock tenants were more likely to accept a less favourable contract. After controlling for endogeneity of treatments in treatment effect models, the welfare effects of livestock rental contracts are positive for tenants. The findings from this study show that rental contracts for fragile and mobile livestock, despite potential moral hazard problems, can emerge in poor rural economies and contribute to factor adjustments and welfare enhancement.

JEL Code: L14

Key words*: *Ethiopia, livestock share contracts, incentives, household panel data, sample selection, instrumental variable regressions and treatment effects

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[1]We would like to thank Ragnar Øygard, Gerald Shively, Sverre Grepperud, Frank Asche, and departmental seminar participants for their valuable comments. The paper also benefited from participants at the Nordic Conference in Development Economics, Stockholm University, Sweden. June 16-17, 2008. All remaining errors are our own.

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1. Introduction

There is a vast empirical literature on land rental contract choices in agriculture (Allen and Lueck, 2003; Holden *et al*., 2009; Otsuka, 2007). However, studies on livestock rental contracts are not common in economic literature. In Ethiopia, both land and livestock share contracts co-exist (Aspen, 1993). These institutions are important in allocating land and non land resources. For example, oxen sharing contract (*mekenajo*) is very common among households owning only one ox where two oxen are needed for ploughing, such as in the Ethiopian highlands.

In contrast to land, animals are mobile and fragile and thus represent a potential moral hazard problem when used for rental purposes (Binswanger and Rosenzweig, 1986). For example, a livestock tenant can eat a leased animal and pretend it died or was stolen. In this paper, we answer the following questions. First, if livestock sharing is prone to moral hazard problems, such as those described by Binswanger and Rosenzweig (1986), how are the moral hazard problems overcome, since we can see diverse forms of livestock contracts even with absent livestock lords[2] in our study areas? Theoretically, as the distance between contracting partners increases, it is easier for the livestock tenant to cheat or pretend the leased animal has died. Second, what factors determine the participation and the choice of livestock share contracts? Third, to what extent do livestock share contracts help poor households to overcome liquidity constraints and reduce poverty? These questions are attempted answered using a unique household panel data, covering the characteristics of matched partners. Knowing the characteristics of matched partners helps to control for the problem of endogenous matching in contract choices (Ackerberg and Botticini, 2002).

[2] See definitions below.

In the land rental market, there is an established naming of the partners tenant and landlord. We have chosen to adopt this terminology also for livestock rental contracts in southern Ethiopia. A livestock tenant is a person or household that rents animals from another person but may also have his/her own animals in addition to the rented in animal(s). A livestock lord is a person or household who rents out animals to his/her partner but may still keep his/her own livestock. A livestock share contract is then defined as a contract in which a livestock tenant and a livestock lord share cash from livestock sales at the end of the contract period or products such as offspring, milk, butter, manure or traction power during a specified contract period. Parties either share the initial purchase cost of the animal (livestock share owners) or one of the parties (the livestock lord) provides the animal to be contracted. A livestock tenant has the responsibility of keeping the animal covering all the variable costs such as labour, fodder, watering and medicine. Contracts also exist in which parties alternate on covering costs and receiving livestock products.

Although the literature on land rental contracts is abundant, we have not seen empirical studies examining livestock rental[3] contracts in agrarian economies. In order to provide a clear understanding of livestock rental contracts, we followed an approach similar to that for land rental contracts. Specifically, the analytical approach chosen builds upon the literature on land rental contract choices (Allen and Lueck, 2003; Hayami and Otsuka, 1993; Singh, 1989; Holden *et al*., 2009; Tadesse *et al*., 2009). However, it is extended to accommodate the specificity of livestock share contracts and context of the study area. Both parametric and non-parametric estimation methods were used to answer the research questions.

The finding of widespread livestock rental contracts in southern Ethiopia refutes the claim that moral hazard makes livestock contracts impossible and implies that there are ways to get

[3] We use the terms share and rental contracts interchangeably in this paper.

around these moral hazard problems or these moral hazard problems are less severe than other constraints that the contract partners face. Livestock rental contracts help households overcome capital constraints and the lumpiness of livestock investments, even in an environment of high production risk and weak formal institutions for contract enforcement. Livestock renting out also facilitates capital accumulation in an agricultural economy where land accumulation is impossible. Furthermore, credit market imperfections and poverty in basic assets are associated with livestock tenants to accept less favorable contracts. After controlling for endogeneity of treatments in treatment effect models, the welfare effects of livestock rental contracts are positive for tenants. Unlike the results in land rental markets in Ethiopia where we have relatively wealthier tenants and poorer landlords (Ghebru and Holden, 2009; Tadesse *et al*., 2009), the livestock rental market is dominated by poor livestock tenants and wealthier livestock lords.

2. Literature review

A recurring issue in development economics is whether poor rural households are caught in various poverty traps (Dercon, 1998). This may imply that the poor cannot afford to buy livestock, a lumpy asset, even when this venture is potentially more profitable than alternative activities. Imperfections in credit and insurance markets limit the ability of the poor to undertake more profitable ventures. We postulate that livestock share contracts can be regarded as a response to such imperfections. Rural financial institutions in Ethiopia are mostly designed with the sole purpose of providing credit for fertilizer and seeds. There are few examples of livestock credit programs in Ethiopia. One exception is the provision of small ruminants and fattening animals on credit by local or international NGOs.

Empirical studies in low income countries suggest that formal risk coping strategies are often costly (Morduch, 1995). As a result, households use various forms of informal risk sharing strategies (McPeak, 2006). Livestock is an important source of liquidity in rural Ethiopia

(Dercon, 1998). Livestock may therefore be used as a buffer stock, allowing a household to smooth consumption when harvests fail. Holden and Shiferaw (2004) found that using livestock as a buffer stock is costly for households as they typically have to sell livestock at very low prices to buy food at very high prices due to covariate risk.

Some studies indicate that in areas where production is uncertain and insurance markets are absent, sharecropping contracts are motivated by the need to share risks (Ackerberg and Botticini, 2002; Otsuka, 2007; McPeak, 2006). Although the risk sharing and transaction cost theories are central to the choice of land rental contracts, there is no convergence among economists towards either of the theories. For instance, Allen and Lueck (2003) found little support for the hypothesis that risk-sharing motivates sharecropping contracts in North America.

Bogale and Korf (2007) found that resource sharing helps poor households enhance their asset base and promote cooperation. However, a study by McPeak (2006) on the role of traditional livestock transfer between herders in northern Kenya suggests that the system provides insufficient support to herders confronting the risk of asset loss and trying to climb out of poverty. This is because the effectiveness of such informal risk coping strategies often fails in case of high covariate risks.

3. The livestock rental market in southern Ethiopia

This section presents the three basic forms of livestock rental contracts in the study area and the cost and output sharing rules among contracting parties for each contract. The three contracts and the sharing rules are summarized in Tables 1 and 2, respectively. About 54 percent of the sample households (N=556) participated in livestock share contracts either as livestock tenants, livestock lords, or livestock shareowners.

Type I contract: single owner-tenancy contract

According to the *Wolaita* ethnic group, one of our study zones, the local name of this type I contract is *Harra*[4]. Under a *Harra* contract, a livestock tenant may provide the animal's owner (the livestock lord) with 10 kg of butter at the first lactation. Thereafter, the tenant has the exclusive right to use the butter, milk, cheese and manure, but has no right to the offspring or proceeds when the animal is sold at the end of the contract period. From the perspective of very poor households, the advantage of *Harra* is that it requires no upfront investment cost and the risk of animal death is carried by the livestock lord. Variable costs, such as labour and land resources, to keep and feed the animal are covered by the livestock tenant. The "rent" accruing to the livestock lord is the live offspring, while he or she recovers the capital investment by selling the animal at the end of the contract (Table 2). This contract also serves as an alternative form of capital accumulation for livestock lords who have relatively better livestock wealth.

Unlike the case of land ownership, there is no restriction on livestock ownership in Ethiopia. This also allows livestock lords to build their livestock capital either by renting out animals to several poor livestock tenants having more children. In many rural areas in Ethiopia, children at the age of six and above actively participate in livestock keeping. By doing so, the poor livestock tenant will get access to milk, butter and cheese for his/her children[5], products that otherwise could have been difficult to get.

[4] This form of rental contract is common in *Wolaita,* a very densely populated area in southern Ethiopia, where severely cash constrained livestock tenants are matched with a relatively rich livestock lord. We found cases where many tenants contracted with a single livestock lord who owns hundreds of animals. In this case, the rental price (cost sharing rule) is often determined by the rich livestock lord. We learnt that in this area a livestock lord who has reached an ownership of over 800 animals (where the rented out animals constitute the largest proportion of this figure), normally organizes a party around his home garden for prestige and as a sort of advertisement.

[5] The livestock tenant could be a widow having many children.

Type II contract: share ownership-tenancy contract

In this contract, both parties share the initial investment costs equally, while benefits such as butter, milk, manure, hides and skin, and traction service (75% of the cases) go to the tenant. Variable costs such as labour, feed, medicine and water[6] are covered by the livestock tenant. Risk, live offspring, and cash from the sale of animals are shared equally and the partners have the right to terminate the contract at any time (Table 2). Livestock lords who reside in cities or those with off-farm income often participate in this type of contracts from the supply side of the market. This enables them to accumulate capital that could be used in case of unemployment in urban centres/or as a source of saving.

Type III contract: shared ownership and rotational contract

In this type of contract, partners equally share initial investment costs and variable livestock costs, such as labour and grazing land and products like manure, milk and butter (Table 2). Sharing is accomplished by rotating the animal among the partners in intervals of a specified duration. This helps to share variable costs and get manure (for *enset*, coffee and other crops) in turns. For example, a milking cow can stay in one of the partners' home for the first three months and stay with the other partner the following three months. There is no clear livestock lord-tenant relationship in this contract; unlike in type I and II contracts, because the parties alternate in providing labour for livestock keeping. Each party has the right to terminate the contract in the event of disagreement or when the end of a contract period is reached.

A fourth type of animal sharing contract that we have not included is oxen sharing contracts on daily basis. This arrangement requires an exchange/sharing of ox on daily basis among

[6] In Ethiopia, fetching water from the river or moving animals to the river implies travelling long distances. Modern livestock husbandry exists only near or in cities and towns like Addis Ababa, Dire Dawa, Awassa, Nazareth and Bahir Dar.

households that have one ox because they need a pair of oxen for ploughing. Only long term oxen sharing contracts are considered in our analysis.

Both in the highland and lowland areas of Ethiopia, livestock are vulnerable to diseases and natural disasters. Hence, contracting partners are expected to face risks when they enter into livestock share contracts. The risk of livestock loss due to drought or disease is shared equally ($\theta = 0.50$) in type II and III contracts, but not in type I contracts (Table 2, sub-column 3). Other risks, such as over-utilization of oxen power, theft and poor management of animals, can be easily verified by parties in small villages.

4. Theoretical framework

The risk sharing and the transaction cost theories are central to the literature in land rental contract choices (Allen and Lueck, 2003; Ackeberg and Botticini, 2002; Otsuka *et al*., 1992; Hayami, and Otsuka, 1993; Knoeber, 1999; Kliebenstein and Lawrence, 1995; Johnson and Foster, 1994). Allen and Lueck (2003) in their study in North America provide little support for risk sharing as an important determinant of land rental contract choices. The authors argue that factors other than risk sharing are more important in influencing the choice of land rental contracts. However, Ackeberg and Botticini (2002) found a role of risk in shaping the choice of land rental contract choices in their study in Italy. Ackeberg and Botticini (2002) study using wealth as proxy for risk aversion found that wealthier tenants are more likely to participate in fixed rent contracts. Similarly, Tikabo and Holden (2004) found that poor landlords and wealthy tenants were attracted to each other to form fixed rent contracts. However, liquidity constraints may be as important explanations for this as risk and risk aversion.

Although the literature in land rental contracts is abundant, we have not seen empirical studies examining livestock rental contract choices in agrarian economies. The problem of moral hazard such as described by Binswanger and Rosenzweig (1986) may be one potential reason for the lower popularity of livestock rental contracts. Another may be that sales markets for livestock are better developed than that for land where legal restrictions often are imposed, like in Ethiopia. Where livestock rental contracts exist, they may contain some level of moral hazard in relation to output sharing and in terms of utilization of oxen traction service. However, with co-ownership or the existence of strong traditional monitoring systems such as unannounced visits by the livestock lord, the need to show evidence such as skin or the hides of the deceased animal, moral hazard problems may be overcome in livestock share contracts.

In land rental contracts, tenants often face problems related to the quality of land to be contracted (Allen and Lueck,2003;Otsuka,2007).This is because landlords may systematically rent out overused land to the tenant. This may to a less extent be the case for livestock rental contracts. A livestock tenant has more information related to the animal (s) contracted. A good quality animal can be judged by its age, pedigree and traction service efficiency, among other criteria. As a result, there is little room for the livestock lord of type I contract to cheat his/her tenant.

Similarly, landlords face output under-reporting problems in land tenancy contracts (Otsuka, 2007). In order to avoid this problem, landlords use various methods such as attendance in person during harvesting time, specification of the type of crop to be planted (e.g. *teff* rather than maize) and close supervision. However, under-reporting of livestock products is not easy. For instance, an offspring from a milking cow contract cannot be hidden (under-reported). The same may be true if the original animal contracted is sold in an open market. Hence, livestock contracts may develop in environments that control or do not encourage bad

behaviour. For instance, products such as milk and butter often go to the tenant since these are harder to monitor and require frequent collection by the owner if they were to be shared (Tables 1 and 2). This may be one of the methods reducing transaction costs and preventing output underreporting in livestock share contracts. Inputs and outputs that require frequent action are typically handled by the tenants while less frequent outputs are typically controlled by the livestock lord.

Land rental contract choices are also influenced by the distance between contracting parties. For instance, fixed-rent land rental contracts are likely to be chosen when the landlord is absent or has less farming experience (Sharma and Dreze, 1996; Otsuka, 2007). We also observed livestock tenants contracting with a distant livestock lord. It is an empirical question however that whether geographic distances between the livestock tenant and livestock lord influences the choice of contract type. Other factors being constant, we hypothesize that, as the distance between contracting parties increases, the tenant has more freedom to use the contracted animal and even pretend the animal has died or been stolen[7].

We argue that as long as the livestock lord has methods to control the problem of moral hazard, contract type I is expected to be less preferred (but better than no contract) for livestock tenants than type II contracts, but is the only contract available when they have no capital to put into the purchase of animals. They then have to approach rich livestock lords for the chance of getting livestock. A good livestock tenant must have sufficient labour for

[7] This study revealed that livestock lords monitor the performance of their animals by making unannounced visits on their way to social gatherings and community meetings. In case anything happens (e.g. death of animals being contracted) the livestock tenant has to show evidence, such as the skin or the hide of the dead animal. This is one way to minimize the problem of moral hazard in the livestock rental market. It is not easy for a tenant who has violated a contract to find another livestock lord to provide an animal rental contract. Livestock lords use rationing to control moral hazard and to ensure that livestock tenants do not violate the contract.

keeping animals, land for fodder production and be financially constrained such that he or she would be willing to accept a less favourable contract, such as a type I (*Harra*) contract.

4.1. A model of livestock rental contract choices

Following the literature in land rental contract choices (Allen and Lueck, 2003; Ackeberg and Botticini, 2002; Tadesse *et al*., 2009), there exists a general relation where the actual observed livestock share contract choices, C_{obs}^{n} are determined by characteristics of the livestock tenant $\left(Z^{lt}\right)$, the livestock lord $\left(Z^{ll}\right)$, village level factors $\left(Z^{v}\right)$, asset endowments (Z^{E}), rental prices $\left(Z^{P}\right)$, market conditions $\left(Z^{M}\right)$, and access to credit $\left(Z^{CR}\right)$.

$$C_{obs}^{n} = C_{obs}^{n}\left(Z^{lt}, Z^{ll}, Z^{E}, Z^{v}, Z^{P}, Z^{M}, Z^{CR}\right)$$

where $n \in \{lt, ll\}$ and C_{obs}^{n} denotes the actual observed livestock rental contracts of livestock lords (when $n = ll$) and livestock tenants (when $n = lt$).

Let us describe the contracts in Table 2 as alternative investment choices for the livestock lords and tenants. The available livestock investment choices are mainly influenced by parties' initial asset levels such as animals, cash, labour and land and these in turn affect their bargaining power. Let outputs and inputs (Table 2) are represented by vectors as:

Output vector, $\mathbf{q^a}$ **Input vector, $\mathbf{x^a}$**

$\mathbf{q^a} = \{q^1, q^2, q^3, q^4, q^5\}$ and $\mathbf{X^a} = \{X^1, X^2, X^3, X^4\}$

Where $\mathbf{a} \in \{1,2,3,4,5\}$ in the output vector represent offspring, milk and butter, manure, draught power and cash when the original animal is finally sold, respectively. Similarly, superscripts in the input vector denote purchase cost, labour, fodder and veterinary service, respectively.

A livestock lord has more power regarding contract formation and termination in type I contract. However, both parties have equal power in type II contract.

$$\mathbf{T^k} = \left\{T^1, T^2\right\}$$

Where $\kappa \in \{1,2\}$ denotes contract termination power that gives the livestock lord a full right of contract termination in T^1. Risk sharing also varies across contracts. This is captured by the sharing rules in the contract, another element of the contract characteristics.

Using the vector of inputs and outputs specified above and households' bargaining powers and risk sharing motives, we can now specify the expected outcome of type I $\left(C^I\right)$ and type II $\left(C^{II}\right)$ contracts (ignoring type III contract because of few observations) for livestock lords, Y^{ll}, and livestock tenants, Y^{lt}. First, we specify the expected outcome from type I $\left(C^I\right)$ contract as:

$$\begin{aligned} Y^{ll}\left(C^I\right) &= \rho^{ll} \sum_{t=1}^{N} \left(P_{q^1}\theta^{\lambda} q^1 + P_{\bar{q}^2}\bar{q}^2 \right) + \varepsilon^{ll} T^1 - P_{x^1} X^1 \\ Y^{lt}\left(C^I\right) &= \sum_{t=1}^{N} \left(\underbrace{\theta^{\lambda}\left(P_{q^2}q^2 + P_{q^3}q^3 + P_{q^4}q^4\right)}_{\text{Tenant carries the risk}} - \varepsilon^{ll} T^1 - P_{x^2}X^2 - P_{x^3}X^3 - P_{x^4}X^4 \right) \left(\rho^{lt}\right)^N \end{aligned} \tag{1}$$

where $t = 1, 2, \ldots N$ denotes time periods of the contracts. The term $\varepsilon^{ll} T^1$ is the livestock lord's value of contract power and is added as a benefit in $Y^{ll}\left(C^I\right)$. A similar term is subtracted in $Y^{lt}\left(C^I\right)$ as the livestock tenant has no power in the type I $\left(C^I\right)$ contract and this represents an extra risk (animal tenure insecurity). The term, $\rho^n = \frac{1}{1+\delta^n}$ and δ^n are the discount factor and the foregone interest on capital as a result of investing in animal sharing, respectively, for livestock lord, when superscript $(n = ll)$ and tenants, when superscript $(n = lt)$. The risk

parameters, θ^{λ} and θ^{τ} (see equation 2 below) represents all outputs and price risks[8], respectively. We defined livestock production risks in relation to drought, disease and live animal price fluctuations, as an important factor determining the choice of contracts. The expression $P_{\bar{q}^2}\bar{q}^2$ in equation (1) indicates the fixed amount of butter that can be provided to the livestock lord.

Similarly, the livestock lords' and livestock tenants' expected incomes from type II $\left(C^{II}\right)$ contracts can be specified as:

$$
\begin{aligned}
Y^{ll}\left(C^{II}\right) &= \alpha\left(\rho^{ll}(P_{q^1}\theta^{\lambda}q^1+P_{q^5}\theta^{\tau}q^5)\text{-}P_{X^1}X^1\right) \\
Y^{lt}\left(C^{II}\right) &= (1\text{-}\alpha)\left(\rho^{lt}\right)^N\left[P_{q^1}\left(1\text{-}\theta^{\lambda}\right)q^1+P_{q^5}\left(1\text{-}\theta^{\tau}\right)q^5\right]\_(1\text{-}\alpha)P_{X^1}X^1 \\
&\quad +\left(1\text{-}\theta^{\lambda}\right)\sum_{t=1}^{N}\left[P_{q^2}q^2+P_{q^3}q^3+P_{q^4}q^4\text{-}P_{X^2}X^2\text{-}P_{X^3}X^3\text{-}P_{X^4}X^4\right]\left(\rho^{lt}\right)^N
\end{aligned}
\tag{2}
$$

Where α and $(1-\alpha)$ are livestock lords' and tenants' share[9] of benefits/costs, respectively. The first expression to the right of $Y^{lt}\left(C^{II}\right)$ in equation (2) is end return of offspring plus the return from the sale of the contracted animal, the second expression represents tenant's share of initial purchase cost, while the last expression denotes the discounted annual benefits and costs to tenants. Except for the initial investment cost, there is no variable cost for the livestock lord. Unlike the case in sharecropping contracts, benefits from the livestock contract may not be divisible (such as offspring) unless they are sold or the number increases.

[8] All outputs in output vector $\mathbf{q}^{\mathbf{a}}$ except q^5 (where q^5 is cash benefit when the contracted animal is finally sold). When contracts are motivated by off-season fattening programs, price of live animal risk is significant. Hence, we defined the risk from q^5 as live animal price risk, θ^{τ}.

[9] For simplicity, we consider benefit sharing at the end of the contract period. Otherwise, benefits may be shared both during and at the end of the contract period.

4.2. The livestock lord model

The livestock lord at first decides either to sell or rent out animals or rent in more land for fodder production. The high population density causes the average farm size to be very low (about 0.5 ha), and this makes it impossible to get more grazing land. In addition, labour is another limiting factor (especially for female-headed livestock lords) for keeping more animals on farm. Hence, the livestock lord may only have the option to either sell or rent out animals. Considering the lack of access to financial markets such as rural banks, livestock price instability and the need to use livestock as store of value or prestige, livestock lords with more animals often prefer to rent out their animals instead of investing in financial markets or other alternative forms of investment. Hence, a typical livestock lord who decides to enter into livestock rental contracts may have self-managed livestock $\left(L_o - L_r\right)$, i.e. net of rented out animals, where L_o and L_r denote currently owned and rented out livestock, respectively. The livestock lord is also expected to have the necessary inputs such as cash inputs that could be used for livestock purchase, X^1, labour input, X^2, a fixed plot of land for fodder production[10], X^3, and veterinary services, X^4 for the animals.

Now the livestock lords' discounted expected net income denoted as Y_{net}^{ll} from self-managed livestock and from the set of observed contracts in village V, denoted by $\left\{C_{obs}^{I,II}\right\}^V$, can be specified as in equation (3).

$$Y_{net}^{ll} = \rho^{ll} \sum_{t=1}^{N} \theta q^{ll} \left[\left(L_o - L_r, \mathbf{X^a}\right)\right] - \sum_{t=1}^{N} \left(\mathbf{PX^a}\right) + \arg\max\left\{C_{obs}^{I,II}\right\}^v \tag{3}$$

where $\mathbf{X^a}$ and $\mathbf{P}$ denotes the vector of inputs and prices, respectively, for the four inputs explained above, i.e. $\mathbf{a} \in \{1,2,3,4\}$. The first and second expressions to the right of equation (3) are the sum of discounted expected income and costs, respectively, from self-managed

[10] Same notations are used for each input and output as explained in the input and output vectors earlier.

animals. Hence, the characteristics of the livestock lord (Z^{ll}), his or her partner household characteristics i.e. the livestock tenant (Z^{lt}), asset endowments (Z^{E}), village level factors (Z^{v}), rental prices $\left(Z^{P}\right)$, market conditions $\left(Z^{M}\right)$, access to credit $\left(Z^{CR}\right)$ and factors that go to the error term (Z^{e}), are expected to influence the contract choice of livestock lords. From the livestock lord perspective, the reduced form of the model can be specified as in equation (4).

$$\text{argmax}\begin{Bmatrix} C^{I} \\ C^{II} \end{Bmatrix}^{*} = f\left(Z^{lt}, Z^{ll}, Z^{v}, Z^{E}, Z^{p}, Z^{M}, Z^{CR}, Z^{e}\right) \tag{4}$$

Although our data set allows observing the characteristics of livestock rental partners for each contract, introducing these as Z^{lt} in equation (4), may still be endogenous to the model. Hence, we assume $Z^{lt} = Z^{lt}\left(Z^{V}\right)$.

4.3. The livestock tenant model

A livestock tenant may also have the option of entering into type I or type II contracts depending on his/her resource endowments and risk preferences. An extremely poor (risk averse) tenant always matches with a wealthy livestock lord through type 1 contract. The tenant then will have access to livestock products such as milk, butter, cheese and traction services with no possibility of getting productive assets such as offspring and cash when the original animal is finally sold. A potential livestock tenant in this case must have sufficient labour and land for fodder production. Tenants have to compete to get such an offer of contracts from the livestock lord. The demand for animals needs to exceed the supply to protect livestock lords from excessive moral hazard. Hence, a relatively wealthy livestock lord has an option of getting the best tenants.

Following similar notations as in equation (4), the livestock tenant's discounted expected net

income Y_{net}^{lt} from self-managed livestock and from the set of observed contracts $\left\{C_{obs}^{I,II}\right\}^{v}$ in village *v*, can be specified as:

$$Y_{net}^{lt} = \rho^{lt}\sum_{t=1}^{N}\theta q^{lt}\left[\left(L_o,\mathbf{X}^{\mathbf{a}}\right)\right]-\sum_{t=1}^{N}\left(\mathbf{PX}^{\mathbf{a}}\right)+\arg\max\left\{C_{obs}^{I,II}\right\}^{v} \tag{5}$$

where L_o is own animals. The vectors are as defined before and the first and the second expressions to the right of equation (5) are the sum of discounted income and costs, respectively, from self-managed animals (own endowments).Using the expression in equation (5), the livestock share contracts are expected to be a function of the characteristics of the livestock tenant (Z^{lt}) and his or her partner household characteristics i.e. the livestock lord (Z^{ll}), village level factors (Z^{v}), asset endowments (Z^{E}), rental prices $\left(Z^{P}\right)$, market conditions $\left(Z^{M}\right)$, access to credit $\left(Z^{CR}\right)$, and other factors (captured by the error term (Z^{e})). From the livestock tenant perspective, we can specify the reduced form of the estimable model as:

$$\operatorname{argmax}\begin{Bmatrix} C^{I} \\ C^{II} \end{Bmatrix}^{*} = f\left(Z^{lt},Z^{ll},Z^{v},Z^{E},Z^{p},Z^{M},Z^{CR},Z^{e}\right) \tag{6}$$

We also assume $Z^{ll}=Z^{ll}\left(Z^{v}\right)$, as explained earlier in equation (4), because of the endogeneity of partner characteristics, Z^{ll}, in the model. The theoretical framework explained in this section motivates the formulation of the following hypotheses and an empirical strategy outlined in section 5.2.

4.4. Hypotheses

The following hypotheses regarding access, participation and contract choice in the livestock rental market are tested in this study.

H1. **The rationale of the livestock rental market lies in the lumpiness of livestock and credit market imperfections**

Participation

H1a. Livestock rental contracts help cash-poor and credit constrained households to access animals for their farm production.

H1b. Access to and participation in livestock rental markets, improve the welfare of participating tenants.

Contract choice

H1c. These constraints cause households with some capital to form contracts with other households with the same need to overcome the investment cost in relation to buying indivisible animals. Market access and household wealth indicator variables are used to test these hypotheses.

H1d. A cash constrained livestock tenant (i.e. with limited or no access to the credit market) is more likely to accept a less favourable contract (type I) compared to a non-cash constrained livestock tenant. A dummy variable for access to credit[11] is used to test this hypothesis.

H2. **Livestock rental contracts help both livestock lords and tenants to balance factor ratios in order to take advantage of crop-livestock synergies**

Livestock rental contracts can be an alternative way of optimizing factor ratios when there are high transaction costs and imperfections in markets for other production factors (e.g. land, labour and manure). Livestock poor households who have more land for fodder production

[11] The best measure for credit access would be to see whether there is a source of credit available to farmers (Doss, 2006). Our data set allow us to distinguish households in different categories based on their credit need: 1) Those that applied for credit to the local peasant association and obtained credit 2) Those applied for credit but did not obtain credit and 3) Those who did not apply for credit due to various factors such as fear of repayments, high interest rate, and distance to local peasant association. Those who applied for credit and got it are considered as farmers with credit access. The second and third farmer categories are considered as those without credit access in our analysis.

are more likely to participate in livestock rental contracts. Tessema and Holden (2007) show that livestock-poor households have lower crop productivity, especially in the production of the perennial staple crop, *enset*. The hypothesis is tested by assessing how the contracts contribute to changing the balance between land and livestock endowments for participants.

H3. **Specific measures are needed for livestock lords to overcome the moral hazard problems of livestock rental contracts**

H3a. Tenants are chosen that will benefit from the contract and that cannot easily find alternative partners. Particularly poor tenants are chosen by absent livestock lords as they are more likely to be rationed and benefit more from continuing the contract.

H3b. Contracts are formulated such that inputs provided by and outputs given to the livestock lord require minimal (less frequent) monitoring when contracts cannot be monitored frequently.

H3c. Tenants are chosen that are easy to monitor (live in the neighbourhood).

H3d. Rationing is used such that many potential tenants have failed to become tenants.

H4. **Livestock-rich livestock lords use type I contracts to accumulate livestock wealth beyond what their own land endowment can carry**

This requires that their expected returns from such contracts are better than from the alternatives in the form of selling excess animals (returns to cash) and renting in land for fodder production for their animals. Hence type I contract is always preferred to type II contract by households with excess livestock. The balance of livestock and land endowments of livestock lords are used to partially test this hypothesis.

5. Data and methods

5.1. Data and study areas

Household panel data collected in two zones, *Wolaita* and *Sidama*, in the southern highlands of Ethiopia, including 278 and 318 households in 2005 and 2007,

respectively,were used. Balanced panel data were developed by dropping some of the households from the 2007 survey. Although most past studies in contract choices ignored collecting information from both contract partners, this study included information from both contract partners in each contract. This helps to control for unobserved household level heterogeneity between contracting parties. Under close supervision by the first author, graduates from agricultural colleges worked to collect detailed data on inputs and outputs, expenditures, credit use, and livestock sharing arrangements.

Livestock rental contracts are more common in one of the study areas, *Wolaita,* which is characterized by high population pressure, land fragmentation, poor market access and land degradation[12]. Access to input and output markets are better in the other study area, *Sidama* zone. Households in both areas engage in crop and livestock production activities primarily to meet their subsistence requirements. Farmers in the *Sidama* zone grow more cash crops, such as coffee and "*khat"* (a stimulant crop), while root crops such as sweet potato, taro, yam, *enset* (false banana) and cereal crops dominate in the *Wolaita* zone. Maize and *enset* are the major staple foods in both areas.

5.2. Econometric model specification and estimation issues

The fact that we have repeated household level observations allows use of panel data econometric methods (Baltagi, 1995; Hsiao, 1986; Wooldridge, 2002; 2005) to identify factors associated with participation, contract choices and their impact on poverty.The usual procedure in panel data methods is to choose between random and fixed effect estimation techniques using standard tests. In this paper, we have chosen a combination of methods (including instrumental variables least squares) that may enable to handle important econometric problems such as of sample selection and endogeneity for our sample. Hence, we

[12] Paper 4 deals with the determinants of adoption of structural soil conservation investment in *Wolaita* zone.

did not attempt to choose between fixed and random effect models for its appropriateness[13] to our data set rather we focus on methods that may enable to solve the above econometric problems. The sequence of analysis is described below.

In order to establish a sample with comparable observations for counterfactual analysis, propensity score matching was used first on households participating in each side of the livestock rental market. This allowed correction for possible selection bias related to observable characteristics of participants and non-participants. While ensuring that the balancing property was satisfied, the following econometric analyses were carried out for the sample that satisfied common support.

Sample selection models

To assess factors associated with participation and contract choice, participation selection models were run to also control for possible selection bias on unobservables related to participation in the livestock rental market for livestock lords and livestock tenants separately using maximum likelihood simultaneous selection models (Heckprob in STATA). Considering the data as cross-sectional, the model may be specified as:

$$y_1 = 1\left[\mathbf{Z_1\beta_1} + u_1 > 0\right] \qquad (7)$$

$$y_2 = 1\left[\mathbf{Z\delta_1} + v_1 > 0\right] \qquad (8)$$

where equation (8) is the sample selection equation and y_1 (contract choice) is observed only when $y_2 = 1$ i.e. for participant households, with the assumption that the vector $\mathbf{Z}$ is always observed. The error terms (u_1, v_1) are independent of $\mathbf{Z}$ with zero mean; $v_1 \sim Normal(0,1)$ and $E(u_1 \mid v_1) = \gamma_1 v_1$. For identification, the model requires at least one variable in $\mathbf{Z}$, i.e., a

[13] It is an empirical question however that which estimation techniques (random or fixed effect) is more relevant. As suggested by Wooldridge (2002), fixed effect estimation is more robust when only time-varying explanatory variables are of interest. However, if both time constant and time-varying factors are equally relevant, random effect models are more appropriate.

variable that determines selection, that is not also in $\mathbf{Z_1}$ (Heckman, 1979). The dependent variable in y_1 (main equation (Table 4)) takes value 1 for type II contract and 0 for type I contract with the condition that participation in the livestock rental market (selection equation) is satisfied. Similarly, the dependent variable in equation (8) takes value 1 for participants (as livestock lord and tenant separately) and 0 for non participants (Table 4, selection equation).

In the tenant models no significant selection bias was found while three potentially endogenous variables (access to credit, livestock excluding oxen (measured in tropical livestock units (TLU) and oxen (TLU)) were included[14] in the second stage, main equation (Table 4). Instrumental variable models were therefore estimated to handle the endogeneity problem. Instrumental variable least squares (2SLS), instrumental variable probit (IV probit), and instrumental variable panel data methods (G2SLS) were used to assess the robustness of the findings from these models (Table 5). Given that the dependent variable (contract choice) was binary, each of the models has its own strengths and weaknesses. STATA provides convenient tests for endogeneity and strengths of instruments with the standard IV, while IV probit may have some efficiency advantages, and IV panel methods help to control for household random effects (Table 5 lower part). Consistent results across the methods should therefore give more confidence in the results (Table 5).

Treatment effect models

Treatment effects models for the impact of participation in the livestock rental market on the welfare of livestock lords and tenants, separately were implemented as endogenous treatment models on the same sample of households that satisfied common support in the propensity

[14] Variable selection in either of the models in Table 4 is based on the hypotheses made earlier and the characteristics of households.

score matching[15].We defined propensity score (pscore) in our case as the probability of participating in livestock rental contracts (as tenant or livestock lord, considered here as treatment, T_{it}) as a function of their observed characteristics, x_{it} and written as:

$$pscore = P(x_{it}) = P(T_{it} = 1 | x_{it})$$

Where $t = 1,2$ denotes the time period for the ith individual. Let $T_{it} \in \{1, 0\}$ be an indicator variable that takes value 1 when households participate in livestock rental contracts as livestock lord or tenant (treated groups) and otherwise zero.

Let Y_{1it} denote the outcome variable (log of per capita consumption expenditure in our case) for participants (treatments) and Y_{0it} the potential outcome in the untreated state. For the ith individual, one wishes to know the treatment effect as $\Delta_{it} = Y_{1it} - Y_{0it}$. However, for each household, only Y_{1it} or Y_{0it} is observed at a specific time. In this paper, we used a regression[16] methods (TREATREG, the two-step consistent estimator option in STATA) to estimate the effect of treatments (participation in livestock rental contracts) on per capita consumption expenditure. This method is a much simpler approach compared to the switching regression methods to estimating endogenous (i.e. self-selected assignment) treatment effects. It simply requires introducing treatments as dummy variable in the outcome equation and estimates the models simultaneously. Hence, the models can be specified as:

[15] See Becker and Ichino (2002) for more details on propensity score matching with STATA commands. Propensity score matching constructs a statistical comparison group by matching observations on livestock rental participants to observations on non participants with similar values of $P(x)$. This method depends on two assumptions. The first assumption is conditional independence assumption, i.e. there is selections on observables and participations are independent of outcomes once we control observable characteristics, x. The second assumption is common support condition, i.e. individuals with the same x values have a positive probability of being both participants and non-participants.

[16] Matching methods could also be used

$$\mathbf{T}^* = \mathbf{Z\mu} + \boldsymbol{\varepsilon} \qquad (9) \qquad \text{(Treatment equation)}$$

$$\mathbf{Y}^* = \boldsymbol{\alpha} + \mathbf{X\beta} + \mathbf{T\delta} + \mathbf{e} \qquad (10) \qquad \text{(Linear outcome equation)}^{17}$$

where all variables (observable and unobservable are shown in vector forms). For simplicity, we ignore superscripts and subscripts denoting treatments and time. TREATREG command uses either the maximum likelihood or two-step methods to estimate the probit treatment equation (9) and a linear outcome equation, (10) simultaneously. For consistency of estimate of (δ), the error terms assume to follow bivariate normal distribution with zero mean and variance covariance matrix,

$$\Sigma_{\mathbf{eu}} = \begin{pmatrix} \sigma_{\mathbf{e}}^2 & \sigma_{\mathbf{ue}} \\ & \sigma_{\mathbf{u}}^2 \end{pmatrix}$$

Following these specifications, we estimated the models with and without the common support in the propensity score matching. We found consistent results across the two alternatives (Table 6).

5.3. Descriptive statistics

Participation, contract choice and wealth effects

About 54 percent of the sample households (N=556) participated in livestock rental contracts either as livestock tenant or livestock lord. In order to see wealth variations between tenants and livestock lords within and across contract types, we undertake mean comparison tests (Table 3). As can be seen from Table 3, livestock tenants who participate either in type I or type II contracts have significantly lower levels of assets such as own livestock holdings in TLU, ratio of own livestock holdings per own land and total *enset* stocks compared to livestock lords (Table 3, see t-values at column C and F). We also find a statistically

[17] In case of dummy dependent variable in the outcome equation, biprobit command (in STATA) can be used to test the impact of a treatment on the outcome equation. In paper 3, we will see how participation in safety net program influences fertilizer adoption (i.e. a dummy outcome equation).

significantly different distribution of relative factor ratios (i.e. own livestock to own land holdings and operational livestock to operational land holdings) for livestock tenants compared to livestock lords (Figures 1 & 2). This finding contrasts the results in land rental markets in Ethiopia, where we have relatively rich tenants and poor landlords (Ghebru and Holden, 2009, Tadesse *et al*., 2009; Holden *et al*., 2009). As can be seen from Figures 1 and 2, livestock rental contracts help livestock lords and tenants to reallocate land and livestock resources (factors of production) to reduce the variation in these distributions and to reduce the gap between the distributions for the two groups. This is likely to lead to more optimal combinations of land and livestock and should enhance the efficiency of their utilization (Tessema and Holden, 2007).This result partly supports hypotheses H1a that the rental contracts help cash-poor and credit constrained households to access animals for their farm production and H2 that contracts help households take advantage of crop-livestock synergies. One important crop-livestock interaction and hence participation in livestock contracts can be explained by the demand for manure for *enset* cultivation. Tenants in type I contract sometimes enter into this contract mainly to get manure from the contracted animal for *enset* cultivation and as well as other cereals (e.g. maize). Hence, they have a better chance of relaxing their capital constraint, and less likely to purchase chemical fertilizer which is expensive for the poor.

There is a statistically significant wealth difference between livestock lords who participate in type I and type II contracts. For instance, livestock lords who rent out animals through type II contracts have lower own livestock, operational livestock holdings and farm size compared to livestock lords who rent out animals through type I (*Harra* contract) (Table 3, column H). This result supports hypothesis H4 that livestock lords who participate in type I contracts have excess animals or those who have excess animals are more likely to participate through type I contract. This type of contract may also facilitate livestock accumulation by livestock lords

beyond the carrying capacity of their limited land resource. On the other hand, we did not find significant wealth differences between tenants who participate in either of the contracts. Also the endowment ratio distribution for non-participants in such contracts was not much different from that of the tenants. This may indicate that there is a shortage of livestock and that there are many potential tenants that are rationed out from the market. If this is the case, it has important policy implications. Other types of interventions could be relevant to enhance a more equitable livestock distribution that would take fuller advantage of the potential livestock-land synergies.

6. Results and discussion

6.2.1 Determinants of participation in livestock rental contracts

In this section, we present results from participation (probit models with sample selection) for livestock lord and livestock tenants (Table 4).We observed a possible sample selection bias in the livestock lord model while this is not the case in the tenant model (Table 4, see LR test results).Variable selection in either of the models (i.e. main or selection equations, in Table 4) is based on the hypothesis made earlier as stated earlier. That is to say a variable that influence the contract choice model (main equation may not necessary) influence the participation equation (selection equation). Similarly, the effect of a particular variable also varies based on the characteristics of households and hence the inclusion/exclusion in either of the models.

Based on these criteria, we introduced the same variables across livestock lord and tenant selection equations but not in the main equations (contract choice models) as the effect of a particular variable may vary across households and contracts. Sometimes, when a given variable is policy relevant (i.e. a must to introduce in a model), we choose to introduce it regardless of its endogeneity problem. For instance, credit access is endogenous in the tenant model since this is expected to influence the choice of contracts in the tenant model but not

livestock lords' contract choice decisions. To control the problem of endogeneity of this variable in the tenant models, we ran additional contract choice models (in Table 5) using suitable instruments. In what follows, we interpret the results from participation selection equations (Table 4) for livestock lord and tenants, separately.

Participation as livestock lord

As can be seen from the selection equation (Table 4), variables such as availability of *enset* stocks (measure of wealth) and livestock ownership excluding oxen in TLU per unit of land have a positive and significant correlation with livestock lord participation decision. This indicates that wealthier livestock lords are more likely to rent out their animals than selling the excess animals or trying to acquire more land for fodder production for the animals. Livestock lords may find the returns from participation in livestock rental market higher than from the alternatives such as selling the excess animals or renting in land for fodder production for the excess animals. Therefore, these results are in line with H4 hypothesis that livestock lords use type I contracts to accumulate livestock beyond what their own land endowment can carry.

Livestock lords with more adult male and female labour per unit of land were significantly (at 5 and 1% levels) less likely to participate in livestock rental contracts (Table 4). Shortage of labour may therefore also cause households to rent out animals. This also indicates the importance of livestock rental market in allocating rural labour across households, a result that also supports hypothesis H2 that livestock renting contributes to factor ratio balancing.

Participation as tenant

Contrary to our expectation, the effect of adult male labour per unit of land is negatively correlated with tenants' participation decision. One possible explanation could be that tenants with more adult labour may prefer to participate in alternative income generating activities (off-farm employment) in neighbouring towns or cities instead of participating in livestock

contracts. Village level factors are also important determining livestock tenants' participation. The lack of significance of tenant characteristics but strong significance of village dummies may indicate that access is rationed but access is better in some villages than others and this could be due to their proximity to some of the rich livestock lords. This indicates that the market is fragmented similar to the land rental market in the area (Tadesse *et al*., 2009). These findings are in line with hypotheses H3c and H3d. The need for monitoring may explain this in case of livestock, while for land it is both due to the need for monitoring and the immobility of land.

6.2.2 Livestock rental contract choices

Using the results in Table 4, the main equations for livestock lords and tenants, livestock lords with more livestock (excluding oxen) per unit of land were significantly (5% level) more likely to use type I contracts. Type I contracts are preferable for rich livestock lords as long as the moral hazard problem can be controlled. Farm size was also positively associated with choice of contract type I, another indicator that wealthy livestock lords prefer this type of contract. Contract type I allows them the full right to use the offspring as part of their asset accumulation strategy. This result is in line with hypothesis H4 that livestock lords use type I contracts to accumulate livestock wealth beyond what their own land endowment can carry.

Oxen ownership of tenants was positively related to contract type II, but the variable was only significant at 10% level. Indicating better oxen ownership may allow tenants to form type II contracts to overcome the investment cost in relation to buying indivisible animals such as oxen. This finding partly supports H1c hypothesis in that contracts help relax constraints imposed by the lumpiness of livestock investment. Tenants who enter into type I contracts have more livestock excluding oxen compared to those in type II contracts. This was a surprising result that contradicts the hypothesis that contract type II is preferred by a bit more wealthy tenants who should be able to obtain more favourable contracts. However, this model

may be contaminated by endogeneity bias. To try to overcome this, a number of instrumental variable models were run to instrument for endogenous livestock endowments and credit access. Table 5 provides the results.

After instrumentation in the credit access variable (Table 5), we found that access to credit has a positive effect (5% level of significance) across the three models[18] and favouring choice of contract type II. Credit-constrained tenants are therefore more likely to be forced to go into contract type I. This result supports hypothesis H1d that a cash constrained livestock tenant is more likely to accept a less favourable contract (type I) compared to a non-cash constrained livestock tenant.

6.2.3. Impact of participation on poverty

Using treatment effect models, we estimated the effect of participation in livestock rental markets as tenant and livestock lord on per capita consumption expenditures (i.e. a measure of poverty). While controlling for endogenity of treatment (participation), using the observations only that satisfied the common support requirement to ensure a comparable sample, we found that access to livestock contracts for tenants contributed significantly to improvement of their welfare (Table 6). This result supports H1b hypothesis that access to and participation in livestock rental market improve the welfare of participating tenants. In the case of livestock lords, we did not find any significant effect on their consumption expenditure (poverty status). One possible explanation may be livestock lords primarily use such contract to accumulate livestock and not to increase their consumption. They may be more investment oriented than the livestock tenants.

[18] The validity of the instruments is confirmed using tests of over identifying restrictions (Table 5).

7. Conclusion

This paper examines the rationale of livestock rental markets in the southern highlands of Ethiopia. While the literature on land rental contracts is abundant, we have not seen empirical studies on livestock rental contracts. Therefore, this paper adds to the empirical literature on applied contracts, that have to date been dominated by the studies of land rental contracts choices. The findings from participation selection models indicate that livestock lords are more likely to rent out animals the more animals they have, the more *enset* stocks they have (wealth variable) and the less male and female labour they have per unit land. Tenants' participation in livestock rental markets is mainly explained by the possible fragmentations of livestock rental markets and factors associated with their family labour endowments.

Econometric results on the determinants of contract choices indicate that livestock tenants are more likely to accept a less favourable contract, called a '*Harra*' or a 'type I' contract, when they are credit constrained. However, if they can afford, the preferred contract for livestock tenants is shared ownership-tenancy contract. That means among tenants that have access, tenants with credit access prefer type II contracts. Both risk sharing motives and liquidity constraints imposed by the indivisible nature of livestock investment are key factors influencing the choice of livestock rental contracts. Our findings support previous studies that examined the effects of capital constraints in land rental contract choices (Laffont and Matoussi,1995; Tadesse *et al*., 2009; Holden *et al*., 2009) and the risk sharing motives for shaping the choice of land rental contracts (Ackeberg and Botticini, 2002; Otsuka, 2007).

The findings from this study show that rental contracts for fragile and mobile livestock, despite potential large moral hazard problems (Binswanger and Rosenzweig, 1986), can emerge in poor rural economies and contribute to factor adjustments and welfare

enhancement. The existence of strong monitoring systems, such as unannounced visits and social gatherings (weddings, funeral ceremonies and public work programs, such as food for work), and kin relationships, help control the moral hazard problems.

It is the egalitarian land distribution with maximum land size of 2.5 hectare that drives wealthier livestock owners to take the chance to rent out their animals as an alternative asset accumulation strategy in a context where accumulation of land is prohibited. This is an alternative way they get access to additional land for fodder production if they cannot rent in land or lack the labour to do so.

Although the land rental markets in Ethiopia are characterized by poor landlords and rich tenants (Ghebru and Holden,2009; Holden *et al*., 2009; Tadesse *et al*., 2009); the opposite is true for livestock rental markets in the study areas as we find that the livestock rental market is characterized by poor livestock tenants and rich livestock lords. The poor tenants gain access to productive assets (livestock) through rental arrangements that relax constraints imposed by capital and the lumpiness of livestock investments. Such rental arrangements enable households to allocate production factors (land and livestock) more efficiently. We conclude, rationing of livestock tenants may be a prerequisite for the sustainability of this institutional arrangement and it is possible that another livestock credit system, possibly sponsored by the government, could provide further welfare gains and allow more widespread accumulation of livestock to take advantage of crop-livestock interactions.

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Table 1. Types and descriptions of livestock share contracts, southern Ethiopia

Contracts	Description of livestock share contracts	Frequency	%
Type I	Livestock lord covers all initial purchase costs or provides the animal to be shared. The livestock tenant, if they can afford, should repay part of the initial value of the original animal to share offspring. Otherwise, they keep getting only dairy products without any right to the offspring.	98	33
Type II	Both parties share initial purchase costs (upfront). All variable costs and benefits such as milk, butter, cheese, manure or traction power (in 75% of the cases) belong to the tenant. But offspring and income from animal sales are shared equally.	179	62
Type III	Parties alternate responsibility for animal upkeep and the benefits of manure and other products such as milk, butter and cheese. This contract is common for milking cow. The initial investment costs and benefits are shared equally.	16	5
Total	Number of valid observations (household level)	293	100

Source: Own survey 2005 and 2007 having a total of 556 households.

Table 2. Cost and benefit sharing rules in livestock share contracts by household type, southern Ethiopia

Types of contracts	Costs (types and % shares) by livestock tenant and livestock lord						Benefits (type and % shares) by livestock tenant and livestock lord							
	Investment cost (% share)		Variable costs (% share) (Labour, feed, medicine)		Risk sharing if animal dies (% share)		Butter, milk, cheese, hides and skin, manure		Offspring		Cash from sale of animals		Draught power	
	Tenant $(1-\gamma)$	L.lord (γ)	Tenant $(1-\Omega)$	L.lord (Ω)	Tenant $(1-\theta)$	L.lord (θ)	Tenant $(1-\alpha)$	L.lord (α)	Tenant $(1-\alpha)$	L.lord (α)	Tenant $(1-\alpha)$	L.lord (α)	Tenant $(1-\alpha)$	L.lord (α)
Type I	0.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.0
Type II	0.5	0.5	1.0	0.0	0.5	0.5	1.0	0.0	0.5	0.5	0.5	0.5	1.0	0.0
Type III	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	–	–

Source: Own survey 2005 and 2007. L.lord stands for livestock lord.

Table 3. Mean comparison tests for major assets by household and contract type, southern Ethiopia

Variables and their descriptions	Type I contract		Column A&B)	Type II contract		Column (D&E)	Characteristics of tenants by type I & type II contracts Column (A & D)	Characteristics of livestock lords by type I & type II contracts, Column (B & E)
	Livestock tenant	Livestock Lord		Livestock tenant	Livestock lord			
	Mean (SD)	Mean (SD)	t-test	Mean (SD)	Mean (SD)	t-test	t-test	t-test
	A	B	C	D	E	F	G	H
Own livestock holdings in TLU	3.15 (1.4)	13.25 (12.3)	4.95***	2.9 (3.7)	9.6 (8.5)	6.3 ***	0.33	2.24**
Operational livestock holdings in TLU	4.4 (5.5)	11.4 (11.9)	3.5***	7.4 (8.3)	4.4 (3.6)	2.9 ***	0.03	2.53***
Own livestock holding per own land $\left(\text{in } m^2\right)$ units	0.0033 (0.008)	0.0057 (.007)	1.7**	0.002 (0.003)	0.007 (0.001)	4.2***	1.41*	0.85
Income from crop and livestock per family size (Birr)	591 (398)	713 (998)	0.712	616 (584)	989 (217)	1.42 *	0.23	0.88
Own farm size, in square meters	5763 (468)	7016 (509)	1.22	5588 (416)	4721 (328)	1.6*	0.21	3.54***
Availability of livestock feed , total *enset* stock	84 (260)	592 (163)	1.98**	91 (233)	404 (644)	3.97***	0.14	1.09
Number of female adults	3.4 (1.5)	3.6 (1.75)	0.65	3.7 (1.5)	3.3 (1.7)	1.7**	1.07	1.1
Number of male adults	3.4 (1.78)	3.8 (1.9)	0.84	3.5 (1.890)	3.52 (1.8)	0.07	0.17	0.81
Farm experience of household head in years	21 (13.3)	25 (14.4)	1.3*	22 (12)	23 (13)	0.53	0.29	0.82
Log of initial investment cost	5.56 (1.29)	5.9 (0.77)	1.44*	5.69 (0.7)	5.6 (0.69)	0.32	0.59	2.15**

Note: ***, **, * significance at 0.01%, 0.05% and 0.1% level, respectively. Absolute values of t-statistics are reported. The mean comparison test was done excluding those households (Livestock lords and livestock tenants) residing outside of the survey region due to lack of full information on their asset position.

Table 4: Factors associated with contract choice, probit models with sample selection

	Livestock lord models		Tenant models	
	Main eqn.	Selection eqn.	Main eqn.	Selection eqn.
Farm size	-0.000*	0.000	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Male labor per farm size	309.372	-344.447**		-208.063*
	(254.58)	(133.83)		(120.22)
Female labor per farm size	410.720	-271.383***		-11.911
	(282.56)	(88.89)		(107.70)
Livestock excluding oxen per farm size	-133.931**	217.794****		24.941
	(57.81)	(39.80)		(43.17)
If partner resides >=30 & <=60 min. walking distance	0.123		0.428	
	(0.31)		(0.42)	
Absent rental partner	0.142		-0.199	
	(0.33)		(0.34)	
Dummy year 2005	0.074		-0.630*	
	(0.22)		(0.33)	
Adult male labor			0.014	
			(0.08)	
Adult female labor			-0.107	
			(0.09)	
Livestock excluding oxen			-0.066**	
			(0.03)	
Oxen TLU			0.106*	
			(0.06)	
Having access to credit			0.295	
			(0.27)	
PA 2		0.188	0.667*	-0.308**
		(0.15)	(0.35)	(0.16)
PA 3		0.186	0.893**	-0.308*
		(0.17)	(0.40)	(0.17)
PA 4		-1.142****	-6.332	-2.404****
		(0.25)	(66.90)	(0.40)
PA 5		0.910**	1.316**	1.184**
		(0.40)	(0.66)	(0.54)
Female headed		-0.256		-0.190
		(0.20)		(0.20)
Oxen TLU per farm size		-144.135		-69.529
		(136.98)		(131.51)
Enset stock per farm size		2.134****		0.252
		(0.41)		(0.34)
No. of children >=6 & <=10 years old		-0.064		-0.121*
		(0.06)		(0.07)
No. of children >=11 & <=15 years old		0.111*		-0.022
		(0.06)		(0.07)
Age		0.005		0.008
		(0.01)		(0.01)
Constant	1.163***	-0.563**	0.328	0.130
	(0.30)	(0.28)	(0.72)	(0.29)
Prob > chi2	0.000	0.000	0.000	0.000
Number of obs.	173(uncensored)	512	193(uncensored)	527
LR test of indep.eqns. (rho=0):	chi2(1) = 9.63		chi2(1) = 0.20	
	prob>chi2=0.000		prob>chi2=0.657	

Dependent variable takes value 1 for type 2 contract and 0 for type 1 contracts in the main equations while it takes value 1 for participants (livestock lord and tenant, separately) or 0 otherwise for selection equations. Asterisks indicates level of significance, *=0.10%, **=0.05%, ***=0.01% and ****=0.001%. PA is peasant association that may comprises a minimum of four or more villages. Robust standard errors are used.

Table 5: Factors associated with livestock rental contract choice, IV models for livestock tenant

	2SLS	IV Probit	G2SLS
Livestock excluding oxen per farm size	101.083	315.531	87.691
	(119.65)	(294.75)	(89.28)
Having access to credit	1.004**	3.058**	0.945**
	(0.41)	(1.33)	(0.40)
Experience	-0.007*	-0.021*	-0.007*
	(0.00)	(0.01)	(0.00)
Male labor per farm size	121.875	446.611	141.968
	(85.39)	(330.32)	(93.95)
Female labor per farm size	-83.850	-222.731	-90.777
	(87.41)	(288.17)	(92.96)
If partner resides >=30 & <=60 min. walking distance	0.205	0.610	0.229
	(0.16)	(0.62)	(0.21)
Absent rental partner	0.141	0.471	0.129
	(0.16)	(0.53)	(0.16)
Dummy year 2005	-0.222	-0.624	-0.226
	(0.17)	(0.47)	(0.14)
Constant	0.469*	-0.207	0.498**
	(0.24)	(0.65)	(0.20)
Prob > chi2	0.000	0.000	0.000
Number of obs.	193	192	193

Tests of endogeneity (2SLS model)

Robust score chi2(3) = 13.2074 (p = 0.0042)

Test of over identifying restrictions

Score chi2(11) = 8.79234 (p = 0.6411)

Wald test of exogeneity (iv probit model) chi2 (2)=8 Prob>chi2=0.024

Rho (for G2SLS) 0.218

Dependant variable takes value 1 for type II contract and 0 for type I contracts. Asterisks indicates the level of significance,*=0.10%;**=0.05%;***=0.01%;****=0.001%. Robust standard errors are used.

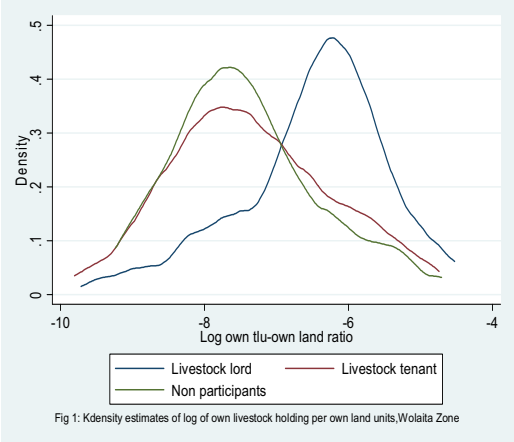
Endogenous variables: Access to credit and livestock excluding oxen

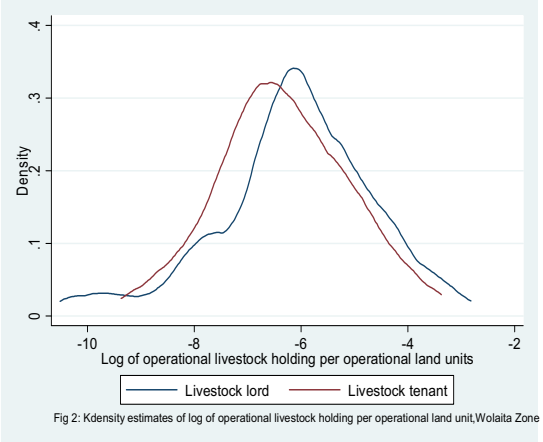
Instruments used: Total number of children between 6 and 10 years old and between 11 and 15 years old, gender,- age , age squared and PA (community) dummies.

Table 6: Treatment Effects Models: Impact of participation in livestock renting on welfare (poverty reduction)

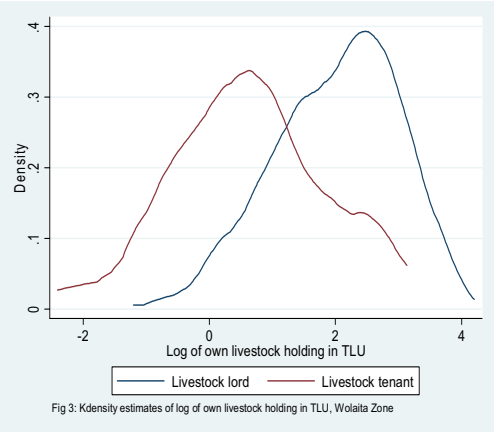
	Without common support		With common support	
	Tenant	Livestock lord	Tenant	Livestock lord
Log of farm experience	-0.034	-0.108*	0.055	-0.048
	(0.05)	(0.06)	(0.06)	(0.08)
Log of male labor per farm size	-89.389**	-98.140**	24.429	-44.704
	(45.34)	(44.36)	(101.34)	(124.62)
Log of female labor per farm size	-5.249	-0.192	-260.989*	-367.655**
	(33.15)	(31.90)	(134.70)	(177.21)
Absent rental partner,>=60 min.	0.127	0.298	0.141	0.348
walking distance	(0.20)	(0.29)	(0.19)	(0.30)
PA 2	-0.206	0.056	-0.228	0.061
	(0.17)	(0.20)	(0.18)	(0.19)
PA 3	-0.316	0.170	-0.376*	0.178
	(0.20)	(0.24)	(0.21)	(0.23)
PA 4	1.013***	0.668***	1.164***	0.785***
	(0.33)	(0.21)	(0.37)	(0.26)
Tenant	1.072*		1.234**	
	(0.55)		(0.60)	
Livestock lord		-0.107		-0.357
		(0.50)		(0.54)
Constant	5.757****	6.379****	5.504****	6.461****
	(0.35)	(0.24)	(0.40)	(0.33)
Treatment equations				
Farm size	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Female headed	-0.345	-0.167	-0.320	-0.058
	(0.39)	(0.46)	(0.40)	(0.49)
Male child <= 5 years old	-0.064	0.039	-0.054	0.106
	(0.18)	(0.20)	(0.19)	(0.21)
Male child >=6 &<=10 years old	0.032	0.221	0.021	0.207
	(0.15)	(0.16)	(0.14)	(0.16)
Male child >=11&<=15 years old	-0.419**	-0.191	-0.410**	-0.184
	(0.17)	(0.20)	(0.17)	(0.21)
Female child <=5 years old	-0.212	0.001	-0.202	0.024
	(0.14)	(0.16)	(0.14)	(0.16)
Female child >=6 & <=10 years old	0.134	0.263	0.128	0.232
	(0.18)	(0.21)	(0.18)	(0.21)
Female child >=11 & <=15 years	-0.074	0.367*	-0.062	0.323
old	(0.19)	(0.21)	(0.19)	(0.22)
Age	0.036	0.069	0.036	0.068
	(0.05)	(0.06)	(0.05)	(0.06)
Age squared	-0.000	-0.001	-0.000	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)
PA 2	0.025	0.755**	0.029	0.748**
	(0.28)	(0.35)	(0.28)	(0.35)
PA 3	0.159	0.699*	0.162	0.698*
	(0.35)	(0.41)	(0.35)	(0.41)
PA 4	-2.198****	-1.239***	-1.871****	-1.056*
	(0.49)	(0.43)	(0.55)	(0.57)
Constant	-0.433	-2.918*	-0.474	-2.875*
	(1.28)	(1.54)	(1.30)	(1.59)
Hazard lambda	-0.617*	0.099	-0.700*	0.256
	(0.34)	(0.31)	(0.37)	(0.33)
Prob > chi2	0.000	0.000	0.001	0.000
Number of Obs.	189	162	133	105

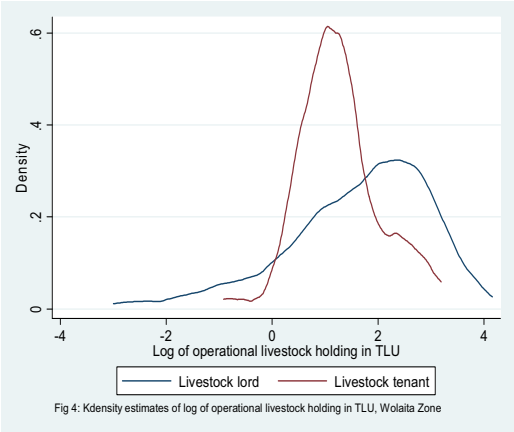
The dependent variable is per capita consumption expenditure for the main equation and dummy variable that takes value 1 for participants and 0 for non participants for the treatment equation using the full sample. Asterisks indicates the level of significance, *=0.10%, **=0.05%, ***=0.01% and ****=0.001. We used the two step consistent estimates of treatment effect model to get robust standard errors and covariance matrix but we are forced to accept the loss of observation.





Note: In Figure 1, a two-sample Kolmogorov-Smirnov test indicates that the difference between the distributions for livestock lords and tenants (D=0.4112; P-value=0.000) and between those for livestock lords and non-participant farmers (D=0.3895; P-value=0.000) is statistically significant. There is also significant difference between livestock lord and livestock tenant in the distributions in Figure 2 (D=0.1695; P-value=0.027). These may be evidence of the efficiency of livestock and land rental markets in reallocating land and livestock across households, in line with hypothesis H2.





Note: Using a two sample Kolmogorov-Smirnov test, we also see significant variation in the distributions (D=0.5177; P-value=0.000) in Figure 3 and (D=0.3298; P-value=0.000) in Figure 4.

Paper III

Risk coping strategies, public works and fertilizer use in southern highlands of Ethiopia

Million Tadesse[*1]

Abstract

In many developing countries, formal credit and insurance markets are less developed. As a result, people resort to various risk coping strategies to smooth consumption. This study examines the role of ex-ante and ex-post risk-coping strategies (RCS) of resource poor farmers with respect to chemical fertilizer use in Gununo area of southern Ethiopia. Results indicate that, controlling for other factors, availability of ex-ante RCS (i.e. reliance on livestock wealth) has a positive effect on fertilizer adoption. In addition, the effect of participation in low wages Employment Generation Schemes (EGS) is found to increase household fertilizer adoption. Farmers who have access to credit have a higher probability of fertilizer adoption after controlling the endogeneity of credit access.

Key words: Risk, fertilizer use, two-part model, binary endogenous regressor, instrumental variable regression, Ethiopia

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[1] I would like to thank many colleagues in the Department of Economics and Resource Management, UMB, Norway. I am grateful to Ragnar Øygard, John Sanders, Gerald Shively, Sverre Grepperud and Frank Asche for their helpful comments on earlier version of this paper. All remaining errors are my own.

1. Introduction

Agricultural production, especially in poor countries, is characterized by production risk related to weather and input response. Past studies from a range of countries indicate that a low level of modern input use may be related to risk aversion on the part of smallholder farmers (Antle, 1983; Binswanger, 1981; Feder *et al*., 1985; Moscardi and de Janvry, 1977; Shively, 1999; Yesuf, 2004). Rosenzweig and Binswanger (1993) show that farmers in risky areas deviate from optimal levels of input use and the impact of this deviation is more severe for poor households compared to the richer ones. Despite efforts by the Government of Ethiopia and Sasakawa-Global 2000 in the mid 1990's in promoting modern input use, to date, the level of fertilizer usage in Ethiopia is very low. Specifically, farmers in this study area on average use about 20kg/ha. The average for Sub-Saharan African Countries (SSA) is less than 10 kg/ha of fertilizer (Crawford *et al*., 2003).

Farmers in poor developing countries are not equipped to mitigate large production shocks. Rosenzweig and Wolpin (1993) and Rosenzweig (1988) show that bullock sales and wealth transfers among family members are used to smooth consumption for households whose income is affected by weather shocks. Fafchamps *et al*. (1998) also show the role of livestock holdings (wealth) in mitigating shocks in rural areas of West Africa. Lamb (2003) shows that availability of off-farm income leads to greater use of fertilizer and helps to smooth consumption in semi-arid areas of India. Income smoothing through off-farm employment is an important risk coping strategy (Morduch, 1995).

Households in developing countries have limited off-farm employment opportunities and depend on government assistance when harvest fails. For instance, farmers in this study area, allocate labor to small scale employment generation schemes (EGS) of the Food for Work (FFW) program during bad weather conditions. This scheme allows a household minimum wage (in kind) which equals 3kg wheat and 120gm cooking oil per day, which supplies 1800 calories per day per person for a family of six members (Fanta and Upadhyay, 2007). In order to get this low-wage "off-farm income", farmers have to work on rural road maintenance, establishing soil conservation structures, and similar public works.

Involvement in EGS programs, reliance on livestock wealth and crop choice (diversification) are key strategies to mitigate production shocks in *Gununo* area of *Wolaita* zone. Farmers, *ex-post,* allocate their labor in EGS of the FFW program. Whereas, crop choices such as allocating more areas for root and perennial crops and reliance on livestock wealth (for sale and sharing purpose) are considered to be *ex-ante* risk coping strategies. However, this classification may not be distinct as livestock could also be used as *ex-post* risk coping strategy. But the *ex-ante* risk reduction role of livestock seems more important than the *ex-post* function. For instance, a study in Bangladesh, Ethiopia and Malawi shows that higher future probability of disasters increases the probability of holding more livestock relative to land *ex-ante* (Yamauchi *et al*., 2009).

The main aim in this paper is therefore to test the role of *ex ante* and *ex post* risk coping strategies of poor farmers on fertilizer adoption. This problem is addressed using

household survey data collected in 2000 from *Gununo* area of *Wolaita* zone, Ethiopia. The findings from this study indicate that livestock wealth contributes to fertilizer adoption in the study area. This finding is consistent with previous studies in other parts of the world that have investigated the role of livestock wealth in mitigating production shocks (Dercon, 2002; Fafchamps *et al*., 1998; Rosenzweig, 1988; Rosenzweig and Wolpin, 1993). I also find a positive role of participation in EGS program for fertilizer adoption. However, one has to note that participation in EGS program is sometimes influenced by supply side constraints (food aid reserves at the local community store) and screening by local EGS program committees often established by zonal or regional food security and early warning offices. Eligible households are those who can contribute their labor in public work programs and that are relatively food insecure. Screening of food insecure households is often subjective and sometimes may lead to bias. Those who are not allowed to participate or self select not to participate (because of the low wage) are assumed to be households having relatively better assets such as land (for renting out), livestock (for sale or renting out), perennial crops (coffee or *enset* (false banana)).

After controlling possible endogeneity problems of credit access, it is shown that farmers who have access to credit have a higher probability of fertilizer adoption. This result is consistent with previous studies on the role of credit in fertilizer adoption in Ethiopia and elsewhere. As expected, econometric results from EGS participation models indicate that households who are relatively wealthy (more livestock per unit of land) are less likely to participate in low-wage income sources, EGS.

2. Related Literature

As discussed earlier, fertilizer adoption is the most risky venture in arid and semi arid areas of Sub-Saharan African countries. Despite efforts by the Government of Ethiopia and Sasakawa-Global 2000 in the mid 1990's in promoting modern input use to date the level of chemical fertilizer adoption is too low even with substantial support by governments. The Ethiopian government has been subsidizing fertilizer for many years to make the price affordable to resource poor farmers. When the government stops subsidizing fertilizer, fertilizer became unaffordable and we observe a decline in its utilization. In the past, much has been said on factors influencing household fertilizer adoption in Ethiopia. For instance, a study by Benin (2006) indicates greater ownership of oxen increase the probability of fertilizer adoption. Croppenstedt *et al*. (2003) shows that, access to credit is the major supply side constraint for fertilizer adoption in Ethiopia. Dercon and Christiaensen (2007) study in Ethiopia also indicates that low consumption outcomes when harvest fail negatively influence fertilizer adoption.

High fertilizer price is another important factor for the low level of fertilizer adoption in Northern Ethiopia (Pender and Gebremedhin, 2006). Earlier study by Holden and Shiferaw (2004) in central highlands of Ethiopia indicates that both production and market risk are important factors influencing fertilizer adoption. A recent study by Bezu and Holden (2008) found the positive role of participation in FFW program on agricultural productivity in northern Ethiopia.

Lack of basic infrastructure is another potential problem that limits technology transfers in Ethiopia. The existing institutions are not capable of delivering the services when

needed and sometimes difficult to provide the services due to complex problems such as lack of roads, telecommunications, lack and inefficient use of trained manpower and inadequate input distribution channels. An important implication from micro studies of adoption is that some of these details can be incorporated into the analysis and rigorous methods of evidence (Foster and Rosenzweig, 2010). Therefore, micro level technology adoption studies are still relevant to identify some of the challenges in agricultural technology transfer in many Sub-Saharan African countries.

3. Conceptual framework and hypotheses

Binswanger (1981) shows that farm households in small community are more or less facing similar risks such as caused by rainfall variability. Hence, differences in their risk aversion behavior are relatively small. However, the difference in access to credit, marketing, extension programs and institutional arrangements are important. Following this study, Eswaran and Kotwal (1989) using expected utility framework, show that household risk preferences are influenced by the resource constraints and capital market imperfections faced by the decision makers. In other words, when credit access is a binding constraint and production risks are uninsured, farm households may use various measures to avoid high income fluctuations such as adopting a technology that entails a low risk - low return (Dercon, 2002; Eswaran and Kotwal, 1989).

Assuming that households may face more or less similar production uncertainty caused by rainfall shock in the study area, it follows that what matters most in their production decisions is differences in their asset endowments, access to new technology (improved seeds, fertilizer, credit, etc), plot quality, availability of drought resistant crops, possibility of participating in off-farm work such as through migration or participation in

low wage work, and their liquidity constraints. These indirectly determine households risk management strategies, either *ex-ante* or *ex-post*.

Following the theoretical farm household model[2] developed by Nykonya *et al*. (2004) and Benin (2006), output from crop production for the ith household denoted by (Q_i) is defined as:

$$Q_i = f(S_i, D_i, K_i, PC_i, H_i, C_i, E_i, FF_i, V_i) \quad (1)$$

Equation (1) states that output from crop production for the ith household is a function of soil quality (S_i); fertilizer input (D_i); crop choice (K_i); endowments of physical capital (PC_i) such as livestock and land; human capital (H_i) (i.e. education, age, labor endowments); access to credit (C_i); extension contact (E_i); participation in off-farm work such as EGS program (FF_i) and natural factors such as rainfall (V_i). From equation (1), fertilizer input may also be expressed as a function of the some of the endogenous variables stated above and other additional factors that may influence the demand for fertilizer (Nykonya *et al*., 2004; Feder *et al*., 1985; Benin, 2006).

$$D_i = D_i(q_i, S_i, C_i, E_i, PC_i, K_i, H_i, FF_i, V_i) \quad (2)$$

Where q_i is the price of fertilizer relative to crop and all other variables are as defined above. Since some of the variables in equation (2) are endogenous, methods for controlling endogeniety problems are presented in section 4.1.

[2] The static form of the farm household model (Nykonya *et al*., 2004) is applied as a conceptual framework to motivate the econometric analysis

I hypothesized households with better initial endowments[3] (land, livestock and off-farm income sources) and access to support services (credit, agricultural extension services, membership in a particular organization) are more likely to cope with the consequence of bad weather compared to those with limited endowments and having poor access to support services. These in turn influence their risk aversion behavior and new technology adoption decisions. Those able to use better risk management strategies (*ex-ante* or *ex-post*) are more likely to invest their resources in relatively risky venture (e.g. chemical fertilizer use) compared to households with limited resources to weather the effect of natural disaster. Morduch (1990) shows that poorer farmers exposed to risk planted less risky crops than wealthier farmers.

3.1 Main hypotheses and variables included

H1. *Ex-post* coping strategies (participation in EGS program): Emergency food aid via undertaking development work such as constructing soil conservation measures, rural roads, and other schemes can be expected to fill short term food and nutrition demand. This may enable households to cope with crop production risk, such as the risks from chemical fertilizer use. Therefore, it is hypothesized that participation in EGS program after a shock is expected to increase household fertilizer adoption decision. This hypothesis is tested incorporating a dummy variable, i.e. participation in EGS program.

H2: *Ex-ante* risk reduction strategies (crop-diversification and livestock wealth): Risk associated with crop failures is expected to be less severe for households that allocate more area for root crops and *enset* (false banana), *ex-ante*. This is because these household can shift their consumption towards root and perennial crops when cereal crops fail. I argue households having more *enset* stocks and coffee trees are more likely

[3] See Carter (1997) for the role of endowment-dependent self-insurance

to resist the effect of production risk caused by fertilizer application on cereal crops such as maize and *teff* than those with small number of *enset* stocks and coffee trees. One has to note that a typical household in the area cultivates both perennial and annual crops as a strategy to diversify income sources during drought period.

Households that have more livestock are expected to have a higher probability of fertilizer use and enhance crop productivity. This is because livestock are sources of liquid assets that can be used to obtain cash immediately or can be used for rental purpose to relax asset indivisibility problems (Tadesse and Holden, 2010). Livestock endowment in TLU (oxen and other cattle) is used as an explanatory variable to test this hypothesis. Details of the variables and their expected impact on household fertilizer use are indicated in (Table 1).

4. Econometric approach and estimation issues

From equation (2), the reduced form of the fertilizer demand function takes the form of equation (3).

$$D_i^* = a + d_i\beta + \varepsilon_i \qquad (3)$$

Where d_i is a vector of explanatory variables as described in equation (2) and β is a vector of coefficients to be estimated, ε_i is a random error term. From equation (3), we observe D_i which is zero if $D_i^* \leq 0$ and equal to D_i^* otherwise. In this regard, equation (3) is the standard Tobit regression model and can be used for analyzing our data set. However, the fact that zero levels of fertilizer usage were observed in this data set, the use of Tobit model may result in biased estimates. An alternative approach is Heckman's (1979) sample selection model, which is designed to account for the case where the

observed sample may be non-random. The Heckman approach is preferable to the Tobit model but still restrictive.

A double hurdle model, originally developed by Cragg (1971), is a more suitable approach to handle the corner solution problems which the standard Tobit model fails to overcome. This method is intensively used in consumer demand literature (Atkinson *et al*., 1984; Garcia and Labeaga, 1996). It is also applied in technology adoption studies in agriculture (Coady, 1995; Croppenstedt *et al*., 2003; Ghadim *et al*., 1999). Although the method has been used to study fertilizer demand, it does not appear to have been applied in developing countries to identify the role of risk coping strategies on household fertilizer adoption.

The double hurdle model requires a probit regression on household decisions for fertilizer use (using all observations) as a first stage (first hurdle) and a truncated normal regression using non-zero observations in the second stage (second hurdle).The model assumes the existence of two latent variables: D_1^{**}, the fertilizer demand function indicating individual's decision to use fertilizer, and while D_2^{**} the intensity (amount) of fertilizer use. Let d_1 and d_2, not necessarily distinct as shown by Cragg (1971), be vectors of explanatory variables that describe initial decisions and the intensity of fertilizer use, respectively. For the first hurdle (probit stage)[4], on the decision to use fertilizer, the model takes the form:

$$D_1^{**} = d_1\beta_1 + \varepsilon_1 \qquad (4)$$

[4] If the error term, ε_1, is assumed to be normally distributed.

Where $D_1^* = 1$ if $D_1^{**} > 0$ and $D_1^* = 0$, otherwise.

The decision on the intensity of use can be specified as a regression truncated at zero:

$$D_2^{**} = d_2 \beta_2 + \varepsilon_2 \tag{5}$$

Where $D_2^* = D_2^{**}$, if $D_2^{**} > 0$, and $D_2^* = 0$, otherwise.

In other words, the second hurdle is similar to the standard tobit model and is capable of generating zero levels of amount of fertilizer, independent of the first hurdle. In the double hurdle (two part) modeling framework applied here, a two-stage process must have been completed if we observe an individual farmer who has decided to use a positive level of fertilizer[5]. The latent variables, D_1^{**} and D_2^{**} are further assumed to follow a bivariate normal distribution:

$$(\varepsilon_1, \varepsilon_2) \sim bivN(0, \Sigma), \quad where \ \Sigma = \begin{bmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{bmatrix}$$

When $\rho = 0$, the model collapses to the independent Cragg model (Atkinson *et al*., 1984). When we further assume that the probability of participation is 1, the Tobit model is nested within the independent double hurdle model ($\rho = 0$). One can compare the Tobit with the sum of the log likelihood functions of the probit and truncated regression (i.e.OLS with zero observations excluded) models separately (Green, 2008).

$$LRT = -2\left[\ln L_T - (\ln L_P + \ln L_{TR})\right] \approx \chi^2(k) \tag{6}$$

Where L_T is the likelihood of the Tobit model with the same coefficients, L_P the likelihood of the probit model, L_{TR} is the likelihood of the truncated regression model, and k is the number of regressors without the constant term. If LRT is significantly higher

[5] It is assumed that both decisions are made jointly.

than the theoretical χ^2 distribution, this will lead to rejection of the Tobit assumption that the coefficients of all variables in these two stages are proportional to each other.

4.1 Estimation issues

Selection of variables to include in each of the two hurdles is often difficult (Atkinson *et al*., 1984; Ghadim *et al*., 1999). One can argue that variables determining the fixed costs of learning or accessing fertilizer would affect fertilizer use decision but not affect the optimal level of use. Therefore, I introduced all household characteristic variables[6] which might determine preferences towards fertilizer use in the participation equation (probit model).

$$d_1 = d(E_i, H_i, S_i, PC_i, FF_i, V_i) \qquad (7)$$

Using these variables and the specification of probit model in equation (4), we can rewrite equation (4) as:

$$D_1^{**} = \beta_0 + \beta_1(E_i) + \beta_2(H_i) + \beta_3(S_i) + \beta_4(PC_i) + \beta_5(FF_i) + \varepsilon_1 \qquad (8)$$

Note that the rainfall shock is assumed the same for all households in *Gununo* area. Hence, the variable that capture rainfall variability (V_i) is not entered in equation (8). This assumption is not unrealistic considering the availability of one rainfall station for all villages in the area. Following Cragg (1971), those variables that can capture the risk aversion behavior of the farmer are included in the second stage regression, which includes some of the variables already introduced in the first stage regression.

$$d_2 = d(H_i, C_i, S_i, PC_i, M_i, K_i, V_i) \qquad (9)$$

[8] Suitable tests of exogeneity for potentially endogenous variables are conducted in the following sections where appropriate.

This is because we expect that the intensity of fertilizer use is strongly influenced by the household's risk preferences. However, variables used for the second stage regression are also used for Tobit model estimation to facilitate the likelihood ratio test procedure. This comparison test using the same variables has been also discussed by (Green, 2008).

Similarly, we can rewrite equation (5) using vector d_2 as:

$$D_2^{**} = \beta_0 + \beta_1(H_i) + \beta_2(C_i) + \beta_3(S_i) + \beta_4(PC_i) + \beta_5(K_i) + \varepsilon_2 \qquad (10)$$

Estimation of equation (8) and (10) requires strict exogeneity of the right hand side variables. However, some of the variables are not strictly exogenous. For instance, participation in EGS (FF_i) programs in probit model and area allocated to root and perennial crops (K_i) and access to credit (C_i), in Truncated regression (i.e. OLS with zero observation excluded) and Tobit models or equation (10) are potentially endogenous variables. Failure to account for the endogeneity problems could result in biased estimates. As a result, instrumental variable probit model was specified using suitable instruments for predicting participation in EGS programs for the first stage regression. Hence, the model for predicting participation in EGS program may be specified as:

$$FF_i^{**} = Z_i\delta + \upsilon_i \qquad (11)$$

Where Z_i contains instruments in (Table 1) and υ_i is the error term. Endogeneity implies $\text{cov}(\upsilon_i, \varepsilon_1) = \rho \; or \; \text{cov}(\upsilon_i, \varepsilon_1) \neq 0$. Substituting equation (11) into (8) gives the reduced form of the model that can be estimated by IV probit model. However, IV probit estimation may not be valid when the endogenous variable is dummy (Wooldridge, 2002 p.477; Carrasco, 2001; Evans and Schwab, 1995). In this regard, a binary probit model (seemingly unrelated bivariate probit model) by allowing the error terms in equation

(8) and (11) be distributed bivariate normal is an alternative estimation method (Wooldridge, 2002 p.477). Consistent results across the models in Table 5 may indicate the robustness of the results.

Crop choice (i.e. land allocated for root and perennial crops) is also be another potentially endogenous variable in the second hurdle. Since this endogenous variable is continuous and uncensored, the Durbin-Wu-Hausman (DWH) two-step procedure based on (Davidson and MacKinnon, 2004) for the truncated regression model was employed. The instrument selected for this test procedure is household perception of soil erosion problem and other household level exogenous variables (Table 1). Tadesse and Belay (2004) found that farmers' perception of soil erosion problems is an important factor influencing household soil conservation adoption in *Gununo* area. Those who perceive the problem of soil erosion on their plots are more curious about which crop to plant for a particular season, hence the choice of a particular crop. However, their perception regarding soil erosion may not directly influence the level of fertilizer use. Using a simple correlation test, it is shown that the soil erosion perception variable is significantly correlated with crop choice (area allocated for root and perennial crops) but not with the level of fertilizer. This is an indication for the validity of the instrument used (STATA 10 manual). The Smith-Blundell's (1986) estimation procedure is also applied for the Tobit model as outlined by Wooldridge (2002, p.531) to control possible endogeneity problem in credit access. One of the main requirements to get access to credit was repayment of last cropping season credit and ownership of at least a half hectare of land. Hence, repayment of last cropping season credit and owning 0.5 ha or more plots of farmland are

used as instruments for predicting access to credit in addition to other exogenous variables in the main equation.

5. Data set and descriptive statistics

This study was conducted in the southern highlands of Ethiopia, namely *Gununo* area of *Wolaita* zone. Due to land shortages, farmers cultivate plots that are not suitable for ordinary crop production, such as steep slopes (Belay, 1992). Around homestead areas farmers cultivate mainly "*enset"*/*ensete vintricosum*/ or (false banana), which is a co-staple food next to maize, coffee, and cabbage. On the field system, seasonal crops such as maize, haricot bean, barley, *teff* and root crops are important. When cereal crops such as maize, *teff* (the most important staple food and cash crop in Ethiopia) fail, farmers can easily shift their consumption towards these crops. Piecemeal harvesting is common for root and perennial crops, unlike the case of cereals. The fact that the *enset* products (*Kocho, Bulla, amicho*) are storable for extended periods of time means that these products can be considered as insurance against crop failures. The same is true with sweet potatoes, most farmers store sweet potato underground (if the need arises, they harvest piece by piece).

A random sample of 120 households proportional to the size of total population was interviewed from six villages during October-December 2000 with 12 months recall period to capture both *belg* and *meher* season production in the area. This is one of the years where the country faced serious food shortage in recent time. Hence, this data set is believed to show households' input use behavior under risk. Data collectors were trained on the contents of a questionnaire and a pre-test of the questionnaire was also conducted. On the basis of the pre-test, some modifications were made to the questionnaire.

The major problem in our data set is the absence of fertilizer price information at household level. This is because price of fertilizer is nationally fixed and there is no price variation across households. However, considering the cross sectional nature of the survey exclusion of price may not influence the results since it can be regarded as constant. Some empirical studies in Ethiopia such as by Croppenstedt *et al*. (2003) used value-cost ratio (VCR) a close approximation for profitability of fertilizer, as explanatory variable. On the other hand, Pender and Gebremedhin (2006) used a nationally fixed price in their estimation.

5.1 Descriptive statistics

Crop failure due to drought, crop disease and poor land management practices are typical problems of the study area. Soil erosion is another important challenge for agricultural productivity in the area (Belay, 1992; Tadesse and Belay, 2004). Nitosol is the dominant soil type and the slope of the area varies from gentle to steep (Belay, 1992).

As shown in Table 2, the majority of the farmers (77%) fall in the poor and very poor wealth category. On the other hand, those farmers who are relatively "rich" account for only about 8 percent of the total households in all villages. The possibilities for off-farm income opportunities are limited and production does not last until next harvest (Table 2). Provision of food for work is the only public policy option available for the poor who are unable to sustain life on their own in case of drought. Some level of effort has been made from the government side in providing subsidies for fertilizer and improved seeds in the early 1990's. Later, the government banned subsidizing fertilizer. As a result, many

farmers were forced to plant their traditional crops without fertilizer. This has an important impact for households to remain under vicious circle of poverty.

From the descriptive statistics (Table 1), it is shown that 55% of our sample farmers' are adopters of fertilizer while 45% are non adopters. The difference is statistically significant (P<0.000). Households that adopt fertilizer were found to have higher *ex-ante* risk mitigating strategies proxied by livestock wealth (both oxen and other cattle ownership) and the difference is statistically significant (Table 1). Non-adopters of fertilizer have a statistically significant higher number of dependent family members.

The average size of cultivated land to support an average family size of seven persons is 0.44 hectare (ha). Small farm size also undermines adoption of other improved soil fertility management practices. Only those households with relatively greater farm size tend to adopt physical soil conservation measures (Table 3). At seven persons per household, the study area is known for its high population pressure.

6. Regression results and discussion

Table 5 presents results from the two step IV probit and seemingly unrelated binary probit models. The approach allows correcting the problem of sample selection and endogeneity problems. Based on the Wald test of exogeneity, the problem of endogeneity of EGS participation is confirmed, $\left(\chi^2_{(1)} = 4.90; p = 0.027\right)$ i.e. the error terms in the EGS participation and fertilizer adoption equations are correlated (Table 5). The fact that EGS participation is dummy endogenous variable, the IV probit specification may not be appropriate (Wooldridge, 2002, p.472). As a result, a seemingly unrelated binary probit model results are also presented in Table 5, last two columns as a robustness check. Since

rho (ρ) is significantly different from zero $\left(LRT : \chi^2_{(1)} = 17.56; p = 0.000\right)$ implies the bivariate specification is valid for the first stage regression (Table 5).Therefore, interpretation of the variables in the following section compares results from the two models but gives due emphasis to bivariate probit model results for the first stage regression.

I also check the appropriateness of hurdle models against the Tobit model by computing the likelihood ratio test statistics (LRT) in equation (12).The results indicate the restrictions in Tobit model were rejected $\left(LRT : \chi^2_{(11)} = 177.12; p = 0.000\right)$(Table 6). This implies that the coefficients of all variables[7] in the double hurdle models are not proportional to each other, contrary to the Tobit model assumption. Hence, the use of double hurdle model is more appropriate for our data set.

It is shown that participation in EGS, an *ex-post* risk coping strategy, has a positive effect influencing households' initial decision to use fertilizer in both specifications (Table 5). This shows the relevance of public work programs (productive safety net program of the government) in supporting agricultural productivity in the study area. It is also shown that households who are relatively wealthy (more livestock per unit of land) are less likely to participate in low-wage income sources (EGS) (Table 5, column 2). Bezu and Holden (2008) also found the positive role of FFW increasing agricultural productivity in northern Ethiopia. Hence, this result confirms H1 hypothesis in that household

[7] The Double-Hurdle model allows the possibility that the initial level of the decision to use fertilizer and the intensity of use are affected by a different set of variables.

participating in EGS tend to be less risk averse and hence more likely to adopt chemical fertilizer.

The effect of livestock capital, the variable livestock excluding oxen per unit of land, found to have a positive *ex-ante* risk reduction role in both sides of the hurdle models (Table 5 and Table 6). Indicating household who have better livestock wealth are more likely to cross both sides of the hurdle models (the decision and the intensity of fertilizer use) compared to those with no livestock. Hence, improving livestock productivity in the area may support the crop production activity by increasing cash income that could be used for the purchase of agricultural inputs. Hence, better crop-livestock integration options must be assessed in the face of decreasing size of farmland.

Availability of female labor per unit of land, as opposed to male labor per unit of land, negatively influence household's initial decision to use fertilizer (Table 5). But once the household decides to use fertilizer, the effect of female labor is not significant. Rather, it is the male labor that is the crucial factor in influencing the intensity of fertilizer use (Table 6, column 1). This result is interesting and in agreement with the socio-cultural conditions in the area. Adult females in many rural areas often spent their time in non-crop production activities (food preparation, child care and off-farm activities such as local brewery and petty trade). Females are also culturally not allowed to plough land by oxen and have no significant impact on fertilizer application and its rate of application. Hence, this variable clearly supports the theory behind the hurdle model, i.e. the effect of a single variable may vary across the two hurdles unlike the Tobit model assumption.

The variable, predicted crop choice, *ex-ante* risk coping strategies, does not affect the level of fertilizer use after controlling its endogeneity (Table 6, column 1). Hence, no support for hypothesis in H2 in that crop diversification does not reduce households' risk aversion behavior related to the use of chemical fertilizer. However, in order to check the reliability of this result, I ran a simple mean comparison test across two groups of farmers (i.e. with and without root and perennial crops abundant households) based on areas allocated to these crops ($\pm$0.125ha). I compare the mean level of fertilizer use across groups. The result indicates that households that have more area for root and perennial crops have a higher mean level of fertilizer use since these crops may help to smooth consumption during drought periods ($t=9.16$; $P<0.000$). This result is supported by previous findings on the role of *enset* and other root crops in this farming system zone (Brandt *et al*., 1997).

Credit access is an important variable determining fertilizer adoption in technology adoption studies. Hence, I examined the role of this variable in this data set controlling possible endogenity problems and the problem of sample selection, using the two-step Tobit and 2SLS models procedures in STATA. It is shown that access to credit positively influence the intensity of fertilizer use, consistent with most past adoption studies in developing countries.

7. Conclusion

This paper examines the role of *ex-ante* and *ex-post* risk mitigating strategies of resource poor farmers on fertilizer adoption in southern highlands of Ethiopia. After accounting for endogeneity problems of EGS program participation, crop choice and credit access variables, the variable livestock capital (an *ex-ante* risk coping strategy), is found to have a

positive impact on the initial decision and intensity of fertilizer adoption. Participation in off-farm employment opportunities via EGS programs (*ex-post* risk coping strategy) also has a positive effect on household fertilizer adoption and hence crop productivity in the study area. It is also shown that households who are relatively wealthy (more livestock per unit of land) are less likely to participate in low-wage work. However, one has to interpret this result with care. Although I attempt to control the problem of self-selection, the low participation of the relatively wealthy households could still be either due to self-selection (because the wage is so low) or targeting by the village committee members.

Farmers who have access to credit have a higher probability of fertilizer use and apply it in order to enhance soil fertility status of their farmland. It is shown that factors that affect the initial level of fertilizer adoption do not necessarily influence the intensity of fertilizer adoption. This is consistent with Debela's (2007) fertilizer adoption study in central highlands of Ethiopia.

Although the *ex-ante* risk reduction and ex-post risk coping strategies of the poor have a positive effect on fertilizer adoption at household level, they often fail in the face of mass (covariate) risks, e,g. when the whole village is affected by drought. As a result, alternative risk mitigation strategies may be promoted for the poor in Ethiopia to mitigate the effect of covariate risks.

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Table 1: Definition of variables, expected impact and tests of mean differences

Description	Expected impact	Adopters Mean(SD)	Non-adopters Mean(SD)	P-value
Dependent variable, log of amount of fertilizer used in kg per cultivated land for Truncated, Tobit and 2SLS models		4.52(0.11)	-	0.000***
Dependent variable, decision to use fertilizer for IVprobit and seemingly unrelated binary probit (yes=1; 0 otherwise)		0.55(0.05)	-	0.000***
Instrumented variables				
Area covered by root and perennial crops (ha)	+	0.27(0.02)	0.26(0.02)	0.248
Participation in EGS program (1=yes)	±	0.75(0.43)	0.73(0.45)	0.690
If household has access to credit (yes=1; 0 otherwise)	+	0.25(0.44)	0.03(0.17)	0.000***
Instrumental variables				
If the household repay his/her loan for last cropping season (1= yes; 0 otherwise)	?	0.74(0.44)	0.18(0.39)	000***
If the household head has position with in the community (e.g. being chairman, cadre, etc) (1= yes; 0 otherwise)	?	0.22(0.42)	0.23(0.41)	0.947
Ownership of plots greater than half hectare (ha)	?	0.57(0.07)	.46(0.06)	0.098*
If the head perceive soil erosion/nutrient depletion as a serious problem (1= yes; 0 otherwise)	?	0.72(0.45)	0.80(0.40)	0.298
Age of household head in years	±	42(2.29)	43(2.06)	0.623
Dummy for household education (1=literate; 0 otherwise)	+	0.42(0.49)	0.33(0.47)	0.297
dependency ratio	_	0.72(0.07)	0.87(0.079)	0.086*
Adult female labor per ha of cultivated land	+	1.83(0.45)	3.09(0.65)	0.064*
Adult male labor force available per cultivated land	+	3.79(0.41)	4.38(0.62)	0.224
Per capita livestock (income from livestock divided by family size).	+	5.90(2.28)	5.81(2.59)	0.489
The ratio of oxen in TLU per cultivated land	+	1.52(0.26)	0.92(0.21)	0.038**
The ratio of other cattle's in TLU per cultivated land	+	4.06(0.39)	2.99(0.38)	0.029**
Plot quality (1=medium; 0= poor)	_	0.66(0.47)	0.66(0.47)	0.576
Degree of soil erosion on farm land (severe to very severe =1, 0 minor or no problem)	+	0.85(0.35)	0.80(0.40)	0.484

* , **, *** ,**** significance at less than the 10% , 5%, 1% and 0.1% level, respectively. Adopters are households who use fertilizer and non-adopters are those who did not use.

Table 2: Wealth category and livelihood strategies in *Gununo* Catchment, Ethiopia

Wealth group	Indicators	N	Percent
Rich	Mostly have 2 oxen	25	7.5
	Have one or two: cows, heifers or bulls		
	Most of them have up to 2 ha of land		
	They give (share out) their animals to be kept by others and obtain 2/3 of the benefit.		
	They rent in land/use other farmers' land		
	Are relatively food secured/ grain reserve lasts until next harvest.		
Medium	One ox is common	51	15.5
	One or no: cow, heifer, bull, goat and sheep		
	Have up to 0.5 ha of land		
	Share cropping/ coupling of ox with others is a common practice.		
Poor	Most of them do not have ox but some have one: ox, sheep and goat	137	41.5
	They keep other individuals livestock to benefit from milk, butter and in rare cases from sale of the original animal contracted.		
	Off-farm activities such as sale of grasses, fuel wood and pottery are common.		
	Have land size up to 0.125ha		
Very poor	Own no ox or other animals	116	35.5
	Most of them are female headed		
	Work on other farmers' field as daily laborers.		
	Sell fuel wood, grasses, pottery, etc.		
	Landless except the homestead area.		
Total household involved in focus group discussions		329	100

N= number of households heads in the study area.

Source: Own survey using Participatory Rural Appraisal (PRA) techniques, 2000.

Table 3: Farm size by improved soil conservation measures adoption, *Gununo* Area, Ethiopia

Farm size (ha)	Adopters		Non-adopters		Total Sample	
	N	Percent of adopters	N	Percent of non-adopters	N	% of total sample
≤0.2500	3	4.9	7	11.9	10	8.3
0.2510-0.5000	14	23.0	18	30.5	32	26.7
0.5100-0.7500	11	18.0	14	23.5	25	20.8
0.751-0.9900	10	16.4	11	18.6	21	17.5
0.9910-1.500	19	31.1	6	10.2	25	20.8
≥1.5100	4	6.6	3	5.1	7	5.8
Total	61	100	59	49.2	120	100

Source: Own Survey, Oct.___Dec. 2000.

Table 4: Distribution of sample households, by their perception soil erosion, *Gununo* area, Ethiopia

Farmers' location	Erosion is Perceived as a Serious Problem		Erosion is not Perceived as a Serious Problem		Total	
	N	% of total farmers	N	% of total farmers	N	% of total farmers
Treated catchment	60	50.0	20	16.67	80	66.7
Untreated catchment	33	27.5	7	5.83	40	33.3
Total households	93	77.5	27	22.5	120	100

Source: Tadesse and Belay (2004). Note: Treated catchments are catchments with physical soil conservation measures while untreated are the opposite.

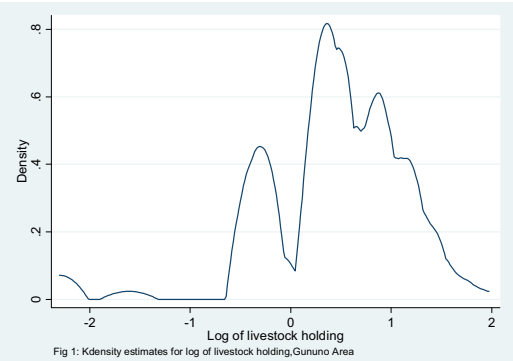

Fig 1: Kdensity estimates for log of livestock holding,Gununo Area

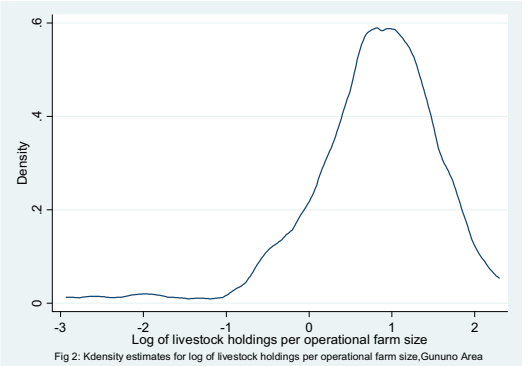

Fig 2: Kdensity estimates for log of livestock holdings per operational farm size,Gununo Area

Table 5: Determinants of fertilizer use and EGS participation, *Gununo* area, Ethiopia

	Instrumental variables probit models		Seemingly unrelated binary probit models	
Explanatory variables	Fertilizer	EGS	Fertilizer	EGS
Participation in EGS scheme	2.429****		1.607****	
	(0.27)		(0.19)	
Age	-0.005	0.003	-0.002	0.032
	(0.01)	(0.01)	(0.01)	(0.04)
Level of education	-0.182	0.098	-0.064	0.645**
	(0.24)	(0.08)	(0.26)	(0.32)
Dependency ratio	0.126	-0.080	-0.073	-0.214
	(0.22)	(0.06)	(0.20)	(0.26)
Good plot quality	-0.425	0.218***		0.379*
	(0.29)	(0.08)		(0.23)
If plots severely eroded	0.425	-0.149	0.576*	-0.505
	(0.28)	(0.10)	(0.33)	(0.45)
Adult female labor per cultivated land	-0.060*	0.018*	-0.083**	0.075*
	(0.03)	(0.01)	(0.03)	(0.04)
Adult male labor per cultivated land	0.003	0.002	-0.006	0.006
	(0.03)	(0.01)	(0.03)	(0.03)
No of oxen in TLU per cultivated land	0.017	-0.012	0.087	0.017
	(0.07)	(0.02)	(0.07)	(0.08)
Livestock excluding oxen in TLU per cultivated land	0.091***	-0.033***	0.118***	-0.107**
	(0.03)	(0.01)	(0.04)	(0.04)
Extension contact	-0.028	0.173*		
	(0.75)	(0.09)		
Age square		-0.000		-0.000
		(0.00)		(0.00)
Male headed		0.045		
		(0.07)		
Household who repaid previous credit		0.060		0.992****
		(0.08)		(0.23)
Having plots >=0.5 hectare		0.016		0.159
		(0.03)		(0.24)
Head with leadership position		0.006		0.310
		(0.02)		(0.29)
Constant	-1.88***	0.597**	-1.95***	-0.47
	(0.56)	(0.27)	(0.61)	(0.97)
Prob > chi2	0.000		0.000	
Number of Obs.	120	120	120	120
Wald test of exogeneity (for iv probit model):		Chi2(1)=4.90	Prob>chi2=0.0269	
Likelihood-ratio test of rho=0 (for bivariat model):		Chi2(1)=17.56	Prob>chi2=0.000	

* , **, *** ,**** significance at less than the 10% , 5%, 1% and 0.1% level, respectively.

Dependent variable takes value 1 if the farmer uses fertilizer, 0 otherwise.

Endogenous variable: participation in EGS program.

Table 6: Determinants of intensity of fertilizer use, *Gununo* area, Ethiopia

Explanatory variables	Truncated	Two Step IV Tobit	2SLS
Age	0.012**	-0.001	-0.032
	(0.01)	(0.03)	(0.03)
Level of education	0.508***	1.309	0.113
	(0.18)	(1.14)	(0.18)
Dependency ratio	0.331*		
	(0.19)		
Adult female labor per cultivated land	-0.004	-0.278**	-0.044*
	(0.02)	(0.14)	(0.02)
Adult male labor per cultivated land	0.094****	-0.033	-0.015
	(0.03)	(0.15)	(0.02)
Plot with quality	0.330**	-1.882	-0.372**
	(0.16)	(1.24)	(0.17)
If plots severely eroded	-0.217	1.121	0.061
	(0.22)	(1.39)	(0.19)
No of oxen in TLU per cultivated land	0.146***	0.387	-0.010
	(0.05)	(0.29)	(0.04)
Livestock excluding oxen in TLU per cultivated land	0.066**	0.354**	0.022
	(0.03)	(0.17)	(0.02)
Predicted credit access	-0.182		
	(0.62)		
Predicted crop choice	-0.156		
	(0.86)		
Having access to credit		12.845***	2.668***
		(3.96)	(0.92)
Root and perennial crops area			-2.012
			(1.61)
Age square			0.000
			(0.00)
Constant	2.75	-2.18	1.52
	(0.50)	(2.54)	(0.68)
Prob > chi2	0.000	0.024	0.000
Number of obs.	51	120	120
Likelihood –ratio test	LR chi2(11)	=177.12	
	Prob>chi2	=0.000	
Wald test of exogeneity (for Tobit):	Chi2(1)	=10.57	
	Prob>chi2	=0.001	
Test of endogeneity (for 2SLS model):	Robust score chi2(2)		=21.09 (p=0.000)
Test of over identifying restrictions:	Score chi2(2)		=2.45 (p=0.293)

* , **, *** ,**** significance at less than the 10% , 5%, 1% and 0.1% level, respectively. Dependent variable is the log of amount of fertilizer used in kg.

Endogenous variables: Access to credit and crop choice (area allocated for root and perennial crops). Repayment of last season credit, having plots greater or equal to 0.5 hectare and all other exogenous variables are used to predict credit access (see Table 1 and our earlier discussion).

Paper IV

Journal of Agriculture and Rural Development in the Tropics and Subtropics
Volume 105, No. 1, 2004, pages 49–62

Factors Influencing Adoption of Soil Conservation Measures in Southern Ethiopia: The Case of Gununo Area

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Abstract
Soil degradation is one of the most serious environmental problems in Ethiopia. The Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on steep and fragile lands and other factors attributed to population pressure. This study used a binomial logit model to identify factors that determine adoption of physical soil conservation measures, namely soil bunds and *fanyajuu* in Southern Ethiopia, Gununo area. Data collected from a random sample of 120 heads of households were used to estimate the binomial logit model. The results show that adoption of soil conservation measures depends on a host of factors. About 78 percent of the sample cases were correctly predicted using the model.

Keywords: adoption, binomial logit model; soil conservation measures, soil erosion

1 Introduction

Ethiopia is one of the largest countries in Africa both in terms of land area (1.1 million km^2) and population (70.7 million). With a per capita GNP of 100 dollars in 2001, Ethiopia is one of the poorest countries in the world (World Bank, 2003). The Ethiopian economy is based mainly on agriculture which provides employment for 85 percent of the labor force and accounts for a little over 50 percent of the GDP and about 90 percent of export revenue. However, low productivity characterizes Ethiopian agriculture. The low productivity of the agricultural sector has made it difficult to attain food self-sufficiency at a national level.

Natural resource degradation is the main environmental problem in Ethiopia. The degradation mainly manifests itself in terms of lands where the soil has either been eroded away and/or whose nutrients have been taken out to exhaustion without any replenishment, deforestation and depletion of ground and surface water. The majority of the farmers in rural areas of Ethiopia are subsistence-oriented, cultivating impoverished soils on sloppy and marginal lands that are generally highly susceptible to soil erosion and other degrading forces. Soil erosion is a phenomenon, which mainly occurs in the highlands of Ethiopia (areas $>$ 1500 meters above sea level) which constitute about 46 percent of the total area of the country, support more than 80 percent of the population,

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and account for over 95 percent of the regularly cultivated land and about 75 percent of the livestock population (SHIFERAW and HOLDEN, 1998). Erosion is most severe on cultivated lands, averaging 42 metric tons (MT) per hectare per year on currently cultivated lands and 70 MT per hectare per year on formerly cultivated degraded lands (HURNI, 1988). According to GIRMA (2001), Ethiopia loses annually 1.5 billion MT of topsoil from the highlands by erosion. This could have added about 1 to1.5 million MT of grain to the country's harvest. A study by SHIFERAW and HOLDEN (1998) shows that the problem of soil erosion is compounded by the fact that some farmers dismantled the conservation structures built in the past through food for work incentives. In fact, until the early 1990s farmers were not allowed to remove the conservation structures once built on their land. However, the introduction of economic reform program in 1990 and subsequent liberalization of the economy also brought more freedom and hence conservation structures could be removed if the land user so wishes.

A review of the relevant literature points to the fact that a number of empirical studies have been undertaken on technology adoption under Ethiopian context. However, nearly all of them have been addressing issues of adoption in relation to improved production technologies. Available evidence shows that studies on the determinants of adoption of soil conservation measures are few and far between. Therefore, this study was conducted in view of bridging this gap. The objectives of this paper are to identify socioeconomic, demographic, institutional and biophysical factors factors, which influence adoption of physical soil conservation measures in Gununo area (Southern highlands of Ethiopia). The rest of this paper is organized in three sections. Section II deals with the research design and methods of data collection and analysis. Section III discusses the findings of the study. The final section summarizes the findings and discusses their policy implications.

2 Research design and analytical method

2.1 Description of the study area

The study area, Gununo, is located in Kindo-Koysha district of Wolaita Zone, the Southern Nations, Nationalities and Peoples Regional State[3]. More specifically, it is located in Doge-Shakisho peasant association, which is found in the southern part of the Ethiopian highlands. The altitude of the study area ranges from 1980 to 2100 meters above sea level. The study area covers 1,006 hectares with an average population density of 523 persons per km^2. Agriculture is the principal economic activity in the study area, though some people derive additional income from basketry, pottery and local beverages. Agricultural production is destined mainly for home consumption. The principal agricultural activity is crop cultivation, which is entirely rain-fed with livestock

[3] With the change in government in 1991, on the basis of ethnic, linguistic and cultural identity, the country was divided into 9 semi-autonomous regional states, one federal capital (Addis Ababa) and one special administrative division (Dire Dawa). According to the Ethiopian Federal Democratic Republic administrative hierarchy, the regional states are divided into zones, districts and *kebeles* in urban areas or peasant associations in rural areas (local administration units), in that order.

rearing as a secondary activity. Almost every farmer practices two cropping systems on his/her cultivated land -a garden system and a field cropping system. In the gardens, farmers plant enset (a staple food of the area)[4], coffee and cabbage. Farmers plant on their fields seasonal crops, such as maize, haricot beans, sorghum, barley and teff (*Eragrostis tef*). Among root crops, sweet potato, Irish potato, taro, cassava and yam are important in the area.

Gununo area is characterized by unimodal rainfall regime with extended rainy season from March to October, although the other months have little to moderate amount of rainfall. Over the 1981-1987 period, the average annual rainfall was 1335 mm and the mean maximum temperature was about 23°C, while the minimum temperature ranged between 15°C and 18°C (SCRP, 1988). Undulating slopes divided by V-shaped valleys of seasonal and/or relatively permanent streams characterize the topography of the study area. Very steep slopes are found along the valley sides, where slopes greater than 30% are very common.

The data for this study were collected from six villages located in the Gununo area. The study covered a total area of 269 hectares with 329 households at the time of the survey (September 2000). The Gununo catchment, which consists of four villages namely Fatata, First Shega, Second Shega and Second Shakisho, was one of the seven national research stations of the Soil Conservation Research Program (SCRP). The SCRP was implemented jointly by the Ethiopian Ministry of Agriculture and the Center for Development and Environment of the University of Berne (Switzerland), in the period 1982-1993. In the course of its implementation, the SCRP introduced and popularized two types of physical soil conservation measures, namely soil bunds and *fanyajuu* in the Gununo area. These structures consist of narrow ridges and canals at slight angle to the contour in order to control erosion and facilitate terrace development. *Fanyajuu* is a terracing process whereby a trench is excavated to form an embarkment on the upper side by throwing the excavated soil uphill whereas soil bunds are constructed by digging a ditch and throwing the soil downhill.

As part of its strategy to popularize soil conservation measures in the Gununo area, the SCRP constructed, free of charge, soil bunds and/or *fanyajuu* on the fields of 220 households (first on the fields of 93 households located in the Gununo catchment and at a later stage on the fields of 127 households located in Buralessa and Gedalla villages, which are adjacent to the catchment) with the belief that these structures would have multiplier effects on the farmers in close proximity to the catchment by way of demonstration and as a result of social interaction. For the purpose of this study the Gununo area was divided into two sites: one with soil conservation structures constructed on farmers' fields by SCRP and another one where there was no direct intervention by SCRP. The former covers an area of 174 ha (74 ha in the Gununo catchment and 100 ha in villages adjacent to the catchment), while the latter covers an area of 95 ha (consisting of Second Shakisho and Second Shega villages located in the Gununo catchment).

[4] Enset (*Ensete ventricosum*) is a banana-like perennial plant grown throughout the Southern Highlands of Ethiopia as the major staple food crop by many cultural groups

2.2 Sampling design

As already noted, the study area was divided in to two sites, one with soil conservation structures constructed on farmers' fields by SCRP (treated site[5]) and another one where there was no direct intervention by SCRP (non-treated site). The treated site consists of four villages, namely Fatata, First Shega, Buralessa and Gedalla while the non-treated site consists of two villages, namely Second Shakisho and Second Shega. In the early 1980s, soil bunds and *fanyajuu* were introduced in Fatata and First Shega villages. More precisely, the SCRP constructed the structures on the fields of the 93 households residing in the two villages. In 1987, following the request made by the farmers in Burallessa and Gedalla villages, the SCRP constructed soil bunds and fanyajuu on the fields of 127 households through the food-for-work scheme.

The survey covered 120 household heads (80 from the treated site and 40 from non-treated site) randomly selected from six villages stratified to include representative samples of areas with (four villages) and without (two villages) direct intervention from SCRP (Table 1). With regard to the sampling technique, proportional random sampling technique was used to select sample respondents from each village.

Table 1: Distribution of sample respondents by villages and farmer group

Site	*Village*	*Total number of households*	*Sampled households*					
			Adopters		*Non-adopters*		*Total*	
			N	*% of total sample*	*N*	*% of total sample*	*N*	*% of total sample*
Treated	Fatata	60	21	17.5	1	0.8	22	18.3
	1st Shega	33	6	5.0	6	5.0	12	10.0
	Buralessa	58	12	10.0	9	7.5	21	17.5
	Gedalla	69	12	10.0	13	10.8	25	20.8
Sub-total		220	51	42.5	29	24.2	80	66.6
Non-treated	2nd Shega	55	6	5.0	14	11.7	20	16.7
	2nd Shakisho	54	4	3.3	16	13.3	20	16.7
Sub-total		109	10	8.3	30	25.0	40	33.4
Grand Total		329	61	50.8	59	49.2	120	100

Although most of the adopters were from villages located in the treated site, there were adopters in villages located in the non-treated site. On the other hand, there were non-adopters even within villages located in the treated site[6]. It should be noted that of the 80 sample respondents selected from the treated site those farmers, who retained the

[5] A treated site is a site where SCP constructed soil conservation structures on farmers' fields.

[6] Adopters were defined as farmers who had either soil bunds or *fanyajuu* or both in at least one plot of their farms at the time of the survey.

introduced technology, either totally or partially, were considered as adopters; whereas those who removed the structures totally were considered as non-adopters. More precisely, of the 80 sample respondents selected from the treated site, 51 were considered as adopters (18 retained the soil conservation structures built on their fields and 33 removed the structures partially) and the remaining 29 farmers were considered as non-adopters (they removed all the structures built on their fields). Similarly, of the 40 sample respondents selected form the non-treated site, 10 adopted the physical soil conservation measures, while the remaining 30 did not adopt the measures.

2.3 Method of data collection

Field research was conducted from September to December 2000. A structured questionnaire was used for the field interviews. The questionnaire was pre-tested by administering it to selected respondents. On the basis of the results obtained from the pretest, necessary modifications were made on the questionnaire. Five technical assistants and two researchers administered the structured questionnaire. In addition to the questionnaire survey, discussions were made with key informants including community leaders, development workers and representatives of non-governmental organizations. Moreover, group discussions were made with randomly selected farmers. These informal techniques helped to acquire useful and detailed information, which would have been difficult to collect through the questionnaire survey.

2.4 Analytical approach

Farmers' decision to adopt or reject new technologies at any time is influenced by a complex set of socioeconomic, demographic, institutional and biophysical factors. Modeling farmers response to agricultural innovations has, therefore, become important both theoretically and empirically. Analysis of the relationship between adoption and determinants of adoption involves a mixed set of qualitative and quantitative data. The response (dependent) variable is dichotomous taking on two values, 1 if the event occurs and 0 if it does not. Estimation of this type of relationship requires the use of qualitative response models. In this regard, the linear probability models, logit and probit models are the possible alternatives. Both the logit and probit models yield similar parameter estimates and it is difficult to distinguish them statistically (Aldrich and Nelson, 1990). However, Maddala (1983) and Gujarati (1988) reported that the logistic and cumulative normal functions are very close in the mid-range, but the logistic function has slightly heavier tails than the cumulative normal function; that is, the normal curve approaches the axes more quickly than the logistic curve. Because of the fact that the binomial logit model is easier to estimate and simpler to interpret, it is used in the present study.

2.5 Working hypotheses and variable specification

Farmers' decision to adopt new technologies at any time is influenced by the combined effect of socioeconomic, demographic, institutional and biophysical factors, which are

related to their objectives and constraints. In this section, the variables to be used in the binomial logit model and the associated working hypotheses are presented.

The dichotomous dependent variable for the adoption model, CNSRV, indicates whether or not a household uses soil conservation measures. CNSRV=1, for households that had either soil bunds, or *fanyajuu* or both in at least one plot of their farms at the time of the survey (adopters) and CNSRV=0 for households that had no soil conservation structures on their fields at the time of the survey (non-adopters). The independent variables of the study are those which are hypothesized to have association with the dissemination and adoption of soil conservation measures. More specifically, the findings of various empirical studies on the adoption of soil conservation measures, the existing theoretical explanations, and the authors' knowledge of the farming systems of the study area were used to select 15 explanatory variables and structure the working hypotheses. The potential explanatory variables, which are hypothesized to influence the adoption of physical soil conservation measures in the study area are presented in Table 2.

3 Results and Discussion

In this section the results of the survey and analytical findings are presented and discussed.

3.1 Descriptive results

As noted earlier, a sample of 120 households consisting of 61 (51%) adopters and 59 (49%) non-adopters was selected from six villages located in Gununo Catchment. About 90 percent of the household heads were males. The survey results show that adopters and non-adopters differ in various aspects. On average, the adopters were relatively younger (42.4 years) than the non-adopters (43.1 years). The non-adopters had slightly larger family size (7.1 persons) than the adopters (6.8 persons). On average each household in the adopter group had 4.5 adult members (active agricultural workers in the age bracket of 15-65 years), while the corresponding figure for the non-adopter group was 3.8. Adopters of soil conservation measures had an average of 1.74 years of formal schooling. The corresponding figure for the non-adopters was 2.25 years. The average size of farmland owned by the sample respondents was 0.8 ha. Adopters owned, on average, relatively larger farm size (0.88 ha) than the non-adopters (0.73 ha). Furthermore, the adopters kept, on average, more livestock (1.8 TLU) than the non-adopters (1.6 TLU). The average land to man ratio for the sample respondents was found to be 0.11 (0.11 for the adopters and 0.12 for the non-adopters). This very low land to man ratio indicates that the area is overpopulated. Therefore, soil conservation technologies, which take some land out of production, like construction of soil conservation structures, have little chance of acceptance by farmers in the study area.

About 59 percent of the respondents reported that their farmlands were susceptible to erosion. Similarly, about 77 percent of the respondents perceived soil erosion as a problem. With regard to security of land ownership right, about 90 percent of the respondents indicated that they felt secure to use their farmland at least in their lifetime.

Table 2: Summary of the Variables used in the logistic regression model.

Explanatory variables	*Unit or type*	*Expected relationship*	*Empirical studies supporting the expected relationship*
AGEF	Age of the household head in years	negative	Gould *et al.* (1989); Sureshwaran *et al.* (1996); Yohannes (1992); Shiferaw and Holden (1998)
FAMILYSZ	The total number of members in a family.	negative	Shiferaw and Holden (1998)
ASSIST	Dummy, 1 if the farmer gets assistance from governmental or non-governmental organization to adopt soil conservation measures; 0 otherwise	positive	Ervin and Ervin (1982); Norris and Batie (1987); Sureshwaran *et al.* (1996); Pattanayak and Mercer (1998)
EDUC	Schooling years of the household head	positive	Ervin and Ervin (1982); Yohannes (1992); Pender and Kerr (1996); Sureshwaran *et al.* (1996)
FARMSZ	Total area of the farm land (cultivated, grazing, homestead and forest) in hectare.	positive/ negative	Ervin and Ervin (1982); Norris and Batie (1987); Gould *et al.* (1989); Sureshwaran *et al.* (1996); Shiferaw and Holden (1998); Mbaga-Semgalawe and Folmer (2000); Boserup (1965)
LANDSECU	Dummy, 1 if the farmer feels that the land belongs to him/her at least in his/her lifetime; 0 otherwise.	positive	Ervin and Ervin (1982); Norris and Batie (1987); Yohannes (1992); Girma (2001); Mulugeta *et al.* (2001)
LANMAN	The ratio of farm size to family size	negative	Shiferaw and Holden (1998); Lapar and Pandey (1999)
INDEPNDT	The number of economically active family members in the household	positive	Pender and Kerr (1996); Sureshwaran *et al.* (1996)
GROUP	Dummy, 1 if the household has a plot in the SCRP catchment; 0 if the household has its land in Buralessa and Gedalla villages.	positive	Mulugeta *et al.* (2001)
PERCEPTN	Dummy, 1 if erosion problem is perceived as a serious problem; 0 otherwise.	positive	Ervin and Ervin (1982); Shiferaw and Holden (1998)
SLOPE	Dummy, 1 if the farmland is steep or very steep; 0 otherwise.	positive	Ervin and Ervin (1982); Norris and Batie (1987); Gould *et al.* (1989); Pattanayak and Mercer (1998); Lapar and Pandey (1999)
TECHATTR	Dummy, for technology characteristics: 1 if farmers express physical soil conservation measures as a source of rodents, running grasses and pose difficulty in plowing; 0 otherwise.	negative	Yohannes (1992); Shiferaw and Holden (1998)
LIVSTOWN	Livestock holdings of the household head in Tropical Livestock Unit (TLU)*.	positive	Shiferaw and Holden (1998)
TYHOUSE	Dummy, 1 if the farmer has corrugated iron roof house; 0 otherwise.	positive	Shiferaw and Holden (1998); Mulugeta *et al.* (2001)
OFFINCOM	Dummy, 1 if the farmer earns off-farm income; 0 otherwise.	positive/ negative	Ervin and Ervin (1982); Clay *et al.* (1998); Mbaga-Semgalawe and Folmer (2000)

* One Tropical Livestock Unit (TLU) is equal to 250 kg which is equivalent to 1 camel; 0.7 cattle; 0.8 horse/mule; 0.5 donkey; 0.1 goat/sheep (ILCA, 1992).

This high percentage could be attributed to the fact that there was no land redistribution in the study area. The majority of the respondents (about 55%) reported that the physical soil conservation structures have inherent problems (the structures being considered as breeding ground for rodents, expansion of grass towards the farm land and posing difficulty in plowing across the field). Sixty-one percent of the respondents indicated that they earned additional income from non-farm activities. Eighteen percent of the sample respondents owned corrugated iron-roofed houses whereas the rest (82 %) owned thatched houses.

Farmers' decision to adopt soil conservation measures is not only influenced by their perception of erosion hazard but also by the types of structures and their attributes. As already noted, of the 80 sample respondents in the treated site, 33 removed the structures partially and 29 removed them totally. The sample respondents who removed the soil conservation structures partially or totally were asked to list down the reasons for their decision and their responses are set out in Table 3. About 55 percent of the sample farmers who removed soil conservation structures partially and about 59 percent of the respondents who removed the structures totally reported that mole rat, running grass and difficulty of plowing across the field were the main reasons for removing the soil conservation structures. Other important reasons for removing structures partially or totally include, the belief that the farmland was relatively flat, the potential loss of land to conservation structures, which occupy part of the scarce productive land, and proximity of the plot, from which the structures were removed, to *enset* field. This is because *enset* plant is believed to help control soil erosion.

Table 3: Distribution of sample farmers from the treated site by their reasons for removing soil conservation structures partially or totally

Reasons	*Removed partially*		*Removed totally*	
	N	*%*	*N*	*%*
Technology attributes[1]	18	54.5	17	58.6
Slope of the farm land was not steep	3	9.1	6	20.7
Shortage of the farm land and technology attributes	7	21.2	0	0
Shortage of land[2]	3	9.1	4	13.8
Plot not far from enset field	1	3.0	1	3.4
Shortage of land and moderate slope of the plot	1	3.0	0	0
Fear of conflicts with neighbors	0	0	1	3.4
Total	33	100	29	100

[1] structures were source of rodents and running grass and increased labor time for land preparation

[2] structures put considerable amount of land out of production

The survey results reveal also the reasons why the majority of the sample farmers in the non-treated site (75 percent) did not adopt physical soil conservation measures (Table 4). Responses from non-adopters in the non-treated site about the reasons for not adopting physical soil conservation measures indicate that loss of cultivable land to conservation structures was the most commonly cited major reason (about 27%) (Table 4). The inherent problems associated with the soil conservation structures, such as becoming sources of rodents and running grass and increasing labor time for land preparation were considered to be the major reasons for non-adoption by about 23 percent of the non-adopters in the non-treated site. Other reasons cited for not adopting physical soil conservation measures include, preference given to indigenous soil conservation measures (13.3%), the perception that soil erosion was not a problem because of the moderate slope of the farmland (10%), lack of government assistance (10%), labor shortage (10%) and relatively high labor requirements to establish and maintain the structures (7%)[7].

Table 4: Farmers' reasons for the non-adoption of physical soil conservation measures in the non-treated site

Reasons	*Number of farmers*	*Percent*
Structures take some land out of production	8	26.7
Structures are sources rodents, running grass and create difficulty in plowing	7	23.3
Prefer indigenous soil conservation measures	4	13.3
The slope of the farm land was not steep	3	10.0
Lack of government assistance	3	10.0
Labor shortage	3	10.0
High cost of labor for establishment and maintenance of structures	2	7.0
Total	30	100

3.2 Analytical findings

The maximum likelihood method of estimation was used to elicit the parameter estimates of the binomial logistic regression model and statistically significant variables were identified in order to measure their relative importance on the farmers' soil conservation

[7] The indigenous soil conservation practices that were reportedly used in the study area include planting of banana, *enset*, crop-residue/trash line, and construction of water-way.

adoption decision. The binomial logistic regression required six iterations to generate the parameter estimates[8].

The value of Pearson - χ^2 indicates the goodness-of-fit test for the fitted model. The likelihood ratio test statistic exceeds the χ^2 critical value with 15 degrees of freedom at less than 1 % probability level, indicating that the hypothesis that all the coefficients, except the intercept are equal to zero is rejected. Another measure of goodness of fit is based on a scheme that classifies the predicted value of the dependent variable, CNSRV, as 1 if $\mathrm{P}_{(\mathrm{i})} \geq$ 0.5 and 0 otherwise. The model correctly predicts 94 of 120 (78.3 percent) observations. The sensitivity (correctly predicted adopters) and the specificity (correctly predicted non-adopters) of the binomial logit model are 78.7 percent and 78 percent, respectively. Thus, the model predicts both groups, the adopters and the non-adopters, fairly accurately.

The maximum likelihood estimates for the binomial logit model are set out in Table 5. The model results indicate that the signs of all the variables, except that of TECHATTR and TYHOUSE, turned out to be consistent with the a priori expectations. Out of the fifteen variables hypothesized to influence the adoption of physical soil conservation measures, four were found to be significant at less than one percent probability level. These include the number of economically active family members (INDEPNDT), whether or not a household has a plot within the SCRP catchment (GROUP), perception of soil erosion problem (PERCEPTN) and attributes of soil conservation structures (TECHATTR). Three variables were significant at five percent probability level. These variables include family size (FAMILYSZ), farm size (FARMSZ) and the type of house (TYHOUSE). Eight of the fifteen explanatory variables that were hypothesised to affect adoption of physical soil conservation measures did not have statistically significant effects.

The estimated binomial logit model shows that family size (FAMILYSZ) affects the adoption of physical soil conservation measures negatively and significantly. This result is consistent with the *a priori* expectation. This is so because households with larger family size are likely to face food shortage in periods of drought. As a result, they try to maximize short-term benefits and would be less interested in soil conservation measures whose benefits can be reaped in the long run.

As expected, farm size (FARMSZ) has a positive and significant influence on the farmers' decision to adopt physical soil conservation measures. The possible explanation is that larger farms are associated with greater wealth and increased availability of capital, which increase the probability of investment in soil conservation measures. Adoption of soil conservation measures is significantly and positively associated with the number of economically active family members (INDEPNDT). The implication is that house-

[8] A technique called variance inflation factor (VIF) was used to measure the degree of linear relationships among the quantitative explanatory variables. Moreover, contingency coefficients were computed for each pair of qualitative variables to check for the degree of association among the qualitative variables. As the results show very small degree of collinearity among the explanatory variables, all of the qualitative and quantitative variables were included in the estimation of the model.

Table 5: The Maximum Likelihood Estimates of the binomial logit model.

Variable name	*Estimated Coefficient*	*Odds Ratio*	*Wald Statistics*	*Significance Level*
Constant	-5.173	0.01	8.014	0.005 ***
AGEF	-0.010	0.99	0.253	0.615
FAMILYSZ	-0.424	0.65	5.113	0.024 **
ASSIST	0.637	1.89	1.435	0.231
EDUC	-0.117	0.89	1.9322	0.165
FARMSZ	2.596	13.40	4.398	0.036 **
LANDSECU	0.729	2.07	0.804	0.37
LANMAN	-8.014	000	2.025	0.155
INDEPNDT	0.698	2.01	8.559	0.003 ***
GROUP	2.189	8.92	13.207	0.00 ***
PERCEPTN	1.927	6.87	8.458	0.004 ***
SLOPE	0.405	1.50	0.623	0.43
TECHATTR	1.465	4.33	8.799	0.003 ***
LIVSTOWN	0.001	1.00	1.027	0.311
TYHOUSE	-1.551	0.21	4.182	0.041 **
OFFINCOM	-0.057	0.95	0.013	0.910
Pearson-χ^2		55.065 ***		
Likelihood Ratio Test		117.114 ***		
Correctly Predicted		78.3[a]		
Sensitivity		78.7[b]		
Specificity		78.0[c]		

*** Significant at less than 1% probability level;

** Significant at 5% probability level

[a] Based on a 50-50 probability classification scheme

[b] Correctly predicted adopters based on a 50-50 probability classification

[c] Correctly predicted non-adopters based on a 50-50 probability classification scheme

Source: model output

holds with large number of active agricultural workers are more likely to invest in soil conservation measures, which are known to be labor intensive. The variable GROUP, which indicates whether or not a household has a plot within the SCRP catchment, has a significant positive influence on the adoption of physical soil conservation measures.

This is precisely because those farmers who have plots with in the SCRP catchment have the possibility to meet the project staff and be well informed about the consequences of soil erosion than those who own land outside the catchment. As anticipated, farmers' perception of soil erosion problem (PERCEPTN) affects the adoption of soil conservation measures positively and significantly. The implication is that farmers who feel that their farmlands are prone to soil erosion are more likely to adopt physical soil conservation measures than those who do not perceive the problem of soil erosion.

The estimated model shows that the technology characteristics (TECHATTR) has a positive and significant influence on the adoption of physical soil conservation measures. The possible explanation may be that despite the perceived negative impacts associated with the technology, farmers adopt physical soil conservation measures. This could be explained by the fact that those farmers who had already adopted physical soil conservation measures were aware of the possible consequences of soil erosion and they retained the structures no matter how problematic they might be. It is, however, important that soil conservation technologies go hand in hand with appropriate technologies, which help mitigate the undesirable effects of the technologies in question. Contrary to the *a priori* expectation, the type of house, used as a proxy for wealth, has a significant negative influence on the adoption of physical soil conservation measures. This may be due to the fact that this variable is not a very good proxy for wealth. In fact, the informal survey results reveal that some farmers who own corrugated iron roofed houses had totally removed the soil conservation structures built by the SCRP. Similarly, some of the farmers who own corrugated iron roofed houses were categorized under the poor wealth category by the key informants, indicating that the possession of a corrugated iron roofed house is not a good indicator of the current wealth status in the study area. It is also interesting to note that, of the 22 respondents who owned corrugated iron roofed houses, thirteen reported that they received remittance from their children who settled in big urban centers and/or abroad, which in our view might make them less interested in soil conservation work.

4 Conclusion

This study attempted to identify important factors, which influence adoption of physical soil conservation measures in the Southern Highlands of Ethiopia, Gununo area. The empirical results show that the major factors influencing adoption of physical soil conservation measures in the study area are: farmers' perception of soil erosion problem; technology attributes; the number of economically active family members; farm size; family size; wealth status of the farmer; and the location of the farmland (whether or not the farmer has a plot of land inside the SCRP catchment). An important implication of the results presented in this paper is that any intervention in soil conservation should recognize the heterogeneity in household characteristics, land holding, institutional patterns and technology-specific traits.

Another implication of the findings of this study is the need to increase farmers' perception of soil erosion problem through the provision of knowledge and demonstration of gains and risk reduction characteristics of soil conservation practices. This is important

because the extent to which farmers understand and feel the need for controlling soil erosion affects adoption of soil conservation measures positively. The results also highlight the need to undertake research on indigenous soil conservation measures, which were reported to be well adapted to the study area by some of the non-adopters. It goes without saying that sustainable use of soil conservation measures critically depends on their suitability to the local ecology and the farming systems. Therefore, it is important to design soil conservation practices, which couple modern scientific knowledge with indigenous technical knowledge to facilitate their dissemination and ensure their sustainability.

Acknowledgements

The authors would like to thank the anonymous referees for their useful and pertinent comments on an earlier version of this paper.

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Appendix A

Household Questionnaire, 2005 and 2007 Survey, Southern Ethiopia

The January 2007 survey includes land rental and livestock share contract partners

Type of Questionnniare

A). Main household :_____ B). Partner household:_____

Zone _____

Homestead GPS coordinates:_____

Woreda _____

Peasant Association (PA): _____

Sub PA (Village): _____

Land rental partner name: _____

How far? In minutes

Household number: _____

Animal share partner name:_____

How far? In minutes

Name of main household head:_____

First interview:	
Second interview:	
Third interview:	

Data checked by	When	Status		Comments
		ok	Return	

No:	Name of hh members	Rel.Head	Sex	Age	Education	experience
1		Head				
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						

Codes: Relation to household head: 1=wife, 2=child, 3=grand child, 4=brother, 5=sister, 6=hired labor 7=other, specify:----------

Sex: 1=female, 2=male. Age: in Years. Farm experience: in years. Education: in years of school.

Same head as previous survey: 1= yes 0= no

Same wife as previous survey: 1= yes 0=no

Other changes in the household: 1= better off-farm activities 2= less/no off farm activities 4= occupation (specify) 5= other (specify)----------

Do you have any position in the PA? 1.yes 0=no

If yes, specify the position- 1) Chairman of the PA 2) secretary 3) Militia (tataki) 4) party member 5) others (specify)

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 assistance.

Type of project PhD study. Collaboration: SARI and UMB

Farm household survey: Consumption Expenditures in the last 12 months (Birr)

Commodity	Quantity Own Prod	Quantity Bought	Price/unit	Unit	Own prod. Cons.Value	Cash Consump. Expenditure	Total Value of Consumption
Teff							
Wheat							
Barley							
Maize							
Sorghum							
Enset, kocho							
Enset, bulla							
Enset, werkie							
Sweet potato							
Irish potato							
Yam (*Boye*)							
Taro (*Boyena*)							
Haricot bean							
Horsebean							
Chickpea							
Sugar cane							
Banana							
Mango							
Papaya							
Avocado							
Guava							
Pepper							
Kale							
Cabbage							
Onion							
Carrot							
Tomato							
Other vegetables							
Garlic							
Coffee							
Chat							
Spices							
Beef							
Sheep							
Goat							
Chicken							
Eggs							
Milk							
Butter							
Leisure (drinks, candies, lotteries etc.)							
Others, specify							

Quantity: Number of units. per: week, month, season or year. Unit: Kg, pieces, sheets, etc.

Total expenditure: Includes value of own production. Cash expenditure: On purchased quantity

Own production: Market value (Birr) of own production.

Where bought: 1: from neigbour, 2: within PA, 3: local market, 4: distant market, 5: trader visiting village

Livestock ownership

Animal type	Stock E.C 98	Stock Current	Livestock sold		Income
			quantity	price/unit	from sale (birr)
Cattle					
Milking cow					
Other cows					
Oxen					
Heifer					
Bulls					
Calves					
Sheep					
Ewes					
Ram					
Lamb					
Goats					
Does					
Bucks					
Kids					
Horses					
Mules					
Donkeys					
Chicken					
Bee hives: Local					
Improved					

Extension Advice

How frequently are you in contact with extension agents per year (Tick)

Type of advice	never	once	two times	three times	> three times
swc					
manuring					
compost preparation					
credit supply					
credit repayment					
fertilizer application					
improved seed use					
home economics					
family planning					

Other sources of income (E.C 1999).

Source	Total Income		Total Income
Hiring out oxen		Migrant income	
Hire out labour		Remittance Income	
Labour exchange		Food Aid	
Assistence received		Government Transfers	
Assistence given		Sale of firewood	
Employment		Sale of Handicraft	
Food for Work		Sale of beverages	
Rent out land		Assistance from relatives *	
		Gifts	
		Petty trade	
		Grain mill	
		Other business/services	

Employment: permanent job locally, Hire out labour: temporary job locally,
Remittance income: Money sent by relatives permanently living elsewhere
Assistance from relatives:
Assistance in kind or in money from relatives living nearby, including labour/help but not in the form of labor exchange.

Type of project: PhD study. Collaboration: SARI and UMB.

Village/sub PA:

Does the household have a land certificate? 1=Yes 0= No If yes, date of receiving the certificate----------

Date of land registration:----------

Family size (when the land allocation was made)----------

The time when the last land allocation was made:----------The number of plots allocated----------

Household name: Interviewer:

Plot leve Overview and defining plots owned and operated by the household

NB: order plots by distance from home and ownership

Plot No.	plot size in sq. meters	distance from hon to plots in meters	Ownership status 2007	Ownership since year	GPS Coordinate	Altitude (elevation)	Orgin of plots	Who decide on plots	Who work on plots
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									

Codes: Ownership of plot: 1=own land, 2=rented in land, 3=rented out land 4= shared in 5= shared out

Distance from home: in meters

Origin of plots: 1. Husband/Husband's family, 2. Wife's family 3). Government 4. Others, specify

Who decide on plots (make production and investment decisions):

1. Husband/male head 2. Joint decisions 3. Wife 4. Female 5. Others, specify----------

Yield and input use plot level data for belg and Meher seasons, last 12 months:

Plot Number	Area Sq. meters	Season	Crops grown, output (kg), area planted (Sq. meters)					Input use			
			main crop	inter crop*	Maincrop output	intercrop output	area	Seeds (kg) main	intercrop	UREA Kg	DAP Kg
1		Meher									
		Belg									
2		Meher									
		Belg									
3		Meher									
		Belg									
4		Meher									
		Belg									
5		Meher									
		Belg									
6		Meher									
		Belg									
7		Meher									
		Belg									
8		Meher									
		Belg									
9		Meher									
		Belg									
10		Meher									
		Belg									
11		Meher									
		Belg									
12		Meher									
		Belg									
13		Meher									

*For intercrops, write the codes, yield and area for the second, third, etc crop in the intercropping system.

Crop codes: 1=wheat, 2=barley, 3=teff, 4=sorghum, 5=maize, 6=haricot bean, 7=horse bean, 8=chickpea, 9=sugar cane, 10=coffee, 11=chat, 12b= enset (kocho), 12c= enset(amicho) 12d= enset (fiber) 13=sweet potato,14=taro,15=yam,16=irish potato,17=kale, 24=mango, 25= others, specify----------

Type of project: PhD study. Collaboration: SARI and UMB.

Household number: ____ Enumerator name: _____ NB: order plots by distance from home and ownership

HH Name _____ PA: _____

Input use plot level data: 2007----contd.

Plot Numbers	Area Sq.meters	Season	Labor used for crop production activities in Mandays (MD)																					
			1MD= 8 hours																					
			Plouging		Weeding				Harvesting				Threshing				*Enset* processing				Manuring			
			Male Labor		Male Labor		female labor		Male Labor		female labor		Male Labor		female labor		Male Labor		female labor		Male Labor		female labor	
			own	Hired	own	hired	own	hired	own	hired	own	hired	own	hired	own	hired	own	hired	own	hired	own	hired	own	hired
1		Meher																						
		Belg																						
2		Meher																						
		Belg																						
3		Meher																						
		Belg																						
4		Meher																						
		Belg																						
5		Meher																						
		Belg																						
6		Meher																						
		Belg																						
7		Meher																						
		Belg																						
8		Meher																						
		Belg																						
9		Meher																						
		Belg																						
10		Meher																						
		Belg																						
11		Meher																						
		Belg																						
12		Meher																						
		Belg																						
13		Meher																						

Crop codes: 1=wheat, 2=barley, 3=teff, 4=sorghum, 5=maize, 6=haricot bean, 7=horse bean, 8=chickpea, 9=sugar cane, 10=coffee, 11=chat, 12= enset 12a=enset (bulla), 12b= enset (kocho), 12c= enset(an 12d= enset (fiber) 13=sweet potato,14=taro,15=yam,16=irish potato,17=kale,18=cabbage,19=onion,20=other vegetables, specify, 21=banana, 22=sugar cane,23=papaya, 24=mango, 25= others, specify----------

Type of project: PhD study. Collaboration: SARI and UMB.
Household number:_____ Enumerator name: _____ NB: order plots by distance from home and ownership
HH Name_____ PA: _____
Input use plot level data: 2007…*contd*

			Exchange labor used (MD)		Conservation labour, mandays			Labor used (mandays) in Tree planting 2005		Oxen used (in hours)	
Plot Number	Area Temad	Season	male	female	New structures	Maintenance	Removal	Labour, Md.	No. of seedling	Own oxen	shared oxen
1		Meher									
		Belg									
2		Meher									
		Belg									
3		Meher									
		Belg									
4		Meher									
		Belg									
5		Meher									
		Belg									
6		Meher									
		Belg									
7		Meher									
		Belg									
8		Meher									
		Belg									
9		Meher									
		Belg									
10		Meher									
		Belg									
11		Meher									
		Belg									
12		Meher									
		Belg									
13		Meher									

Crop codes: 1=wheat, 2=barley, 3=teff, 4=sorghum, 5=maize, 6=haricot bean, 7=horsebean, 8=chickpea, 9=su 12b= enset (kocho), 12c= enset (amicho) 12d= enset (fiber)
13=sweet potato,14=taro,15=yam,16=irish potato,17=kale,18=cabbage,19=onion,20=other vegetable 24=mango,25=other fruit,specify_____

Land disputes

Have you ever had any conflicts or claims regarding the land you own? Yes = 1, No =0_____ If NO, go next page

Household

Village:

Subvillage

:

2005 Plot No.	disputes on plot? Last 15 years,	If yes, when? Year	Type of conflict	Case taken to court? 1=yes,0=no	Person taking case to court	Person being charged (defendant	Sex of other party	Age of other party	How was dispute resolved?	Outcome of dispute

Type of conflict: 1. Border dispute, 2. Inheritance dispute, 3. Land rental dispute, 4. Animal grazing/encroachment on communal land, 5. Animal grazing/encroachment on private land, 6. Dispute related to land taking and compensation. 7. Other, specify_____

Sex of other persons: 1=male 0=female

Person taking case to court/ Person being charged: 1. This household head. 2. Other family member, specify relationship…….. 3. Neighbour, 4. Other person in community. 5. Other person, specify……

How was dispute resolved: 1. Agreement among parties. 2. Resolved by elders, 3. Decision in social court. 4. Decision in woreda court. 5. Unresolved 6. Others, specify----------

Outcome of dispute: 1.This household won the case. 2. This household lost the case, 3. Compromise solution, 4. No solution.

Do you today have enough land for your family's food requirments? 1. Yes 2. No

Has the quantity or amount of household's lands changed during the last 10 years? 1. Yes there is less 2. Yes there is more 3. No

If yes, give reasons…….

Type of project: PhD study. Collaboration: SARI and UMB. NB: Order plots by distance from home and ownership

Farm plot level data: Ownership, land rental contracts enforcement

Name of Household Head:_____ Enumerator name:_____

Household number: PA: Date: _____

Plot No.	Land rental markets and payments										
	If the farmer rent in part or all of his/her plot						If the farmer rent out part or all of his/her plot				
	why	amount paid/timad	Duration	Partnership	when pai	from wh	why	amount paid/ti	contract period	When paid	for whom
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											

Why: 1= lack of labor 2= availability of labor 3= enough farm land 4= shortage of farm land 5= lack of money to purchase fertilizer and seeds

6= sick/disable 7=to share risk 8= lack of oxen 9= to pay debt 10= others, specify

From/for whom: 1= relative, 2= close neighbour 3=outside my kinship 4= others, specify

When paid: 1. Immediately when contract made 2. Just after harvest 3. Others, specify_____

Contract duration: 1. Less than 1 year 2. 2 years 3. 3 years 4. greater than 3 years

Land rental price per timad per year----------Birr

Partnership: how long have you been partner?_____months

Are you interested in renting out some (more) of your land more than :Yes/no

If no, why?----------

If yes, how much more land would you rent out Timad:----------

Were you interested in renting out some land last year? Yes/no

If yes but actually did not rent out, what are the reasons----------

If no, why?----------

Are you interested in renting in some (more) land than you did last tir:yes/no

If no, why?----------

If yes, how much more land would you rent in? Temad:

Were you interested in renting in some land last year? Yes/no

If yes but actually did not rent in, what are the reasons

_____

If no, why?_____

Did you have many candidate partners to choose from land rental contracts? Yes/no

If yes, what criteria did you use to select your partner?----------

1. Reputation 2. Trust 3. Endowments 4. Kinship 5. Others, specify----------

Did you face conflict (disgreement) with your partner related to the the land rental contracts you

If no, why?

1= my partner showed good reputation (relation) in the past

2= my partner is my close relative (same kin) 3= my partner is same religion with me

4= others (specify)----------

Livestock share contracts

Did you participate in animal share contracts during the last 3 years? 1= yes 2= no_____

If yes, are you the one who keep the animal? 1= yes 2=no

If no, did you contribute money or share out the animal? (Tick one of the following and specify

1) contribute a total of_____Birr

2) share out animal 3) Others specify

When did you first participate in animal share contracts? _____years

Type of animals shared, initial costs and profit shared last 3 years

Type	Animal keeper		Partner farmer		duration of
	initial cost	Profit shared	Initial cost	profit shared	contract (years)
Oxen					
cow					
heifer					
bull					
goat					
Total					

Who covers animal keeping costs? 1) animal keeper 2) partner 3) share equally 4) others, specify----------

Do you share the risk in case the animal die? Yes/no. If yes, how much----------

Did you have many candidate partners to choose from for animal share contracts? Yes/no

If yes, what criteria did you use to select your partner?----------

1. Reputation 2. Trust 3. Endowments 4. Kinship 5. Others, specify----------

Did you face conflict (disgreement) with your partner related to the contract you had?Yes/no

If no, why? _____

1= my partner showed good reputation (relation) in the past

2= my partner is my close relative (same kin) 3= my partner is same religion with me

4= others (specify)----------

Regarding distress land rentals

1. How many years out of the last ten years did you experience food shortage? 1=Never, 2=Once, 3=2-3 times, 4=4-6 times, 5= >6 times, 6=Every year

2. Did food shortages affect your land renting activity? 1=yes, 0=no

3. If yes, how? 1=Rent out more land

2=Rent out land for cash

3=Rent out land on long-term contract for cash

4=Other, specify:

4. Did your household experience serious sickness and during the last 5 years 1=yes 0=no

5. If yes, explain details:

Who were sick? 1. 2. 3

Sick how long?

Cause of sickness

6. Did sickness affect farming activity? 1=yes, 0=no

7. If yes, how? 1=Sold animals, 2=Produced less, 3=Rent out land, 4=other, what?

8. Did sickness affect land renting (sharecropping) activity of the household? 1=yes, 0=no

9. If yes, how? 1=Rent out land, 2=Rent out more land (if rented out before)

3=Changed type of rental contract from sharecropping to fixed rent

4=Changed type of contract to more specify

10. Did the household experience death of family members during the last ten years? 1=yes, 0=no

11. If yes, give details:

Who died? 1. 2. 3.

Year of death:

Cause of death:

12. Did the death affect the production activities of the household? 1=yes 0=no

13. If yes, how? 1=Sold animals, 2=Produced less, 3=Rent out land, 4= other, what

14. Did death(s) affect land renting (sharecropping) activity of the household?

15. If yes, how? 1=Rent out land, 2=Rent out more land (if rented out before)

3=Changed type of rental contract from sharecropping to fixed rent

4=Changed type of contract to more long-term contract, 5=other,specify

Type of project: PhD study. Collaboration: SARI and UMB.
Farm plot level data: Land rental contracts (sharecropping) NB: Order plots by distance from home and ownership
PA: _____

Name of Household Head: _____ Enumerator: _____

Household number: _____ Date: _____

																	Soil fertility
Plot	If the farmer sharecrop in plot (fill)								If the farmer sharecrop out (fill)								measures
No.	why?	input sha	output		Amount	from	Type of	Duratio	why?	input	output	Amount	for who	Type of	Duratio		last 3 years
			share	input (bi	output(	whom	contract			share	share	input cost(birr)	output(I	contract			
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	

Codes Why: 1= lack of labor 2= availability of labor 3= enough farm land 4= shortage of farm land 5= lack of money to purchase fertilizer and seeds 6= sick/disable 7= to share risk 8= others,

From/for whom 1= relative, 2= Close neigbour 3= outside my 3=outside my kinship 4= others, specify

Type of contract 1= written contract approved by PA committee 2= written contrac 3= oral contract 4= others, specify----------

Input cost shar 1= equal input share 2= tenant covers all the costs initially but get it back later 3. landlord cover the initial cost but get it back later 4) Tenant covers all cost 5) landlord covers all costs

Input cost share: total amount of input cost in birr covered by the tenant

Output share= 1= equal share 2=equal share after subtracting input costs 3= others, specify

Amount shared: specify amount obtained in Birr----------

How do you calculate input costs at harvest when you cover costs initially? 1) Deduct same amount 2) Use current price 3) Take grain equivalent

Contract duration: 1. Less than 1 year 2. 2 years 3. 3 years 4. greater than 3 years

Type of soil fertility measures : 1= manuring 2= use of chemical fertilizer 3= tree planting 4= physical soil conservation measures 5=fencing 6= leave the land fallow 7= construct a house 8= cut trees 9=others, specify

Type of conflict: 1= boundary 2= ownership 3=between father and son 4= among brothers and sisters 5= among wife and other relatives 6= husband and wife in crop allocation 7= poor performance by tenan 8= others, specify----------

Status= 1= resolved by PA committee 2= resolved by elderly/religious people 3= not resolved 4= others (specify)----------

In case landlord covers fertilizer cost, who is responsible for fertilizer application? 1. Landlord 2. Tenant 3. Both 4. Others, specify----------

Are you interested in sharing out some (more) of your land m Yes/no

If no, why?----------

If yes, how much more land w share out? Timad:----------

Were you interested in renting out some land last year? Yes/no If yes, for which plot----------

If yes but actually did not rent out, what are the reasons----------

If no, why?----------

Are you interested in sharing in some (more) land than you d yes/no

If no, why?----------

If yes, how much more land w Temad:

Were you interested in sharing in some land last year? Yes/no If yes, for which plot----------

If yes but actually did notshare in, what are the reasons

If no, why?

Did you have many candidate partners to choose from? Yes/no

If yes, what criteria did you use to select your partner?----------

1. Reputation 2. Trust 3. Endowments 4. Kinship 5. Others, specify----------

Did you face conflict (disgreement) with your partner related to the share contracts you had?Yes/no

If no, why?

1= my partner showed good reputation (relation) in the past

2= my partner is my close relative (sam 3= my partner is same religion with me

4= others (specify)----------

If you want, can you rent out any of your plots (including grazing land) without approval from the PA? Yes/no

If yes, specify the agreement (contract) made with your partner ……

If no, specify the agreement (contract) made with the PA ……

Type of project: PhD study. Collaboration: SARI and UMB.

Farm plot level data:

Woreda: _____ Interviewer: _____ NB: order plots by distance from home and ownership

PA= _____ Date of interview: _____ Household number: _____ (use same order as before)

Village _____ Household head name: _____ Altitude _____

Plot N0.	Soil type	Soil depth	Slope	Plot quality	Susceptibi to erosion	Degree of soil degrad	Types of conserv. st	year of est shement	area occup by cons.str	Length of cons. struc	No. of harvestable tre		Number of young tree		Changes last three years			Reasons for changes			Quality of
											Eucalyptus	Natural/O	0-3 years	4-7 years	Cons. stru	Land quali	Yields	Cons.struc	land qualit	yields	Cons.struct.
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					

Soil type: 1=*Arada* (Black), 2=*Leda* (Dark brown), 3=*Goshi* (Red) 4=*Bossoluwa (white)* 5=others, specify

Soil depth: 1=Shallow (<30cm), 2=Medium (30-60 cm), 3=Deep (>60 cm)

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

Plot quality: 1=Poor, 2=Medium, 3=Good quality

Susceptibility (exposure) to erosion: 1=high, 2=medium, 3=low, 4=none

Degree of soil degradation: 1=highly degraded, 2=degraded, 3=moderately degraded, 4= no degradation

Types of conservation structures: 1=traditional ditches, 2=cut-off drains, 3=artificial waterways 4=raised boundary bunds, 5=stone/soil bunds, 6=grass strips, 7=Fanya juu, 8=Other, specify

Changes in conservation structures: 1=improved, 0=no change, -1=removed/reduced quality

Changes in land quality: 1=improved quality, 0=no change, -1=worsened land quality

Changes in yields: 1=increased yields, 0=no yield change, -1= reduced yields

Reasons for change: 1= more cons.struct. constructed 2= cons.struc. removed 3= due to decline in land quality 4= drought 5=pests and diseases 6= others, specify

Quality of conservation structures: 0=poor, 1=medium, 2=good

Type of project: PhD study. Colla Woreda: _____ Interviewer: _____
Farm household survey: Credit con PA= _____ Date of interview:
Village Household head name: _____
Did you apply to get credit in the last 12 months? Yes /no (If no go to B, non-users of farm credits)
If yes, have you obtained farm credit ? yes/no (If no, go to A, non-users of farm credits)
If yes, give details (for those applied for credit and received)

Purpose credit	Source	amour Birr or	Amou (Birr or kg)	Unit	Duratior the loan	Collateral? 1=yes,	when paic	repayment status (Birr) amount repaic	amount not rep	why failed to repay?
Fertilizer										
DAP (kg)										
Urea (kg)										
Improved seeds										
maize (kg)										
teff (kg)										
wheat (kg)										
sweet potato (kg)										
potato (kg)										
Cash (Birr)										
milking cow										
Sheep										
Goat										
Animal fatening										
chicken										
consumption										
family events										

Codes: Source: 1= government (Bureau of Agriculture) 2= Government (omo microfinance) 3= NGOs 4= local money lenders 5= relati
6= neigbour 7= informal institutic 8= shop keepres 9= others, specify
when paid= state number of months after the contract (agreement)
why failed: 1= crop failure due to rainfall shortage 2= low crop price coincides with the repayment time 3=repayment time not yet
5=most contracts I had with (government /others sources) have been extended for additional years
6=I assumed it is better to repay the credit later (when crop/livestock price rise) including the fine(penality).
7= I took the credit with out my interest (simply gave me as a package) 8= illness 9=others, specify
consumption includes all expenses related to food purchase and expenses on health,transport

Ask Non-Users of Farm Credits
A) Applied but not used credit in the last 12 months, give their reasons
1= the fertilizer delivered very late 2= lenders asked me to co-sign with others not familiare with me
3= the cost of credit became so high, hence decided not to use.
4= due to health problem (human a 5= fear of repayment 6=I do not need credit since my farm land is fertile
7=I did not know the benefit from using the credit 8= others (sepcify)----------
B) For those not applied, give their reasons
1= I assumed my application would be rejected since I did not repay previous loan 2= I assumed my application would be rejected
becuase there are many applicants 3= I did not know to whom to apply 4= I do not want credit 5= high transportation cost to get the cred
6= lack of nearby formal credit age 7= high interes 8= expensive to pay the initial payment 9= fear of loss of assets
10=too tough penality 11=too risky to take credit 12=others, specify----------

Is the current credit repayment time (i.e repayment right at harvest) suitable to you? Yes/no

If no, why and suggest which month you would prefer to repay your loan?----------

If no, what alternative repayment plan can be designed?----------

If you have never borrowed from any credit sources before what is (are) the main reason (s)?

Reasons		Yes=1	No=2
No need for credit			
unable to form a group			
unable to meet compulsory saving requirment			
Inactive poor			
others, specify			

Were you borrowing credit from any of the above sources but have quit now? Yes/no
If yes, why did you quit ?

Reasons	Yes=	No= 2
Do not need credit any more		
The credit is too small to meet my needs		
Difficult to form a group		
Group requirment to pledge personal assets as collateral		
Group meeting/discussion requirments are not suitable for me		
Easier to get loans from other sources		
Return from the loan is low given the risk involved		
others, specify		

If no, indicate the type of credit and loan size you applied for---------- ----------
Have any of your applications for credit in the last 12 months rejected? Yes/no

If yes, why and when----------

If yes, were you able to get credit from other sources (outside of this credit agent) in this particular year? Yes/no
If yes, explain----------
If no, why? 1= I did not apply to get credit from other sources 2= I applied to get credit from other sources but my application rejected
3= others (specify)----------

What do you think the major reason why your second application rejected again?
1= I was unable to provide collateral (initial payment) 2= lenders use the same credit distribution channel (i.e PA) and knew borrowers
3= My application was not on time. 4=others (specify)

Have you ever received extension advise/ letter of warning from lenders because of delay to repay your loan, last three years? Yes/no
If yes, did you repay after the warning? Yes/no Ifyes, when and how much? ----------

If yes, how did you pay
If yes, how did you manage to repay the loan?
1= selling crops at a lower price 2= selling livestock 3=Lenders took another asset in exchange for the debt I had
4= got prison terms for about ----------montand when----------

For those who obtained credit in 1998 E.C (2005/06) i.e last 12 months.

Is the credit you have obtained exactly what you would like to get? Yes/nc

If no, indicate the type of credit and loan size you applied for----------
Have any of your applications for credit in the last 12 months rejected? Yes/no

If yes, why and when----------

If yes, were you able to get credit from other sources (outside of this credit agent) in this particular year? Yes/no
If yes, explain----------
If no, why? 1= I did not apply to get credit from other sources 2= I applied to get credit from other sources but my application rejected
3= others (specify)----------

What do you think the major reason why your second application rejected again?
1= I was unable to provide collateral (initial payment) 2= lenders use the same credit distribution channel (i.e PA) and knew borrowers
3= My application was not on time. 4=others (specify)

Have you ever received extension advise/ letter of warning from lenders because of delay to repay your loan, last three years? Yes/no
If yes, did you repay after the warning? Yes/no Ifyes, when and how much? ----------
If yes, how much did you repay
If yes, how did you manage to repay the loan?
1= selling crops at a lower price 2= selling livestock
3=Lenders took another asset in exchange for the debt I had
4= got prison terms for about ----------mont and when----------

Some farmers are not willing to repay their loan even during good harvest season, _____
Do you think increasing penality motivate such farmers to repay their loan? Yes/no
If no, what methods should be used by lenders?----------

Could you please tell us yield differences you obtained from fertilized and unfertilized plots:

Crop ty	yield (kg/tem	year a	Crop price
	fertiliz	unfertilized p	at farmgate

One of the major problems to repay farm credit such as fertilizer is the coincidence of low crop price with credit repayment time (usually at harvest). To minimize such problem one alternative is to adjust the repayment time.
Are you willing to pay for the additional interest on the borrowed capital if you are allowed to repay anytime within a year

but interest rate increases by 1% every month if you do not pay at harvest time and reaches 5% in June, July and August) ? Yes/no

If yes, how much are you willing to pay (WTP) for aditional interest on the borrowed capital if you are allowed to pay as follows:

Alternative repayment schedule (months)

Type of credit	Immediately yes=1 no=2	After 3 months	In June, july and august (with 5% rate)
Fertilizer			
Improved seed			
Credit in cash			

Appendix B

Partner Household Survey, Southern Ethiopia

S.no	Questions	Unit	Answer
1	Type of partner: 1=Landlord, 2=Tenant, 3=Animal owner, 4=Animal tenant	Code	
2	Household number for contract partner in main sample	Number	
3	For land contract partners: Plot number of main sample household	Number	
4	Sex of household head: 1=Female, 0=Male	Code	
5	Age of household head:	Years	
6	Household size	Number	
7	Number of male labour force in adult equivalents	Number	
8	Number of female labour force in adult equivalents	Number	
9	Ethnic group: 1=Oromo, 2=Sidamo, 3=	Code	
10	Religion: 1=Orthodox, 2=Islam, 3=Protestant, 4=	Code	
11	Education of household head: Number of years of school completed	Years	
12	Skills: 1=Carpenter, 2=Driver, 3=	Code	
13	Position in community: 1=Chairman of the PA, 2=Secretary, 3=Militia (tataki), 4=Party member, 5=Land Admin. Committee (LAC) member, 6=Social court judge, 7=Other, specify:	Code	
14	Off-farm employment: 0=No, 1=Seasonal agricultural labour, 2=Unskilled nonagricultural labour, 3=Skilled employment, 4=Government job, 5=Businessman, 6=Self-employed, 7=Other, specify:	Code	
15	Marrital status: 1=Married, 2=Polygamous, 3=Divorced, 4=Widow, 5=Single	Code	
16	If polygamous household, number of wives:	Number	
17	Number of children, if polygamous indicate number of children for each wife	Number	
18	Age of children: (for each wife separately)	Ages	
19	Years of schooling of children (for each wife separately)	Years	
20	For polygamous households: Where do the wives live? (Kebelle name below) Wife 1: Wife 2: Wife 3:	Distance In km	
21	Health status of household: 1=Very good, 2=Good, 3=Poor, 4=Very poor	Code	
22	Sickness in family last year? 1=Very severe sickness, 2=Severe sickness, 3=Less severe sickness, 4=No sickness	Code	
23	Death of family members last year? 1=Yes, 0=No	Code	
24	Food security situation of household: 1=Chronically food insecure, 2=Food deficit in >3 out of last 10 years, 3=Food deficit 1-3 out of last 10 years, 4=Never food insecure	Code	
25	Asset holding of households: Number of houses	Number	
26	House with corrugated iron roof: 1=Yes, 0=No	Code	

27	Bicycle(s): 1=Yes, 0=No	Code	
28	Other transportation equipment: 1=Yes, 0=No, if yes, specify:	Code	
29	Ox plough: 1=Yes, 0=No	Code	
30	Radio: 1=Yes, 0=No	Code	
31	Number of oxen:	Number	
32	Number of cows:	Number	
33	Number of young cattle:	Number	
34	Number of sheep	Number	
35	Number of goats	Number	
36	Number of donkeys/mules/horses (equines)	Number	
37	Number of shared in animals, specify type:	Number	
38	Number of shared out animals, specify type:	Number	
	Other assets, specify:		
39	Do you have a land certificate? 1=Yes, 0=No, 2=Expect to get soon NB! Ask to see the certificate to verify information below	Code	
40	Number of own plots of land?	Plots	
41	Total Farm size (own land)	Temad	
42	From land certificate: Gender of main owner of certificate: 1=Male, 0=Female	Code	
43	Number of plots on certificate	Number	
44	Do you own any plots that are not on your certificate? 1=Yes, 0=No	Code	
45	If yes, number of own plots not on certificate	Number	
46	If yes, why not on certificate? 1=Too small, 2=House plot, 3=Were rented out, 4=Were missed during registration, 5=Other, specify:	Code	
47	Number of wives on certificate	Number	
48	Number of wives with own certificate	Number	
49	Number of children on certificate	Number	
50	Number of plots on certificate	Number	
51	Plot 1: Plot size in temad	Temad	
52	Plot 1: Land quality type: 1=A (Good), 2=B (Medium), 3=C (Poor)	Code	
53	Plot 1: Distance from home: Minutes walk	Minutes	
54	Plot 2: Plot size in temad	Temad	
55	Plot 2: Land quality type: 1=A (Good), 2=B (Medium), 3=C (Poor)	Code	
56	Plot 2: Distance from home: Minutes walk	Minutes	
57	Plot 3: Plot size in temad	Temad	
58	Plot 3: Land quality type: 1=A (Good), 2=B (Medium), 3=C (Poor)	Code	
59	Plot 3: Distance from home: Minutes walk	Minutes	
60	Plot 4: Plot size in temad	Temad	
61	Plot 4: Land quality type: 1=A (Good), 2=B (Medium), 3=C (Poor)	Code	
62	Plot 4: Distance from home: Minutes walk	Minutes	
63	Plot 5: Plot size in temad	Temad	
64	Plot 5: Land quality type: 1=A (Good), 2=B (Medium), 3=C (Poor)	Code	
65	Plot 5: Distance from home: Minutes walk	Minutes	
66	Number of rented in (including sharecropped) plots	Number	
67	Number of rented out (including sharecropped) plots: Use plot	Number	

	numbers above for rented out plots		
68	Rent-in plot 1: Plot size in temad	Temad	
69	Rent-in plot 1: Land quality: 1=A (Good), 2=B (Medium), 3=C (Poor)	Code	
70	Rent-in plot 1: Distance from home: Minutes walk	Minutes	
71	Rent-in plot 2: Plot size in temad	Temad	
72	Rent-in plot 2: Land quality: 1=A (Good), 2=B (Medium), 3=C (Poor)	Code	
73	Rent-in plot 2: Distance from home: Minutes walk	Minutes	
74	Rent-in plot 3: Plot size in temad	Temad	
75	Rent-in plot 3: Land quality: 1=A (Good), 2=B (Medium), 3=C (Poor)	Code	
76	Rent-in plot 3: Distance from home: Minutes walk	Minutes	
77	For landlord partners: Which of the above plots is rented out/sharecropped by the main sample household partner?	Plot number	
78	Did you have access to credit for purchase of farm inputs (fertilizer, seed) last year? 1=Yes, 0=No, 2=Don't know	Code	
79	Did you have access to credit for purchase of animals last year (long-term credit)? 1=Yes, 0=No, 2=Don't know	Code	
80	Do you participate in an *edir* group? 1=Yes, 0=No	Code	
81	Do you participate in an *ekub* group? 1=Yes, 0=No	Code	
82	Did you demand credit for farm inputs last year? 1=Yes, 0=No	Code	
83	If yes, how much credit did you demand for farm inputs last year?	Birr	
84	If yes, how much credit did you get for farm inputs last year?	Birr	
85	Did you demand credit for purchase of animals last year? 1=Yes, 0=No	Code	
86	If yes, how much credit for purchase of animals did you apply for?	Birr	
87	If yes, how much credit did you get for purchase of animals last year?	Birr	
88	Did you demand credit for consumption purposes (family events, health expenses, school expenses etc.) last year? 1=Yes, 0=No	Code	
89	If yes, how much credit did you demand for consumption purposes last year?	Birr	
90	If yes, how much credit did you get for consumption purposes last year?	Birr	
91	If you did not get as much credit as you demanded for any of the purposes above, what did you do? 0=Did nothing, 1=Sold animals, 2=Rented out land, 3=Reduced other expenses, 4=Worked off-farm, 5=Other, specify:	Code	
92	How many out of the last ten years did you experience shortages? 1=Never, 2=Once, 3=2-3 times, 4=4-6 times, 5=>6 times, 6=Every year	Code	
93	Did food shortages affect your land renting activity? 1=Yes, 0=No	Code	
94	If yes, how? 1=Rent out more land, 2=Rent out land for cash, 3=Rent out land on long-term contract for cash, 4=Other, specify:	Code	

95	Did your household experience serious sickness during the last 5 years? 1=Yes, 0=No	Code	
96	If yes, did sickness affect farming activity? 1=Yes, 0=No	Code	
97	If yes, how? 1=Sold animals, 2=Produced less, 3=Changed land renting	Code	
98	If sickness affected land renting, how? 1=Rented out land, 2=Rented out more land, 3=Stopped or reduced renting in of land, 4=Changed type of rental contract from sharecropping to fixed rent, 5=Other change, specify:	Code	
99	Did your household experience death in the family during the last 5 years? 1=Yes, 0=No	Code	
100	If yes, did death in family affect farming activity? 1=Yes, 0=No	Code	
101	If yes, how? 1=Sold animals, 2=Produced less, 3=Changed land renting	Code	
102	If death affected land renting, how? 1=Rented out land, 2=Rented out more land, 3=Stopped or reduced renting in of land, 4=Changed type of rental contract from sharecropping to fixed rent, 5=Other change, specify:	Code	
	For LANDLORD and TENANT PARTNERS:		
1	What is the size of the plot you rented in or out to the main sample household?	Temad	
2	Why did you rent/sharecrop in/out the plot? 1=Lack of labour, 2=Availability of labour, 3=More land than I could manage, 4=Shortage of land, 5=Lack of cash to buy fertiliser and seeds, 6=Sick/disable, 7=To share risk, 8=Other, specify:	Code	
3	Relationship to partner: 1=Blood-relative, 2=In-law, 3=Close neighbour, 4=From same kebelle, 5=From other kebelle, 6=Other, specify:	Code	
4	Cash input share: 1=Equal share, 2=Tenant covers all initially but gets back later, 3=Landlord covers all cash costs initially but gets back later, 4=Tenant covers all costs, 5=Landlord covers all cash input costs,	Code	
5	Output share: Grain: 1=Equal share, 2=Equal share after subtracting input costs, 3=Other, specify:	Code	
6	Output share: Straw: 1=Equal share, 2=Equal share after subtracting input costs, 3=Other, specify:	Code	
7	Total cash input costs on plot	Birr	
8	Total output value: Crop type: Amount (kg): Price per kg: Straw: Amount(kg): Price per kg:	Birr	
9	Actual output vs. expected output: 1=Above expectation, 2=As expected, 3=Below expectation	Code	
10	If above expectation, why? 1=Good weather, 2=Good management	Code	

	by tenant, 3=Good price, 4=Other, specify		
11	If below expectation, why? 1=Drought, 2=Pest problem, 3=Too little inputs applied, 4=Poor management by tenant, 5=Other, specify:	Code	
12	For landlord: Will contract with same tenant be renewed for the plot? 1=Yes, 0=No	Code	
13	If no, why not? 1=Poor performance of tenant, 2=Found another partner, 3=Will cultivate land him-/herself, 4=Dispute with tenant, 5=Could not agree on contract terms, 6=Offered better deal by other tenant, 7=Tenant did not conserve the land well, 8=Other, specify:	Code	
14	Type of contract: 1=Written contract approved by PA, 2=written contract approved by elderly religious leader, 3=Oral contract with witnesses, 4=Oral contract among partners only, 5=Other, specify:	Code	
15	Duration of contract: 1=Less than one year, 2=One year, 3=Two years, 4=Three years, 5=More than three years, 6=Open-ended (continue till one partner stops),	Code	
16	Who is responsible for soil fertility/soil conservation on the plot? 1=Landlord, 2=Tenant, 3=Shared	Code	
17	What is the soil fertility/soil conservation status of the plot? 1=Good, 2=Medium, 3=Poor	Code	
18	Amount of fertiliser used on the plot last meher season (DAP+Urea)	Kg	
19	Amount of animal manure used on the plot last meher season	Kg	
20	Amount of labour used for soil conservation during last year (Landlord+tenant)	Mandays	
	Animal Sharing		
21	Did you have a animal share contract during the last two years? 1=Yes, 0=No	Code	
22	If yes, are you the one who keeps the animal(s)? 1=Yes, 0=No	Code	
23	If no, did you contribute money or share out the animal? 1=Contributed money, 2=Shared out animal, 3=Other, specify:	Code	
24	If contributed money, how much?	Birr	
25	If no to the first question, did you ever participate in animal sharing contracts ever before? 1=Yes, 0=No	Code	
26	If yes, why not any more? 1=Have enough animals, 2=Lack of partners, 3=Lack of grazing land, 4=Lack of labour, 5=Fear of losing the animal shared, 6=Others, specify:	Code	
27	Have you ever attempted but failed to participate in animal sharing contracts? 1=Yes, but failed to share in, 2=Yes, but failed to share out, 0=No	Code	
28	If yes, when?	Year	
29	If yes, how many did you contact?	Number	
30	If sharing, 1=Share out, 2=Share in	Code	
31	If sharing, type of animal(s) shared? 1=Oxen, 2=Cow, 3=Heifer, 4=Bull, 5=Goat, 6=Other	Code	
32	Number of animals shared in or out?	Number	

33	Initial costs of animal keeper?	Birr	
34	Profits share of animal keeper?	Birr	
35	Initial cost of partner farmer?	Birr	
36	Profit share of partner farmer?	Birr	
37	Duration of contract: Contract one: Animal type	Years	
38	Duration of contract: Contract two: Animal type	Years	
39	Who covers animal keeping costs? 1=Animal keeper, 2=Partner, 3=Share equally, 4=Other, specify:	Code	
40	Do you share the risk in case the animal dies? 1=Yes, 0=No, 2=Depends on the cause of death	Code	
41	Why do you participate in animal sharing? 1=Have enough labour, 2=Cash constraint, cannot afford to buy animal, 3=To get manure for crops, 4=Lack of fodder and grazing land for animals, 5=To help relative, 6=Other, specify:	Code	
42	How is your partner in terms of wealth? 1=Rich, 2=Medium, 3=Poor, 4=Very poor	Code	
43	Did you have many candidate partners to choose from for animal share contracts? 1=Yes, 0=No	Code	
44	How many partners to choose from?	Number	
45	If yes, what criteria did you use to select your partner? 1=Reputation, 2=Trust, 3=Endowments, 4=Kinship, 5=Same ethnic group, 6=Same religious group, 7=Other, specify:	Code	

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ISSN: 1503-1667
ISBN: 978-82-575-0893-7

Million Tadesse Aytenfisu was born in Arsi-Abomssa, Ethiopia, in 1972. He obtained a BSc. Degree in 1993 and a MSc. Degree in 2001 in Agricultural Economics from Alemaya University, Ethiopia.

This dissertation consists of an introduction and four independent papers. The first two papers examine informal contractual arrangements in agriculture. The third paper focuses on the effects of informal risk coping strategies of poor farmers on fertilizer adoption. The final paper further considers household soil conservation technology adoption behaviour in a risky environment. The dissertation aims at providing empirical evidence on applied contracts in land and livestock, the effect of risk coping measures on input use, household soil conservation technology adoption behaviour and poverty in Southern Highlands of Ethiopia. The thesis is based on an original data set and uses various econometric methods to answer the research questions and test alternative hypotheses. The findings from this dissertation provide new insights into applied contracts in land and livestock. Particularly, the results from paper 2 adds to the empirical literature on applied contracts in agriculture, that have to date been dominated by the studies of land rental contracts choices. The contracts are developed in response to the missing credit and insurance markets in the region. Thus, contracts are found to be an important household adaptation to risk and resource sharing strategies of the poor in Ethiopia. This dissertation also adds to our understandings of rural poverty and the effect of informal risk coping measures on fertilizer adoption and the extent of household land management practices in Southern Highlands of Ethiopia.

Associate Professor Ragnar A. Øygard and Professor Stein T. Holden were Million's supervisors.

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