ECONOMIC BURDEN OF MALARIA AT HOUSEHOLD LEVEL: DO INSECTICIDE TREATED BEDNETS (ITNs) REDUCE THE BURDEN IN TIGRAY, ETHIOPIA?

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Declaration

I, Kondwani Nyirongo, do hereby declare that this thesis, except where duly acknowledged, is a product of my own research investigations and findings. To the best of my knowledge, this work has never been previously published or submitted to any other university for any type of academic degree.

Kondwani Nyirongo

Ås, May 2011

Dedication

This paper is dedicated to all those committed in the fight against malaria to save lives of innocent children dying from the disease world-wide every passing hour.

Acknowledgement

To God be glory and honour for the gift of life and my success stories for He knew me by name before I was born. It is my prayer that God will bless Associate Professor Mette Wik (supervisor), Professor Stein Holden, Dr Hosaena Ghebru, Betty Legasse, fellow 2010/11 NOMA students, enumerators, data entry clerks, humble respondents and Norwegian tax payers through NOMA program for making this paper a reality.

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Abstract

The broader impact of malaria need not to be over emphasized with the disease claiming life of a child every 45 seconds and attributed to slow economic growth in malarious areas of the world. Beyond this broader picture, there has been wavering empirical evidence on the impact of the disease at micro level especially on households' consumption expenditures and crop land-productivity. This study investigated the economic burden of malaria at household level i.e. the impact of the disease on households' consumption expenditures (direct cost burden) and crop land-productivity and the role of ITN interventions in Tigray, Ethiopia. Using equality mean test on the two years (2006 and 2010) panel data, the study found negligible annual direct cost burden of malaria (0.69% of consumption expenditure) which is not catastrophic (significantly less than 10% of consumption expenditure) to household consumption expenditure. Estimation of the instrumental variable regression on 2010 cross sectional data, however, unveiled that malaria lowers crop land-productivity by 11.25% through loss of labour due illnesses and care giving. Most importantly, the study also found that ITN interventions play an important role in cushioning the economic burden of malaria in the region and doubling coverage may almost wipe out the burden. The above research findings have important policy implications on crop land-productivity improvement, design and adoption of malaria control interventions in Tigray.

Key words: malaria, economic burden, ITN interventions, Tigray, Ethiopia

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List of Abbreviations and Acronyms

ETB	Ethiopian Birr
HSEP	Health Services Extension Program
ITN	Insecticide Treated Bednet
IRS	Indoor Residual Spray
MOH	Ministry of Health
THB	Tigray Health Bureau
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
US$	United States Dollar

1.0 Introduction

Every 45 seconds a child dies from malaria in Africa (UN 2011). Neither children nor adults are spared from malaria in Ethiopia. It contributes up to 20% of the 109/10000 under-five mortality rate (UNICEF 2010) and 22% of deaths in health facilities (MOH 2005-2006). Malaria also accounts for an annual estimate of 9 million cases for which only 4-5 million are treated in health facilities (UNICEF 2009). This represents 18% of all outpatient health facility consultations (MOH 2005-2006) and the largest single cause of morbidity in Ethiopia (UNICEF 2009).

Malarial burden is shouldered both by households and government through loss of life, illness, loss of labour and cost of prevention as well as control measures. Chima et el (2003) reported that household annual expenditure on preventive measures ranges from US$2.88 to US$ 25.20 and expenditure on treatment ranges between US$ 4.92 and US$ 312.00 in Sub-Saharan Africa. In Rwanda, cost of treating malaria contributed up to 19% of the Ministry of Health operating budget (Ettling & Shepard 1991). When it comes to malaria and household agricultural labour supply, Larochelle & Dalton (2006) found a significant negative relationship between the two for the case of rice production in Mali. At macroeconomic level, studies by McCarthy et al (2000) in a cross section of countries (dominated by Sub Saharan Countries); Gallup & Sachs (2001) in malarious and non malarious cross-country analysis; and Asante et al (2005) in Ghana found that malaria negatively affects annual real national income growth by 0.55%, 1.3% and 0.4%, respectively.

Considering the above mentioned public health and economic concern, the government of Ethiopia has been implementing a free ITN distribution program under the National 5 years (2006-2010) strategic plan for malaria prevention and control. Sixteen million ITNs were distributed in malarious areas between the years 2006 and 2007 (Belay & Deressa 2008). Tigray region is not spared from malaria hence it benefited from the free ITN distribution program. Despite the widespread of malaria, and the efforts and resources devoted to fight the disease in the region, to the knowledge of the author no study has been conducted to establish its economic burden[1] at household level and the impact of ITN in terms of reducing the economic burden. Though Owani (2007) found reduced malaria incidences for individuals who spent more months using bed nets in the region, no linkage was made to crop land-productivity and the implication for households' expenditure. Studies carried out in the region indicate low household willingness to pay for ITN. Cropper (1999) reported that only 30% of households were willing to pay for recovery cost of ITN (US$6) despite the fact that this cost was just 0.68% of the mean annual income in the area adjusted for the life span of the bed net. In the same region, Owani (2007) found out that households were willing to pay for only 15.8% of the actual cost of unsubsidized ITNs. This raises important questions as whether this is due to low purchasing power among the households or because malaria prevention is not a priority based on its economic burden.

This research aimed to investigate the economic burden of malaria at household level and the role of ITNs distributed through the free ITN distribution program in reducing the burden in Tigray region. In this study, the economic burden of malaria constituted households' direct financial expenditure for malaria prevention and treatment, as well as loss of crop land-productivity due to loss of household labour for both the patients and care givers. The study, therefore, attempted to expound the linkage between malaria shocks, preventive interventions and agricultural production at household level. This was done by answering the following specific research questions: *a) Are direct costs of malaria (direct cost burden) catastrophic to households' consumption expenditures? b) Do malaria shocks significantly affect crop land-productivity at household level? c) Do ITN interventions reduce household malaria direct costs and crop land-productivity losses?*

The rest of this paper is structured as follows: Chapter 2 provides background information for the study areas. Thereafter, underlying theory and literature is expounded in chapter 3 to provide the basis for the study hypothesis. Chapter 4 describes data and methods used in testing the study hypothesis. Afterwards, the study results are discussed in chapter 6 from which conclusion and policy implications are drawn that constitute chapter 7.

[1] Economic burden refers to the effect of malaria attack on household consumption expenditure and/or household crop land-productivity through family labour supply loss

2.0 Background

Tigray region, located in the northern part of Ethiopia, is not spared from malaria as about 78% of the total population (4.5 million) is at risk to the disease (THB 2006). In 2006, malaria treatment accounted for 28% of all patients treated in the region's health facilities and was the number one cause of outpatient diagnosis, admissions and deaths (Paulander et al. 2009). Malaria is hypo-endemic in areas below 2,200 metres above the sea level with seasonal transmissions mainly between September and November as well as March through June following the summer and belg rains, respectively (Ghebreyesus et al. 1996). The construction of micro-dams in drought prone areas has further prolonged the malaria transmission seasons in the region (Amacher et al. 2004; Ghebreyesus et al. 1998). The *Anopheles gambiae s.1* vectors Plasmodium *falciparum* that cause about 60% of malaria infections and Plasmodium *vivax* that accounts for the remaining 40% of the infections in the region (Ghebreyesus et al. 1998; Tulu 1993). Tigray region is also prone to malaria outbreaks as evidenced by a wide spread of four serious outbreaks between 1987and 2006. These outbreaks caused mammoth suffering and deaths in the western part in 1987, the north-central part in 1990, the whole region in 1991 and in southern Tigray[2] in 2005, as indicated in the figure 2.1.below:

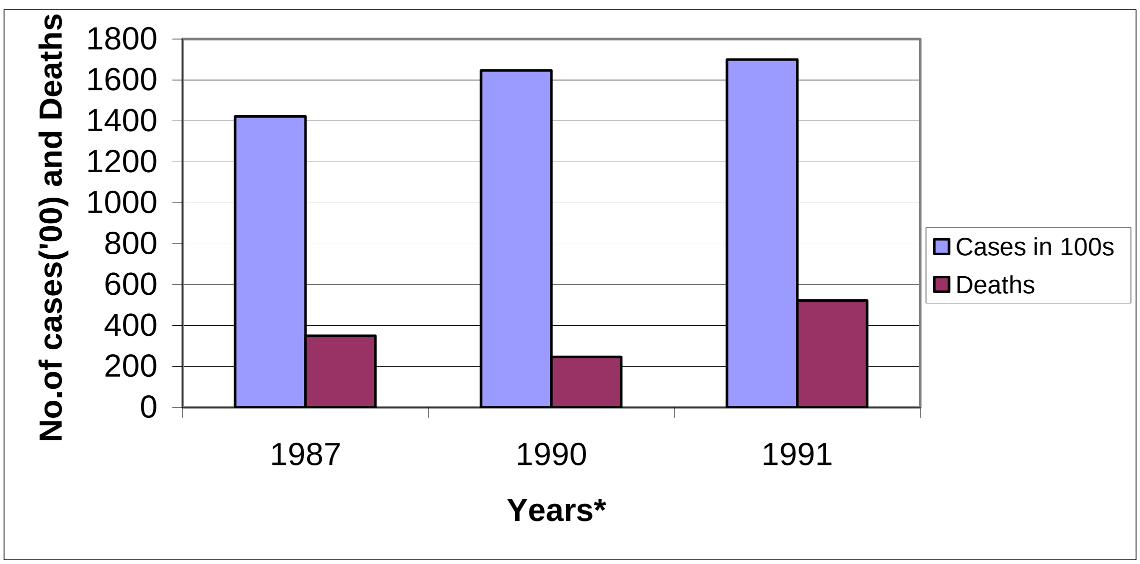

Figure 2.1: Reported Malaria Cases (in100s) and Deaths Tigray during Major Outbreaks

Note: *Data Source: (Ghebreyesus et al. 1998); *Data for the 2005 outbreak not available*

[2] ***See location of these zones in the figure 2.2***

The rural farming households are the most hit with malaria in the region since they occupy low lying areas with water ponds, micro-dams and streams where malaria thrives (Amacher et al. 2004; Ghebreyesus et al. 1998) and subsistence farming also flourishes. Malaria imposes extra household expenditure on both preventive and treatment measures. One malaria episode to an adult household member causes average loss of 18 labour days while an attack to a child leads to loss of 2 labour days after adjusting for labour substitution in the region (Cropper et al. 1999). This loss of labour could in turn affect agricultural productivity at household level as Paulander et al (2009) indicated that malaria epidemics occur during planting and harvesting periods when labour supply is critical.

The fight against malaria in the region was governed by the national five years strategic plan (2005-2010) that aimed at reducing the burden by half through early diagnosis and prompt treatment; selective vector control; and epidemic prevention and control (MOH 2004). Distribution of free ITNs at household level was the major malaria prevention intervention within the plan complemented by in-door residual spraying and environmental management (MOH 2008). The 2010 target for ITN coverage and utilization was 80% in the region. By the end of 2006, 32.5% of the population living in malarious areas of the region were already covered by ITNs (Owani 2007).

This study follows up the sample of Owani (2007) drawn from four malarious districts, namely: Kara Adiyabo, Debdebo, Tsaeda Ambora and Adi-Menabir (*see Figure 2.2*). Primary health care units are the major providers of health services including malaria interventions in the study areas. All health units in the region are supported by six district hospitals above which five are zonal hospitals that are further supported by a regional referral hospital located in Mekelle, the capital of the region (Paulander et al. 2009). Malaria treatment is free of charge in the public health units except for the fee for the registration card of US$0.37 (2010 *ETB* to US$ exchange was 13.5). Some rural households still incur transport costs in seeking malaria treatment from public health facilities as Ghebreyesus et al (1996) indicated that public health facilities are located far apart in some communities in the region. This, therefore, may defeat the assertion of free malaria treatment by the government. There are no ITN selling outlets in the study areas but almost every household has been provided with at least one free of charge ITN from the government between 2006 and 2010.

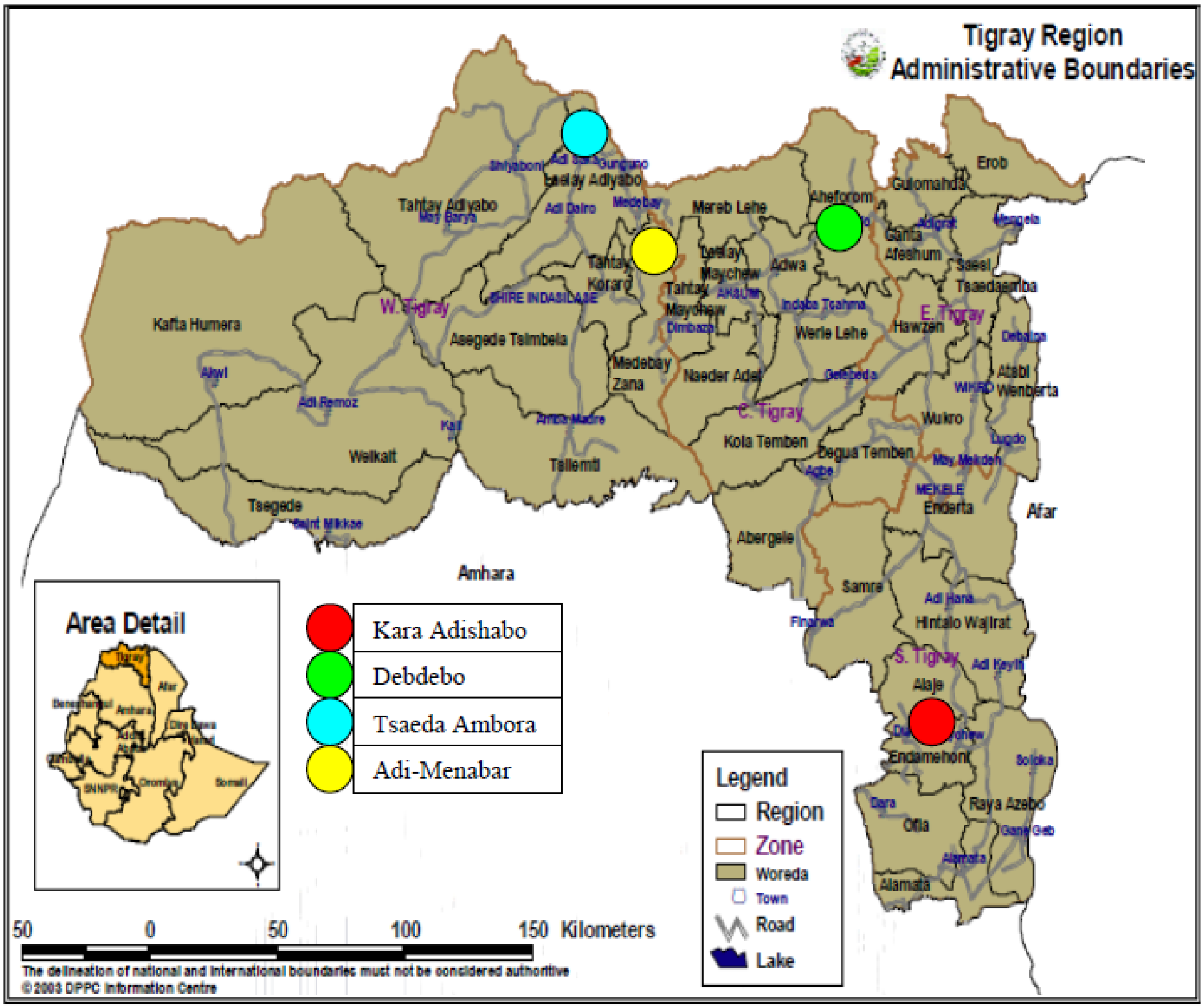

Figure 2.2: Map of Tigray Region Showing Location of Study Areas

(Adapted on a map sourced from http://www.reliefweb.int/rw/RWB.NSF/db900SID/SKAR-64GEB2?OpenDocument)

Subsistence agriculture is the major economic activity in the study areas. The major crops grown by households are teff, wheat, barley and maize with chat being an important cash crop in Kara Adiyabo. They also rear animals like donkeys, cattle, camels, goats and chicken. Agricultural labour demand is mostly met by household own labour supply that is complemented by oxen which provide drought power for tilling the land. There is limited use of hired labour (Hagos et al. 2003) amid pervasive labour market inefficiencies in the region (Holden et al. 2001; Woldenhanna & Oskam 2001). High dependence on household own labour supply, therefore, leaves agricultural production at household level vulnerable to labour risks due to malaria shocks (Dercon 2002).

3.0. Literature Review and Research Hypothesis

3.1. Literature Review

Malaria commands vast literature with diversity not only in terms of area of focus (like epidemiological and socio-economic) but also methodological approaches. This section reviews a spectrum of socio-economic studies with differing methodological approaches to synthesize theory behind the economic burden of the disease as well as the impact of ITNs as preventive intervention at household level. The broader picture of economic burden of malaria is presented first, followed by a review of various approaches used in evaluating the burden of the disease on households, and the challenges faced. The last part of this section reviews impact studies on ITN interventions at household level.

3.1.1. The Economic Burden of Malaria

Malaria and poverty are intimately connected (Gallup, J.L. & Sachs, J.D. 2001). At macroeconomic level, studies that used both static (Asante et al. 2005; Gallup, J.L & Sachs, J.D 2001; McCarthy et al. 2000) and dynamic (Gollin & Zimmermann 2007) models have found that poverty thrives where malaria flourishes through reduced economic growth. The annual growth reduction due to malaria has been estimated to range between 0.25% (McCarthy et al. 2000) to 1.3% (Gallup, J.L & Sachs, J.D 2001). This intimate relationship between malaria and poverty has backward linkage to the impact of malaria at household level. Malaria incapacitates the labour force, causes death and diverts resources from economic growth enhancing activities to prevention and treatment interventions. Customarily, the economic impact of malaria has been estimated by summing up direct costs of expenditure on prevention and treatment; and the indirect costs of productive labour time lost due to malaria morbidity and mortality (Asenso-Okyere & Dzator 1997; Shepard et al. 1991). Some studies also recognize that suffering and grief is another category of costs that could be added to the economic burden of the disease though none of the studies have valued the suffering and grief due to their complexity.

3.1.2. Household Direct and Indirect Costs of Malaria

Malaria inflicts direct and indirect costs to households (Chima et al. 2003). Household direct costs of malaria include financial expenditure incurred in prevention; treatment as well as other non-medical expenses such as transport costs to and from the health facility and special foods for the patient. On the other hand, indirect costs are linked to loss of household labour through sickness and care-giving. This loss of labour force can translate into loss of agricultural productivity in agricultural based rural economies. Chima et al (2003) indicated that direct and indirect costs can be summed up to provide total economic costs of malaria at household level. The methods of estimating the economic cost of malaria at household level have, however, differed from one study to the other. In addition to methodology, variation in estimated costs of malaria in different settings is driven by epidemiological and socio-economic factors as well as timing of surveys.

Direct household costs to malaria accounted for 2% of household expenditure in rural Sri Lanka, 2.9% in rural Nigeria (Russell 2004) and up to 14.1% in Ghana (Asante et al. 2005). At national level in Malawi, direct cost of treatment amounted to only 2% of household income but alarmingly 28% of income amongst very low income earning households (Ettling et al. 1994). These studies were based on reported household expenditures over two or four weeks. Chima et al (2003) pointed out that the approach mentioned above, do not reflect disparities in the burden and costs of the disease through out the year.

Leighton & Foster (1993) in Kenya and Nigeria and Attanakaye et al (2000) in Sri Lanka estimated household indirect costs of malaria by multiplying the average daily income by the households' labour days lost through malaria related morbidity. This approach assumed that households faced the same daily wage rate and productivity of labour. In addition to using labour loss through morbidity, Shepard et al (1991) incorporated labour loss through mortality in studies conducted in Burkina Faso, Congo, Chad and Rwanda. With the mortality approach, labour days lost was estimated by extrapolating age of death to life expectancy. This was a strong assumption that could have overemphasized indirect cost of malaria at household level. Results from the above mentioned studies revealed different indirect costs per malaria episode to households in different countries. The average indirect cost for a malaria episode was highest in Chad (US$12.6) and lowest in Burkina Faso i.e. US$4.61 (Shepard et al. 1991). The above mentioned studies did not control their results for labour substitution for sick days through both intra-household replacement and hired labour.

3.1.3. Labour Substitutability

Labour substitutability has been at the centre of controversy in studies trying to estimate the effects of health shocks on household labour as well as productivity. Sauerborn & Adam (1996) indicated that labour substitution is one of the reactionary coping mechanisms that households employ to cushion labour loss through health shocks. The household can replace the lost labour through both intra-household (Abegunde & Stanciole 2008) and inter-household substitution as well as the labour market. This replacement, however, depends on household labour endowments (Sauerborn & Adams 1996), communal relations and how well the labour market functions in an economy. Chima et al (2003) indicated that intra-household labour substitution is the most commonly employed coping strategy by households. Cropper et al (1999) found existence of labour substitution in Ethiopia though there was net loss of labour days due to malaria attacks at household level. The authors found that about 28% of the lost labour days due to one malaria episode to an adult household member were replaced through intra-household labour substitution. Larochelle & Dalton (2006) ascertained that intra-household labour substitution is only possible for labour endowment rich households and not otherwise in Mali. Hired labour could also replace family labour lost through illness (Sauerborn & Adams 1996). Labour substitution through the market, however, depends on how well the labour market functions and the liquidity constraint of households that are hit by malaria shocks. Cropper et al (1999) found limited evidence of labour replacement through the market in Tigray, Ethiopia. This is because the labour market in the area is characterized by inefficiencies due to high transaction costs (Holden et al. 2001) and entry barriers due to liquidity and credit constraints (Woldenhanna & Oskam 2001). All in all, ignoring labour substitution in estimating the impact of malaria shocks on household labour supply and output could lead to over-estimation of the burden.

3.1.4. Malaria Shocks, Household Agricultural Labour and Productivity

A malaria attack is accompanied with morbidity to the sick person who sometimes requires care giving by other household members. This translates into loss of household agricultural labour supply when the attack infect or/and affects the productive household member and coincide with agricultural production activities at household level. This loss of household labour could further negatively affect agricultural production if not replaced for by mechanisms like intra-household substitution and hired labour as outlined in the section above. In trying to establish the link between malaria and household agricultural labour supply, Larochelle & Dalton (2006) estimated the marginal effect of health transient shocks (primarily caused by malaria and schistosomiasis) on household agricultural labour supply in rice growing areas of Mali. They estimated a regression model where household labour supply (family and hired) was the dependent variable and labour lost through health shock was the independent variable controlled for household characteristics and environmental factors. The authors purposively included hired labour in the dependent variable (household labour supply) to control for labour substitution through the market. On the other hand, intra-household labour substitution was controlled for by inclusion of the household dependence ratio in the band wagon of regressors. The impact of transient shocks were estimated differently for non-active household members (age below 15 years and above 60 years) and active members (between 15 and 59 years) through separate regression models. Both models indicated that transient health shocks negatively affected labour supply in rice production with no effective intra-household labour loss substitution. The study further found limited labour substitution through hired labour. However, it did not establish the implication of the reduced household labour supply on rice production.

Abegunde & Stanciole (2008) indicated that household productivity could be affected if a household member is affected by chronic disease. The authors further acknowledged the possibility of intra-household labour substitution to mitigate productivity losses. The above results augment the findings of Croppenstedt & Muller (2000) who established that morbidity status of households negatively affect agricultural productivity in Ethiopia. The fact that malaria is not a chronic disease and only one of the many contributors of ill health further complicates its relationship to agricultural productivity at household level. Few studies have been conducted to establish the link between the two. An attempt by Audibert (1986) to estimate the impact of malaria on rice production in Cameroon using the Cobb-Douglas production function not only faced insignificance of the parameter estimates but was also susceptible to biases. These biases originated from the endogenous nature of malaria illnesses at household level which was used as one of the explanatory variables in estimating the production function.

Wang'ombe & Mwabu (1993) also ended up with insignificant coefficients in their quest to estimate the impact of malaria on household income and cassava production in Kenya. One possible explanation for their results was the practice of labour substitution. Audibert et al (1999) addressed the complexity of labour substitution by estimating the impact of malaria to cotton producing households that had at least 25% of active members with higher levels of parasitaemia in their blood (>500 parasites per *ul* of blood) in Côte d'Ivoire. This cut-off point ensured large labour loss that could not be replaced easily by the affected households. Using the production frontier, they established increasing production inefficiencies with the increasing percentage (from the threshold of 25%) of active household members found with higher levels of malaria parasitaemia.

3.1.5. The Impact of Insecticide Treated Bednets (ITN) on Malaria at Household Level

Insecticides treated bednets have been shown to significantly reduce malaria morbidity and child mortality in short term trials (Lengeler 2003). ITN can reduce under-five child mortality up to 50% and help reduce re-infection after successful treatment (UNICEF 2009). Findings by Owani (2007) and Belay& Deressa (2008) also established a positive impact of ITN on malaria incidences shortly after their introduction during the 2006 malaria epidemic in Tigray region, Ethiopia. The studies above, however, did not provide the economic value of the bednets on households in terms of the marginal burden reduced. These studies were also conducted within the first half of ITN lifespan (within two years after massive distribution of ITNs to households in the region) hence there is no evidence on the sustainability of the impact to the end of ITN lifespan at household level. This skepticism is also shared by Smith et al (2009) who indicated that the theoretical basis remains poorly defined for attributing reduced malaria incidences to ITN in areas where high coverage of ITN has just been achieved. This cynicism informs the formulation of hypothesis H2 and H4 to investigate the long-term (after more than two years of introduction) impact of ITNs on economic burden of malaria at household level.

3.2. Hypothesis

The foregoing review of literature induces this study to provide the economic burden of malaria at household level and the value of insecticide treated bednets to households in terms of the reduced economic burden of malaria in the long-run. This will be done by testing the following hypothesis as informed by literature:

H1: Malaria shocks impose stress on household consumption expenditure and household's own agricultural labour supply

H2: ITN interventions cushion households from direct costs of malaria

H3: Household labour loss due to malaria attacks negatively affects crop productivity at household level

H4: Increased ITN coverage lowers crop land-productivity losses due to labour loss caused by malaria shocks at household level

4.0 Data and Methods

The first part of this section describes the data used in terms of types, method of collection and key variables. Thereafter, shortfalls in the dataset are highlighted, followed by steps employed to maintain its quality. Then methods used to test study hypotheses (fore stated in the preceding section) are expounded. This chapter concludes with descriptive statistic for all key variables to provide a platform for the discussion of the study results in chapter 5.

4.1. Data

The study uses both panel and cross-sectional household level data. The two period panel data was constructed from randomly sampled 152 households from five malarious communities (Kara Adiyabo, Debdebo, Tsaeda Ambora and Adi-Menabir[3]) in Tigray surveyed in 2006 and 2010. The two survey periods had slightly different objectives i.e. the 2010 survey focused on economic burden of the disease and the impact of ITNs on the same, while the 2006 aimed at soliciting the households' commitment to acquire ITNs and their impact on malaria prevalence. The research hypotheses on the household's direct malaria costs were tested using the panel data since both the 2006 and 2010 surveys collected data on key variables for these hypotheses. On the other hand, testing of hypotheses on indirect malaria costs at household level was restricted to cross-sectional data because of data limitation for key variables in the 2006 survey data. Such missing variables included crop output with their prices (for Kara Adishabo) and number of labour days households lost due to malaria shocks.

Both the 2006 and 2010 surveys were part of a series of five rounds panel data (1998 to 2010) collected by the Norwegian University of Life Sciences in collaboration with Mekelle University[4] covering 400 randomly selected farm households from a stratified sample of 16 communities (tabias) in the region. The 2010 Tigray data collection exercise was conducted in the month of June - coinciding with the same period the 2006 data set was collected. It involved a total of 18 trained enumerators, able to translate research questions from English into local language (Tigrinya) in the region, employed to conduct household interviews. These enumerators were closely supervised by a group of thirteen master's degree students and two

[3] See their location in *figure 2.2* in *chapter 2*.
[4] Mekelle University is in Tigray, Ethiopia and it hosted the 2010 spring courses for Master Degree Students under NOMA program

former NOMA[5] students from Mekelle University under the guidance of Professor Holden[6] and Dr Hosaena Ghebru[7]. The team was organized in three sub-teams comprising of six enumerators and five supervisors. In each sub-group, two enumerators were responsible for administering the household questionnaire, two for the plot questionnaire, and the remaining two enumerators were administering the household perception as well as health (malaria) questionnaires. Each of the three sub-teams had a team leader and a Tigrinya fluent master student who was in-charge of administering community based checklists to key informants. These key informants included Land Administration Committee members, local leaders, health workers and government administrators at local levels. This approach, therefore, ensured collection of integrated information covering all aspects of the household welfare and the prevailing economic conditions of the study area.

In case of the malaria questionnaire, key variables included general knowledge of the household head on malaria; preventive measures being practiced and their costs; frequency of malaria attacks and their implications on agricultural labour supply at household level; treatment behaviours and their accompanied costs; coverage and access to malaria-related health services provided by the government and other non state organizations. In addition to malaria related variables, this paper also used crop production and basic household demographic data for its analysis.

4.2. Data Collection Challenges, Shortfalls and Remedies to Ensure Quality

Understanding the local language was the major challenge faced during data collection but it was circumvented by engaging enumerators that were fluent in the local language. These enumerators were thoroughly trained in order to enhance their understanding of the questionnaires to reduce possibilities of interviewer's bias. This step was complemented by spot checking of questionnaires right away after interviews where corrections of mistakes and follow-ups on data gaps were made there and then. There were also daily feedback meetings between enumerators and supervisors to further sort out mistakes in the data collected. These

[5] NOMA program is a collaborative masters program between the north university (Norwegian University of Life Science) and Universities from the south (Ethiopia, Malawi and Uganda)
[6] Professor Holden works with the School of Economics, Norwegian University of Life Science
[7] Dr Hosaena works with Mekelle University in Tigray, Ethiopia

efforts were followed up by massive data cleaning after completion of data entry. All these steps were taken to ensure data quality. Specifically for malaria data, the major challenge was to accurately collect data on malaria attacks suffered by households since no blood testing was made. This challenge, however, was addressed by verifying the reported malaria attacks in the person's health registration card at household level. Details on the types of drugs used to cure the reported illnesses were also used to scrutinize malaria cases from cases of other fevers.

The prominent shortfall in the dataset relate to some differences between the 2006 and 2010 survey tools rendering it difficult to construct a panel that can be used to adequately test all the research hypotheses. Some households surveyed in 2006 were not interviewed during the 2010 survey because they were not willing to participate. The above mentioned non-responsiveness of some respondents further shrinked the sample, making it difficult to construct a large panel data. This study, therefore, uses both panel and cross-sectional data to complement each other where the above mentioned data shortfalls exists.

4.3 Methods

The study uses a combination of descriptive statistics and regression analysis in testing its hypotheses. The regression analysis utilized both panel and cross-sectional data approaches with differing estimation methods for the purposes of testing robustness of the results. Testing of the first study hypothesis through provision of descriptive statistics provided the bigger picture of the burden that malaria shocks exert at household level through both direct costs and loss of agricultural labour supply that may translate into indirect costs if it lower crop land-productivity. Specifically, test for equality of means was employed to determine whether direct costs of malaria impose stress on households' consumption expenditure. The mean for the proportion of direct malaria costs to consumption expenditure was tested against the catastrophic threshold mean of 0.10 at household level (Prescott 1999; Ranson 2002) as cited in Russell (2004). Thereafter, a set of panel data models were used to dig deeper into the direct costs of malaria at household level. These models were employed to investigate the impact of ITNs on direct costs of malaria by testing the second research hypothesis. To make the story of economic burden of malaria at household level complete, the instrumental variable regression model was estimated on crop production cross-sectional data to analyse the indirect costs of malaria at household level. These models investigated the impact of labour loss due to malaria on crop productivity and the role of ITN in cushioning the impact. Graphs are also presented across various analytical approaches to provide visual representation of the results found through testing of research hypotheses.

4.3.1. Model 1: Impact of ITN on Malaria Direct Costs

Model 1 estimated the long term impact of ITN interventions on direct costs of malaria using panel methods. This approach was helpful in clearing skepticism on the long term impact of ITN on malaria as the most widely used preventive intervention (Smith et al. 2009). Data on the direct costs of malaria[8] at household level was collected in a panel of two periods i.e. 2006 and 2010. First, the pooled (population average) estimator which requires satisfaction of ordinary least squares assumptions (Woodridge 2009) was estimated to establish correlation between direct malaria costs and ITN interventions at household level. The pooled estimator was specified as follows:

$$y_{it} = \alpha + x_{it}^{'}\beta + \mu_{it} \tag{1.1}$$

Where: i=1,2,3,…,152 (number of households interviewed)

The household time specific idiosyncratic error term (μ_{it}) was assumed to be normally distributed. In order to ensure satisfying homoskedasticity and normality assumptions, the dependent variable entered the model as log of direct costs of malaria (y_{it})[9]. The vector of explanatory variables (*see table 1*) was captured by $x_{it}^{'}$ in the *model 1.1* with the time periods 2006 and 2010 represented by *t* where as α represented the constant term. With the pooled estimator, however, we could not get random variation in the slope with varying time period in our dataset and parameter estimates could be less asymptotically efficient as compared to random effects estimator (Woodridge 2009). This, therefore, prompted the study to also estimate the *model 1* above through the random effects estimator. The random effect estimator

[8] Household direct costs of malaria are measured in Ethiopian Birr (June 2010 *Birr* to *US$* exchange was 13.5)
[9] Plot of direct cost of malaria shows normal curve when we take the log of the variable as indicated in *figure A1a and A1b* in the appendices

(*in equation 1.2 below*) allowed random parameter variation where the slope (α_i) for the direct costs of malaria varied across individual households.

$$y_{it} = \alpha_i + x_{it}^{'}\beta + \mu_{it} \qquad (1.2)$$

The above pooled and random estimators assumed strict exogeneity (Woodridge 2009) which is very strong assumption for direct malaria costs. This is because there may be individual household specific unobserved heterogeneities, like genetic factors e.g. sickle cell (Aidoo et al. 2002) and immunity due to extended exposure to malarial parasites (Cohen 1977), leading to differing susceptibility levels to malaria attacks. This could have translated into unobserved heterogeneities among households to incurring direct costs of malaria. This problem necessitated estimating the *model 1* using the fixed effects estimator *(equation 1.3)* to avoid bias in parameter estimates that could have risen due to correlation between the time invariant unobserved heterogeneities and the regressors (x_{it})(Woodridge 2009). In this case, the fixed effect approach was perceived to provide consistent parameter estimates as compared to the pooled and random effects estimators.

$$y_{it} = \alpha_i + x_{it}^{'}\beta + \mu_{it} \qquad (1.3)$$

Where regressors (x_{it}) can be correlated with the time invariant component of the idiosyncratic error term (μ_{it})

After estimating *model 1* using the three different approaches, one efficient estimator had to be selected. The Breusch and Pagan Langrangian test was employed to select the best estimator between the pooled and random approaches. On the other hand, the Hausman's specification test was used to choose the consistent estimator between random effects and fixed effects specifications. In addition to the above stated steps taken to ensure robustness of the results, all the estimators were also subjected to standard errors clustered at household level.

The treatment variable (ITN intervention) entered the model in three forms: First, the number of ITN(s) owned by the households as a continuous variable. This helped us to establish whether the number of ITN owned at household level regardless of household size matters in reducing the burden. Second, the ratio of ITN to household size was regressed as a continuous treatment variable in the model. This took into consideration the within-household ITN coverage in estimating the impact of ITN on the direct costs of malaria. Third, a dummy was constructed from ITN-household ratios where one represented a ratio of 0.5 and above, zero for otherwise. This was a proxy indicator for effective coverage of ITN intervention. The above approaches provided good basis for evaluating the impact of ITN interventions in Tigray where we did not have enough with and without counterfactual data[10] as well as no before and after ITN counterfactuals[11]. These ITN treatment variables were controlled for other factors like distance to health facilities; literacy level of household head; age and sex for household head; and the status of household dwelling house as indicated in the *table 4.1* below.

[10] Majority of households at least owned ITN (82.2% and 76.1% in 2006 and 2010, respectively)
[11] Mass distribution of free ITNs by government started in 2005 hence no before and after counterfactual data.

Table 4.1: Description of Variables in Model 1

	Description (Type and Measurement)	**Hypothesized Relationship to Dependent Variable**
Dependent Variable		
Household direct costs of malaria	Household annual expenditure on malaria prevention and treatment measures. It was measured in Ethiopian Birr (ETB). The 2006 costs were adjusted for inflation using the consumer price index[12]	
Independent Variable		
ITN[13] (Appearing in different forms alternated in the estimated model)	Number of ITN(s) owned by households	-
	Ratio of ITN to household size	
	Ratio of ITN to household Size (1= 0.5 & above; 0=otherwise)	
Distance to health facility	Measured in minutes spent to walk from household's dwelling place to the nearest health facility. It was a proxy indicator for access to treatment interventions.	+
Literacy level for household head	Dummy (1=literate; 0=otherwise).	-
Household head sex (male=1)	Dummy (1=male, 0=otherwise)	+
Household dwelling house	Type of dwelling house as proxy for how well the households were protected from mosquitoes (vectors of malaria) through good housing (1=good housing i.e. iron roofed; o=otherwise)	-

[12] CPI data obtained from *http://www.tradingeconomics.com/ethiopia/consumer-prices-index-average-imf-data.html*

[13] Only ITNs that were in functional state (physical and expected lifespan of 4years) were recorded to avoid counting non functional ITNs as shown in *figure B2* in the appendices

4.3.2 Model 2: Impact of Malaria Shocks on Household Crop Productivity and the Role of ITN

This model established the household indirect costs of malaria by estimating the impact of labour days lost through malaria attacks on crop land-productivity. To this end, the value of crop yield per operational land size was regressed on labour days lost due to malaria shocks, controlled for some factors of crop productivity[14] and produce market access at household level, through a regression model. The variable on hired labour was also factored in the regression in order to investigate the role of labour markets in substituting for the lost labour due to malaria shocks.

Labour loss at household level is, however, endogenously determined by the frequency and extent of malaria shocks suffered during the agricultural season. The frequency and extent of malaria shocks could as well be proxy indication of how well or badly the households are covered by both preventive and treatment interventions. This necessitated estimating the regression model through instrumental variable approach with a variable each on frequency of malaria shocks, ITN interventions and access to curative health services used as instruments. The number of malaria episodes suffered by the household represented the frequency of malaria shocks. On other hand, the ratio of ITNs to household size gave an indication of household coverage with preventive interventions while distance to health facility was a proxy for household access to malaria treatment interventions. This approach both controlled for endogeneity bias and simultaneously estimated the effect of ITNs as well as treatment interventions on the estimated impact of labour loss on crop land-productivity. Below is the formation of the model:

$$y_{1i} = x_i^{'}\beta_1 + y_{2i}^{*}\beta_2 + \mu_i \qquad (2.1)$$

$$y_{2i}^{*} = x_i^{'}\alpha_1 + z_{2i}^{'}\alpha_{2j} + v_i \qquad (2.2)$$

Where: i=1, 2, 3,…, 137 (households interviewed) & j=1,2,3(instrumental variables)

[14] Labour supply (own and hired), draft power (oxen), average distance to plots, fertilizer, proxy for managerial skills (sex and literacy level for household head), irrigation practices and land market participation.

In the *equation 2.1* above, y_{1i} represented the value of crop yield per operational land holding, $x_i^{'}$ represented a vector of factors that affect crop productivity and market access *(see table 4.2)*, y_{2i}^{*} represented the number of labour days households lost due to malaria episodes during the year while μ_i referred to stochastic error term. The variable y_{2i}^{*} was endogenous hence controlled for through estimation of *equation 2.2* where $x_i^{'}$ was a vector of exogenous factors affecting crop productivity and market access in *equation 2.1*, $z_{2i}^{'}$ was a vector of instrumental variables for the endogenous variable y_{2i}^{*} while v_i was the error term in *equation 2.2*.

The two stage least squares instrumental variable method was used to estimate *model 2* where labour loss was captured in number of days hence a continuous variable. This estimation allowed conduction of post-estimation tests for endogeneity, strength of instruments and their validity under the over-identification condition (Greene 2008; Woodridge 2002). With this regard, Durbin and Wu-Hausman tests were used to determine whether labour loss due to malaria shocks at household level was endogenous; F-statistic was used to test for joint strength of the instruments; and Sargan and Basmann tests were employed to test validity of the research instruments under over-identification restrictions. Use of robust standard errors ensured robustness of results even under violation of homoscedastic assumption.

Below is *table 4.2* that describes variables used in *model 2.* This description includes how the variables were measured and the expected sign from the regressions.

Table 4.2: Description of variables in model 2

Variables	**Description (Type and Measurement)**	**Hypothesized Relationship to Dependent Variable**
Dependent Variable		
Crop Output Value per tsimdi[15] of land	Obtained by multiplying unit crop output per operational land size (tsimdi) by its price[16]. This approach circumvented the problems of mixed-cropping and varying crop types across different households [17] (ETB)	
Independent Variables		
Household head sex	Dummy (1=male, 0=Otherwise)	+
Literacy level for household head	Dummy (1=literate, 0=otherwise).	+
Household own labour supply	Measured in man days supplied in plowing, weeding, harvesting and threshing (continuous)	+
Average distance to plots	Measured in walking minutes[18] (continuous)	-
Irrigation farming	Household had an irrigable plot (Dummy: 1=yes; 0=otherwise). Proxy indicator for participation in irrigation farming	+
Oxen ownership	Dummy (1=own oxen; 0=otherwise).	+
Fertilizer	Quantity of fertilizer (kilograms) applied during the season-summation of DAP and UREA (continuous)	+
Hired labour	Number of man days supplied by hired labour (continuous). Indicator for agriculture labour market participation	+

[15] One tsimdi equals one quarter of hectare

[16] Each study community had its own average crop prices calculated from the reported household data on crop selling activities

[17] Most households grow more than one crop and types of crops vary across households. Crops analysed included barley, wheat, teff, maize, millet, sorghum, field peas and faba beans

[18] Averages calculated from total reported distance to all operational plots at household level

Land market participation	Indicate whether the household participated in land market either as landlord or tenant (dummy variable; 1=participate, 0=otherwise)	?
Access to produce market	Measured in minutes spent to walk from household's dwelling place to the nearest produce market (continuous)	-
Labour loss (*Endogenous Variable*)	Number of reported days lost due to malaria episodes aggregated for the reporting period (continuous)	-
	Dummy whether the household reported labour loss (1=yes; 0=otherwise).	
Instrumental Variables	**Description (Type and Measurement)**	**Hypothesized Relationship to Endogenous Variable (Labour loss)**
Number of malaria attacks	This captured total number of malaria episodes[19] suffered by household members which gave the frequency of malaria shocks at household level (continuous)	+
ITN	Ratio of ITN to household size-proxy indicator for the extent of household coverage with preventive interventions (zero upwards)	-
Distance to health facility	Measured in minutes spent to walk from household's dwelling place to the nearest health facility. It was a proxy indicator for access to treatment interventions	+

[19] Not all malaria attacks lead to labour loss at household level

4.4. Descriptive Statistics for Key Study Variables

It was imperative for this section to provide descriptive statistics in two sets considering the fact that two data sets, panel and cross-sectional, were both used in the study. *Table 4.3* provides statistics for key variables on direct costs malaria as captured in the panel data set while statistics for analysis of indirect costs of malaria from cross-sectional dataset are presented in *table 4.4*. On a good note, statistics for similar variables (like sex and age of household head, ITN ownership) for the two datasets for the year 2010 do not significantly differ despite having different total number of observations hence indicated no attrition biases.

Table 4.3: Descriptive Statistics for key variables in analysis of direct costs of malaria

Variables	2006		2010	
	Obs[20].	Mean (SD)	Obs.	Mean (SD)
Age of household head (years)	152	46.71(14.74)	152	50.22 (15.06)
Household size	152	4.92 (2.19)	152	5.07 (2.19)
Distance to mosquito breeding place (walking minutes)	152	11.32 (5.00)	152	10.39 (11.20)
Distance to health facility (walking minutes)	152	48.51 (30.00)	152	54.57 (48.97)
Number ITN owned	152	1.34 (0.91)	151	1.36 (0.96)
Malaria shocks	145	6.10 (19.92)	151	3.38 (5.98)
Direct costs of malaria(ETB)	152	415.29 (1161.74)	152	78.39 (205.67)
Medical Expenditure (ETB)				515.73 (1231.86)
Cash consumption (ETB)			152	5867.06 (1231.86)
Total consumption (ETB)			152	12516.16 (9059.53)
	Obs.	**Frequency (%)**	**Obs.**	**Frequency (%)**
Sex of household head (female)	152	43 (28.29)	152	44 (28.95)
Literate household heads	97	55 (36.18)	97	55 (36.18)
Good housing	58	7 (12.07)	152	55 (36.18)
Own ITN	152	125 (82.24)	151	111 (76.16)
ITN-household size ratio of 0.5 & above	152	49 (32.24)	152	33(21.71)
Households suffered malaria shocks	145	96 (66.21)	151	94 (62.25)

[20] Obs. means number of observation

Table 4.4: Descriptive Statistics for key variables in analysis of indirect costs of malaria

Variable	Obs.	Mean	Standard errors
Value of crop output (ETB)/tsimdi	136	4630.75	6550.09
Average distance to plots (minutes)	137	24.04	26.90
Plot size (tsimdi)	137	5.96	4.49
Own labour supply (man days)	137	85.66	56.07
Hired labor supply (man days)	137	12.19	29.24
Fertilizer (kg)	137	48.09	44.84
Distance to produce market (minutes)	111	95.51	65.65
Labour loss due to malaria shock (man days)	137	11.99	18.54
Distance to health facility (minutes)	136	48.18	42.49
Malaria shocks(number)	137	3.15	4.52
ITN-household size ratio	137	0.30	0.28
	Obs.	**Frequency (%)**	**Standard Errors.**
Sex of household head (female)	137	38 (28.36)	0.04
Literacy level	137	46 (34.33)	0.04
Own oxen	137	69 (51.49)	0.04
Participation in labour market	137	56 (41.79)	0.04
Participation in credit market	137	40 (29.85)	0.04
Participation in land market	137	53 (39.55)	0.04
Own irrigation plot	137	24 (17.91)	0.03
Households with ratio of ITN to household size of at least 0.5	137	29 (21.64)	0.04
No. of households losing labour days due to malaria shocks	134	67 (50.00)	0.04
No. of households both losing labour and hiring labour	70	44 (32.9)	0.21

5.0 Results and Discussion

5.1. Overview of Malaria Shocks and Impacts at Household Level

The majority of the households suffered malaria shocks i.e. 66.2% and 62.2% in the two periods of 2006 and 2010, respectively. The mean number of malaria episodes per household decreased from 6.2 in 2006 to 3.4 in 2010. This difference is clearly illustrated by kernel density distributions in the *figure 5.1.1* below. The difference in malaria shocks between the two periods could be attributed to increased knowledge and use of preventive interventions as scaled-up by the government under the Malaria Roll Back Initiative (MOH 2008). The relatively higher malaria episodes in 2006 also reflect an epidemic that affected Kara Adiyabo, one of the study areas.

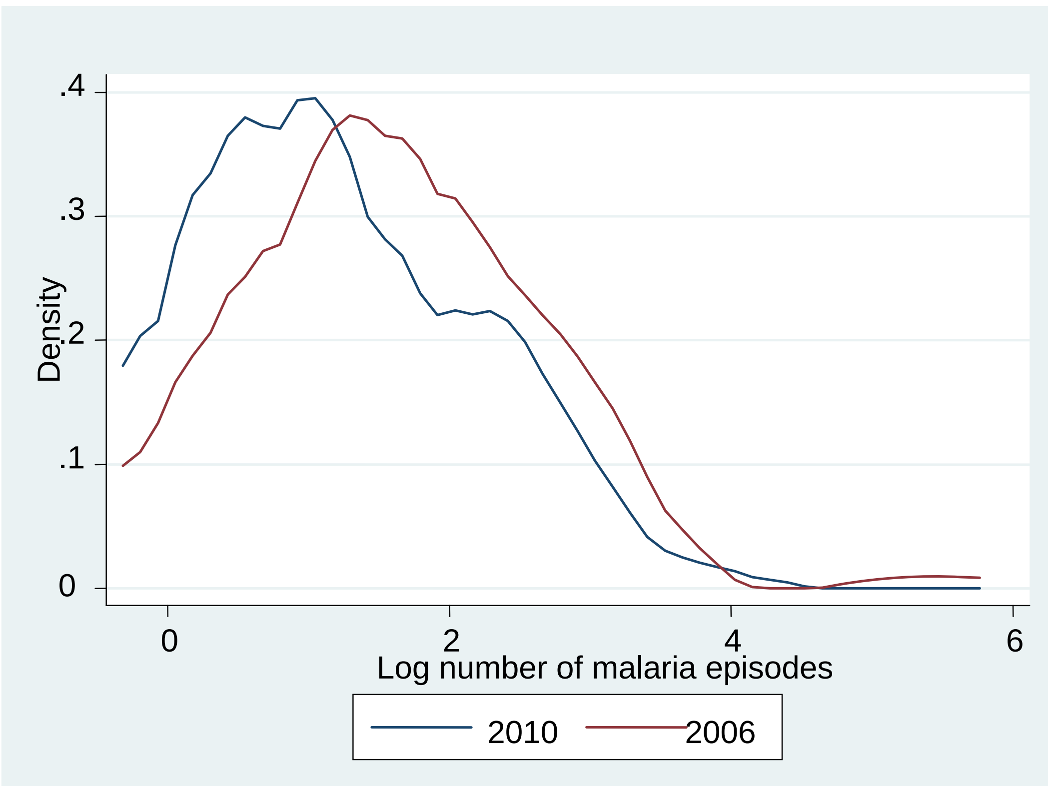

Figure 5.1.1: Kernel Density Distribution of Malaria Episodes at household level by Year

The above mentioned malaria shocks lead to 54.0% and 44.7% of households incurring direct costs of malaria in 2006 and 2010, respectively. On the other hand, the malaria shocks in 2010 lead to 50% of households to lose a mean of 23.5 man days due to sickness and care giving. On the overall, the mean number of labour days lost by households due to malaria was 11.99 in the study area. Households with ITN-household size ratio below 0.5 lost more labour days as compared to their counterparts (*see figure 5.1.2 below*). Section 5.2 builds on this broader picture of the malaria burden by providing deeper insights into the direct costs and the role of ITN interventions while *section 5.3* unearths the hidden cost of the disease in crop production at household level.

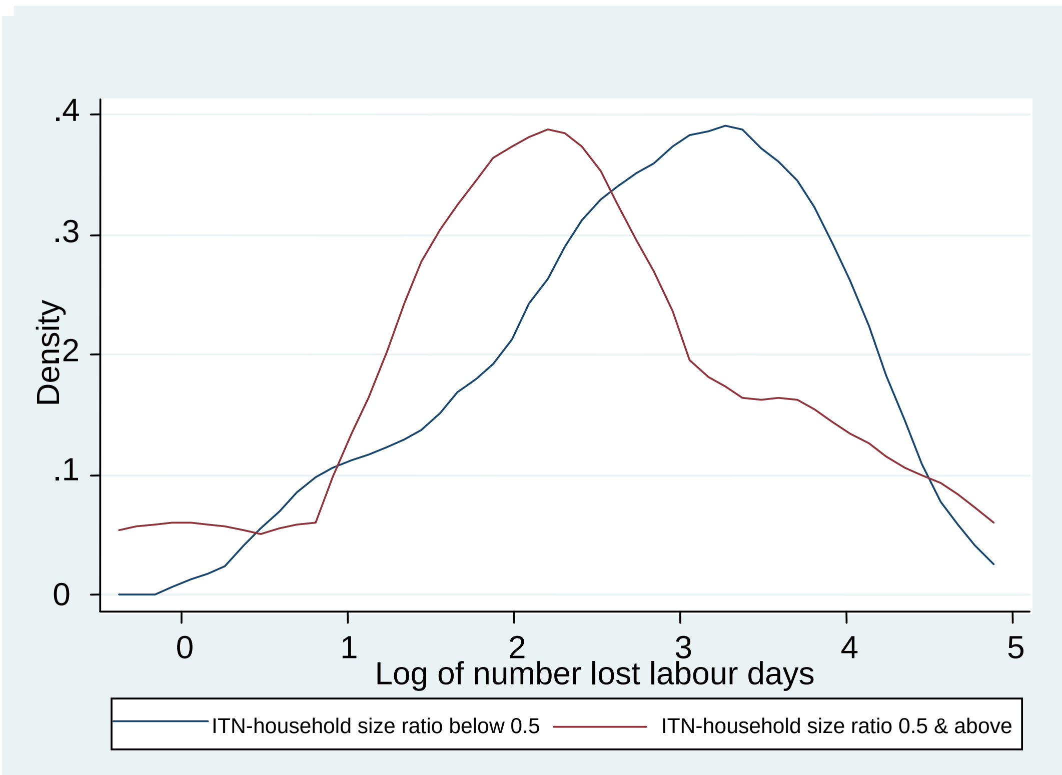

Figure 5.1.2: Kernel Density Distribution of Log of Number of Days Lost due to Malaria Shocks

5.2. Direct Costs of Malaria and the Role of ITNs at Household Level

5.2.1. Mean Direct Costs of Malaria and Implications on Consumption Expenditure (Direct Cost Burden[21] of malaria)

The mean annual direct cost of malaria was ETB[22] 415.29 and ETB 78.39 in 2006 and 2010, respectively. These costs contributed to 15% of total medical expenditures, 1.34% of cash consumption expenditure and 0.69% of total annual household expenditure in 2010[23]. The results from the equality mean tests (*see table 5.1 below*) indicate that direct cost burden of malaria of 0.69% is significantly lower than the catastrophic threshold level of 10% of the household consumption expenditure or income (Prescott 1999; Ranson 2002) as cited in (Russell 2004). This is contrary to the first study hypothesis that postulated that malaria imposes stress on household consumption expenditure. This low direct cost burden of the disease could be an explanation for the households' low willingness to pay for ITN interventions found in the area (Cropper et al. 1999; Owani 2007). Interestingly, the direct cost burden of malaria found above (0.69%) is almost equal to households' willingness to pay for ITN reported by Cropper (1999) in the region. Cropper (1999) reported that only 30% of households were willing to pay for recovery cost of ITN (US$ 6) despite the fact that this cost was just 0.68% of the mean annual income in the area adjusted for the life span of the bed net. This result might indicate that households make adoption decisions based on direct costs without incorporating indirect costs of the disease.

Low direct cost burden on its own, however, does not mean the economic burden of malaria is insignificant in the area unless indirect costs (*hidden costs in crop production*) are also negligible, which is not the case as shown by the results in *section 5.3*. The direct cost burden of malaria found in Tigray (0.69%) is lower than in Ghana (Asante et al. 2005), Kenya (Chuma et al. 2006), Malawi, Sri Lanka and rural Nigeria (Russell 2004) at 14.1%, 6.5%, 2%, 2% and 2.9%, respectively. This lower direct cost burden in Tigray could be explained by the hypo-endemic nature of malaria transmission (Ghebreyesus et al. 1996), increased access to free malaria treatment in public health facilities (MOH 2007) and expanded prevention through the free

[21] Direct cost burden refers to the percentage of household direct costs of malaria on household expenditure
[22] Ethoipian Birr (ETB) to *US$* exchange averaged 13.5 during the survey period (Commercial bank of Ethiopia)
[23] There was no consumption expenditure data for 2006

ITNs government program (MOH 2008). The role of ITNs in mitigating direct costs of malaria at household level in Tigray is ascertained in the section below.

Table 5.1: One-sample t test for direct cost burden of malaria compared to a threshold of 0.10 (10% of household consumption expenditure)

Details	**Direct cost burden**
Mean (se)	0.0068857 (0.00014769)
t-statistics	-63.0488
Degrees of freedom	151
Pr(T<t)	0.0000

5.2.2. Role of ITN interventions on Direct Costs of Malaria

Eighty-two percent of households owned at least one ITN in 2006 as compared to 76.1% in 2010 with median of one and two nets in the two years, respectively. Plotting the direct costs of malaria using Kernel density in *figure 5.1* provides no clear differences for households with and without ITNs.

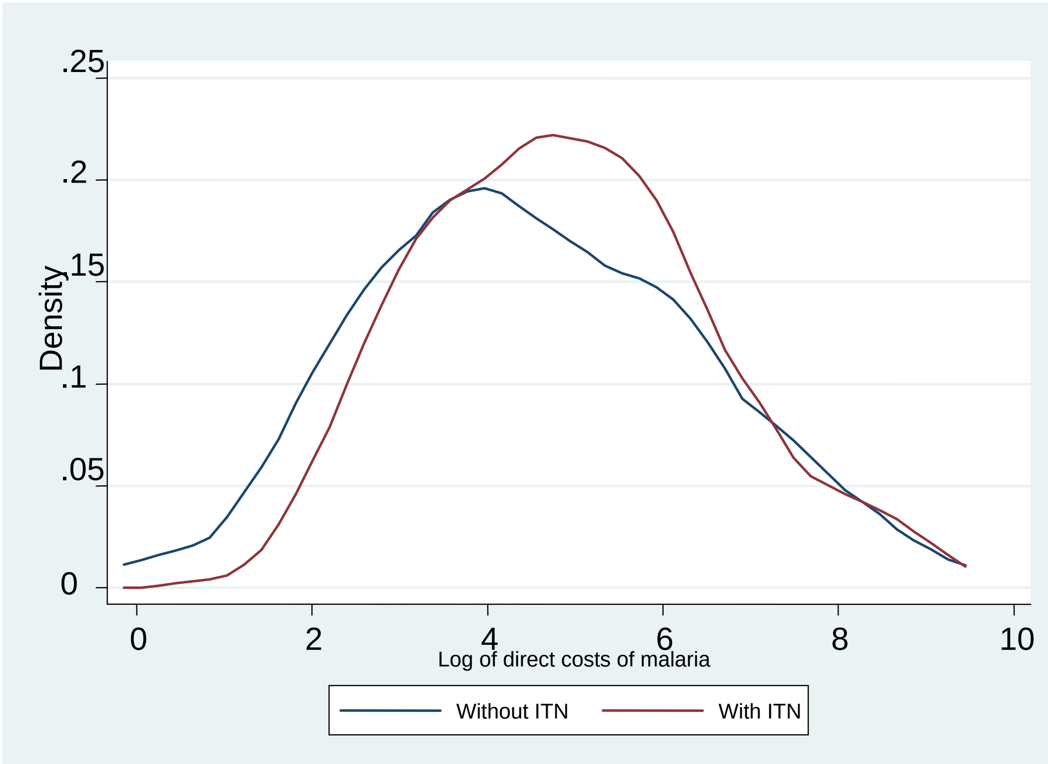

Figure 5.2.1: Kdensity for Direct Costs of Malaria for Households with & without ITN

The difference in direct costs, however, becomes clear when household size is taken into consideration to capture effective coverage of ITN at household level. Figure *5.2.2* clearly shows that households with ITN-household size ratio of at least 0.5 had lower direct costs than there counterparts with a ratio smaller than 0.5 which is a proxy for starting point of effective coverage[24] in this study.

[24] With ITN-household size ratio of at least 0.5, we are guaranteed that more that half of the household is covered by ITN interventions. The free ITN program in 2010 was distributing one net to households with size below four and two nets to those households with at least four members (*see figure B1 in the appendices*)

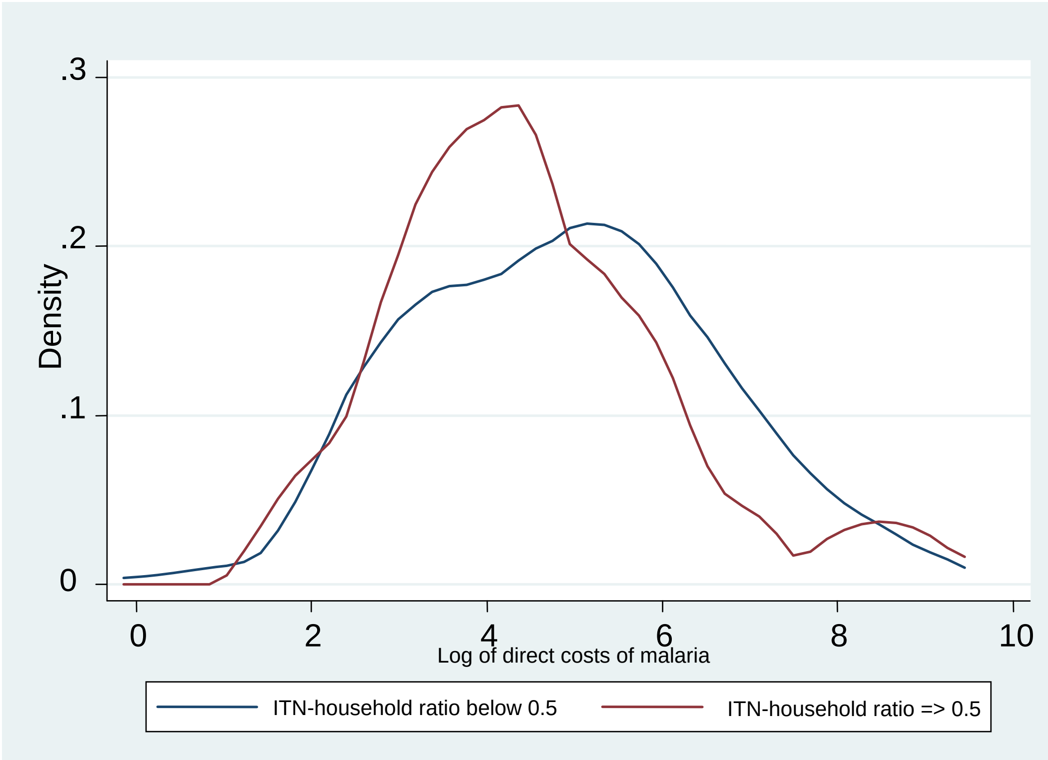

Figure 5.2.2: Graph showing distribution of log of direct costs of malaria by ITN-household ratio

The pictorial results presented above are ascertained by the estimation of *model 1* under pooled, random and fixed effects assumptions. The results indicate that the number of ITNs owned by the households does not significantly reduce direct costs of malaria until intra-household coverage is taken into consideration. As the ratio of ITNs to household size increases, direct cost of malaria significantly (*10% level of significance*) decreases at the household level. The decrease in direct costs of malaria becomes more significant for household that have ITN-household size ratio of at least 0.5 as compared to their counterparts with a ratio below 0.5. This result is robust across all the three estimators (pooled, random and fixed effects) though the fixed effects estimator gives consistent parameter estimates compared to random effects estimator as confirmed by the hausman[25] test as indicated in the *table 5.2* below. Only results from the fixed effects estimator are presented in the *table 5.2* because of their consistency,

[25] The Hausman test is ideal because the *model 1* displays normality and homoskedastic as indicated by *figure A1b* for dependent variable and small differences between ordinary and robust standard errors in *tables C2a* and *C2b* in the appendices

based on the Hausman Test, while results from the pooled and random models are presented in *table C1* in the appendices.

Table 5.2: Model 126: The Role of ITN on direct costs of malaria at household level (Log of direct malaria cost was the dependent variable)

Independent Variables	***Treatment Variable (ITN Intervention)Entering Models in Three Forms***		
	Number of ITN	***ITN-Household Size Ratio***	***ITN-Household Size Ratio Dummy (1=0.5 and above, 0=otherwise)model 1.3)***
	Fixed Effects Estimators (b/se)	**Fixed Effects Estimators (b/se)**	**Fixed Effects Estimators (b/se)**
Distance to health facility	0.036 (0.02)	0.034 (0.02)	0.027 (0.01)**
Age of household head	0.038 (0.06)	0.055 (0.05)	0.039 (0.03)
Sex of household head	5.120 (3.08)	0.470 (3.65)	1.415 (1.75)
Distance to mosquito breeding place	-0.111 (0.08)	-0.064 (0.06)	-0.063 (0.03)
Iron roofed dwelling house	-7.261 (2.92)*	-7.955 (2.62)*	-6.155 (1.40)**
ITN Intervention	-1.584 (0.79)	-8.425 (3.35)*	-4.161 (0.76)***
Constant	2.505(5.77)	5.599 (5.65)	3.526 (2.72)
Model Test (Prob>chi2)	0.122	0.070	0.007
Number of Observations	76	76	76
R^2	0.834	0.95	0.961
Hausman (P-values)	0.0247	0.0063	0.0000

Note: Significance levels * 0.10; ** 0.05; *** 0.01; **** 0.001
b refers to parameter estimates; se represents standard errors corrected for clustering at household level

The results above show that, improving ITN per capita coverage by 100 points (ratio of 0.1) would lower direct household costs of malaria by 9.4 times (by 842.5%) in Tigray. For instance, doubling the current ITN per capita coverage (i.e. 320/1000 to 640/1000 individuals) would dramatically reduce the annual average direct costs of malaria at household level from

[26] The model is estimated under pooled, random and fixed effects estimators with standard errors corrected for clustering at household level. ITN interventions enters in the three different forms i.e. number of ITN owned, ITN-household size ratio and dummy for ITN-household size ratio (1=0.5 & above) in each of the three model estimations. Only estimation model that gave consistent estimates is presented for each ITN category based on the Hausman test. The rest of the models are presented in *table C1* in the appendices.

ETB78.39 to ETB1.23[27]. The marginal reduction in the direct costs of malaria, however, diminishes as ITN coverage per capita increases. For example, at the cut-point of 500/1000 (50% ITN per capita coverage), the difference in direct costs for those equal and above would only be 5.2 times (416%) lower than their counterparts below. All in all, improving ITN per capita would bring tremendous reduction in direct cost burden of malaria in Tigray.

In addition to ITN interventions, good housing also significantly reduces direct costs of malaria at household level in the study area. Good housing lowers direct cost of malaria by 7 (615%) to 9 times (796%) as shown in *table 5.2*. The magnitude in the reduction of direct costs, astonishing as it is, can be explained by two reasons. First, good housing (closed eaves and iron roofed) reduces the likelihood of *Anopheles gambiae s.1* (vector of malaria in Tigray) to enter and rest in homes hence reducing malaria risks. This explanation is consistent with the findings of Lindsay (2002) who found out that good housing (closed eaves, iron roofed and ceiling) is associated with fewer mosquitoes indoors than houses without these features in 18 of 20 studies conducted. Gunawardena et al (1998), specifically, found out that households living in poor housing in Sri Lanka were 2.5 times more vulnerable to malaria than those with good housing. Such reduction in malaria risks is likely to have multiplier effects on the reduction of direct cost of the disease hence big parameter estimates as observed above. Second, the study did not investigate whether households were covered by indoor residual sprays (IRS) through the government malaria control program between 2006 and 2010. If this method was really used in the study area between the two panels then it could be another reason behind large parameter coefficient for good housing since IRS is more efficient in reducing malaria incidences in long term under good housing conditions than poor conditions (Konradsen et al. 2003).

Generally, there was no robust evidence that distance to health facilities significantly increases direct cost burden in Tigray[28]. This result could be explained by the use of community health attendants in administering prompt malaria treatment to households under the expanded Health Services Extension Program (MOH 2007) that could render distances to health facilities not to

[27] See detailed calculations in the *appendices calculations D1*
[28] Though it positively correlates with direct cost burden but it is only significant (5%) in one (fixed model) in the 9 models estimated as shown in *table C1* in the appendices

be a significant variable in the determination of direct costs of malaria. These community health attendants are located within the vicinities of the rural households.

The pooled and random effects models, though not consistent[29], also indicate that living near mosquito breeding places may lead to higher direct costs of malaria[30]. The non robustness of the result could be explained by small variations in the distances to mosquito breeding places (with mean of 10 walking minutes) in the area (*see figure A2 in the appendices*) with the expansion of micro-dams construction under the Sustainable Agriculture and Environmental rehabilitation Program (Amacher et al. 2004; Ghebreyesus et al. 1998).

5.3. Hidden Costs of Malaria: The Impact of Malaria on Crop Productivity and the Role of ITNs

Despite the study findings that direct cost burden of malaria are not catastrophic to households' consumption expenditures, estimation of the instrumental variable *model 2* (*see table 5.3*) revealed significant hidden costs of malaria in crop production in Tigray. This finding is in agreement with Croppenstedt & Muller (2000) who established that morbidity status of households negatively affect agricultural productivity in Ethiopia. Loss of one labour-day by the household due to malaria shock resulted into loss of about ETB 43.45 worthy of crop value per *tsimdi* of cultivated land i.e. US$ 12.74 per hectare[31] (*second stage estimation in table 5.3)*. This implies that malaria, on average, accounts for 11.25%[32] of crop-land productivity loss in malarious areas of the region. Labour shocks due to malaria worsens the already existing labour shortages at household level as indicated by the significant positive marginal productivity of own labour supply. This rules out complete cushioning of the hidden malaria costs through intra-household labour substitution. The above result concurs with the findings of Cropper et al (1999) who found net labour loss due to malaria attacks at household level despite the existence of intra household labour substitution in the study area. The labour market, however, proves to

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[29] Based on the Breusch & Pagan Lagrangian multipliers and Hausman tests

[30] As the distances to mosquito breeding places decrease (by one minute walking time), the direct costs increases by 5% to 6%. Significant at 10 % level only *(see table C1 in the appendices*)

[31] One tsimdi =0.25 hectares and the 2010 Birr to US$ exchange rate was 13.5 (Ethiopian Commercial Bank, June 2010)

[32] See detailed calculations in the appendices calculations *D2.1*

play a significant role in cushioning the labour losses due to malaria though it is not a perfect substitute to the lost household labour. This is substantiated by the finding that it takes more than one hired labour days to completely cushion one lost household labour-day due to the disease[33]. Imperfect substitution between the two forms of labour may indicate the existence of adverse selection and moral hazard in the labour market. Households are also unable to completely cushion crop land-productivity loss due to malaria shocks through the labour market as indicated by the positive marginal hired labour productivity in *table 5.3* below. This might entail constrained labour market in the region due to high transaction costs (Holden et al. 2001) exacerbated by liquidity and credit constraints (Woldenhanna & Oskam 2001).

Malaria hidden costs increase as the number of malaria episodes increase at household level. One malaria episode leads to households losing about two labour days. This situation significantly worsens as the distances households have to cover to reach their cropping plots increase. On a good note, these hidden costs of malaria are indirectly cushioned by ITN interventions[34]. Improving ITN per capita coverage by 100 points (ratio of 0.1) may reduce the average household lost labour by 1.76 days hence reducing the average hidden costs by 14.68 percent. The results, ceteris paribus, suggest that doubling the current ITN per capita coverage (.i.e. from 320/1,000 to 640/1,000) may almost wipe out the hidden costs of malaria in the region[35]. Caution, however, should be taken in interpretation of these results considering the fact they are only significant at 80 percent level of confidence. Possible explanation to the above result is the observed small variations in the ITN-household size ratio in the sample with many household having ratios below 0.5 (79.46%). This relates to the targeting mechanism of free ITNs under the government program that provide one ITN to households with sizes below four and two ITNs to those households with sizes of at least four[36].

As expected, the use of inorganic fertilizer (DAP and UREA) and participation in the credit market significantly and positively increase crop land-productivity through increased yields in

[33] The parameter estimates for hired labour is less than one (in absolute terms) in the first stage estimation of *model 2* in *table 5.3*.
[34] Significant at 80% level of confidence (p=0.19)
[35] Reduce these costs by 93.9% (from ETB 520.97 to ETB 31.54) as indicated in appendices calculations *D2.2d* and *D2.2g*
[36] See one of the 2010 ITN distribution functions captured in photos in the *figure B1* in the appendices

the study area. Participation in the credit market reduces capital constraints hence households are able to acquire productivity enhancing inputs like fertilizer and improved seeds. With reduced liquidity constraints, households can also enter the labour market and to some extent (*as discussed above*) cushion the labour losses due to malaria shocks.

Table 5.3: Model 2: Hidden costs of malaria in crop production and the role of ITNs (Number of labour days lost due to malaria and value of crop output per tsimdi[37] were dependent variables for first and second stage estimation, respectively)

Variables/Tests	First Stage Estimation	Second Stage Estimation
	b/robust se	***b/ robust se***
Labour days lost[38]		-43.45(19.05)**
Average distance to plot	0.12(0.07)*	0.58(4.54)
Own oxen	3.72(3.53)	172.29(254.45)
Own labour supply	0.60(0.04)	8.72(4.67)*
Hired labour	-0.11(0.06)*	5.18(7.18)
Literacy	-1.03(3.60)	88.42(249.14)
Credit participation	1.95(3.70)	869.82(325.48)***
Land market participation	2.25(3.92)	272.90(285.81)
Male headed household	0.39(4.18)	49.40(281.79)
Fertilizer (kg)	-0.03(0.04)	7.44(2.87)***
Distance produce market	0.04(0.03)	1.73(2.36)
Own irrigation plot	-1.38(3.88)	252.34(402.54)
Constant	-6.20(5.69)	-370.25(488.46)
Model Test (Prob > chi2)	0.000	0.002
Number of Observations	108.00	108.00
R^2	0.35	0.24
Adjusted R^2	0.25	
Instruments		
Distance to health facility	0.06(0.04)	
No. of malaria episodes	1.76(0.48)****	
ITN-household size ratio	-7.97(6.04)	
Endogeneity Tests		
Durbin (score) chi2 (1)		4.20**
Wu-Hausman F (1,94)		3.54*
Test for strength of instruments		
F-joint statistics		6.50****
Test for validity of instruments		
Score Chi2 (2)		0.22
Sargan		0.30
Basmann		0.26

Note: Significance levels: * 0.10 ** 0.05 *** 0.01 **** 0.001; b refers to parameter estimates; se represents standard errors. There was no multicollinearity in the model as all variables passed the collinearity tests (_rmcoll, __rmdcoll and Variance Inflation Factor (VIF) - see *table C3* for results)

[37] Measured in Ethiopian Birr (ETB)
[38] Endogenous variable (number of labour days lost due to malaria shocks)

6.0 Conclusion

The study findings on the economic burden of malaria at household level in Tigray, Ethiopia are two faced. Pleasingly, the direct cost burden of malaria (0.69% of consumption expenditure) is insignificant and not catastrophic (much below the limit at 10% of consumption expenditure) to household consumption expenditure. The above promising result is, however, eclipsed by the gloomy faced finding that the disease lowers crop land-productivity by 11.25% through lost labour due to illness and care giving. This is amid the revelation of deficient labour substitution through constrained labour market and intra-household arrangements. All is not lost yet as ITN interventions has proven to cushion households from the economic burden of malaria. This cushioning, however, becomes more significant with increased coverage of ITN interventions at household level. The cushioning of the direct cost burden is also more pronounced for households living under good housing conditions than their counterparts with poor housing conditions. Interestingly, the study findings suggest that doubling the current ITN per capita coverage (.i.e. from 320/1,000 to 640/1,000) may almost wipe out the average direct costs[39] and hidden costs[40] of malaria in the region.

The above research findings have important policy implications towards the fight against malaria in the region. First, the findings show large scope for crop land-productivity improvements by scaling up the fight against the disease. Second, the fact that direct cost burden of malaria is negligible, but hidden costs are significant, entail that messages promoting the adoption of malaria interventions at household level have to explicitly capture these hidden costs that are often ignored in their adoption decisions. Third, the above messages should be followed up by the opening of ITN markets where large sized households could buy (after being convinced by informative messages above) to complement on ITNs they receive through the free government distribution programs in order to improve their specific ITN coverage ratios. Fourth, for targeting purposes of malaria preventive interventions, priority should be given to those households with poor housing since they are the most vulnerable to the disease in the region.

[39] Reduce direct costs from ETB 78.39 to ETB 1.23 but the marginal reduction decreases as ITN coverage increases.

[40] Reduce hidden costs by 93.9 % but only significant at 80% level of confidence hence caution should be taken in interpreting the results.

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Appendices

Appendix A: Graphical Figures

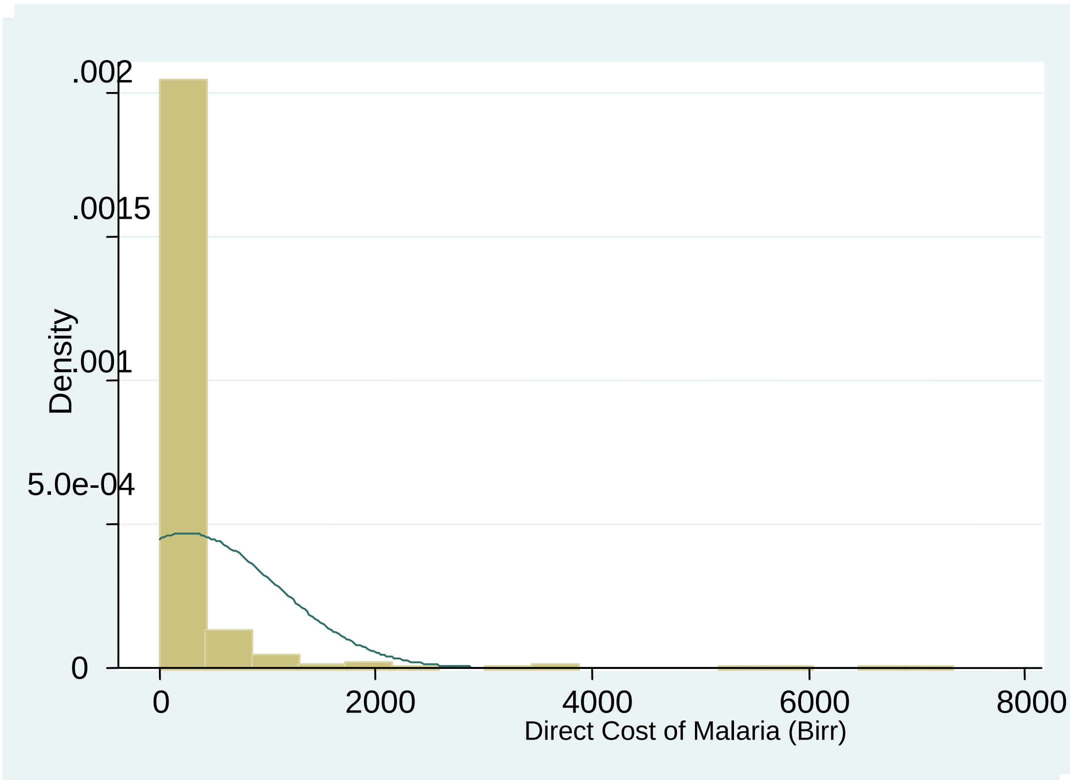

Figure A1a: Histogram with Normal Curve for Direct Cost of Malaria

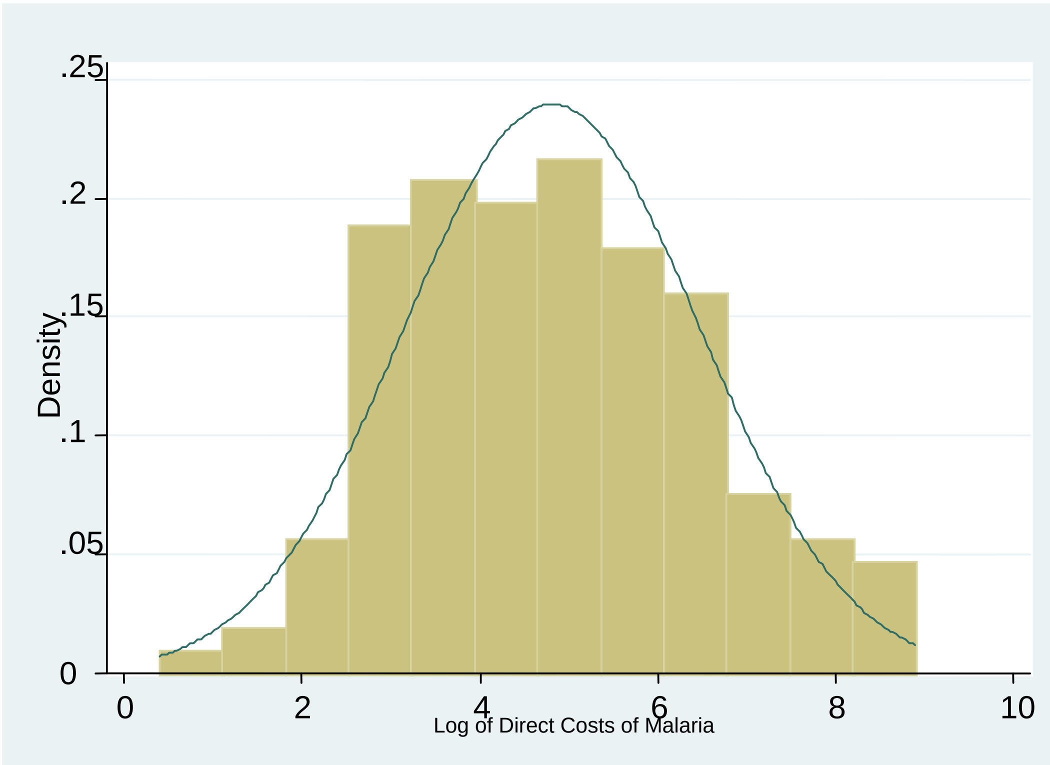

Figure A1b: Histogram with Normal Curve for Log of Direct Costs of Malaria

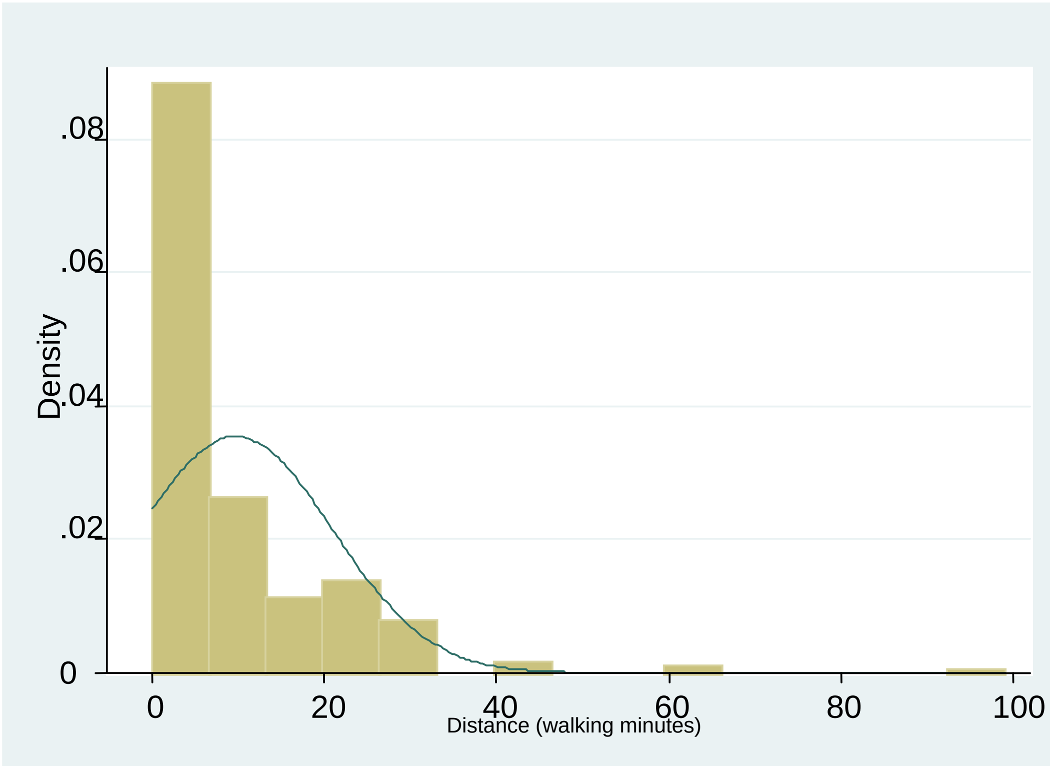

Figure A2: Distribution of distances from homes to malaria breeding places

Appendix B: ***Photos***

Figure B1: Households receiving free ITNs in Adi-Menabir, Tigray (photo taken on 21/06/2010)

Figure B2: Non-functional ITNs used to cover hay in Debdebo, Tigray (photo taken on 18/06/2010)

Appendix C: *Tables*

Table C1: Role of ITN on direct costs of malaria at household level appearing in all three forms of estimations with ITN interventions entering in three forms (Log of direct malaria cost at household level was the dependent variable)

Independent Variables			***Number of ITN***			***ITN-household size ratio***			***ITN-Household Ratio Dummy (1=0.5 and above, 0=otherwise)***
	Pooled (b/se)	**Random (b/se)**	**Fixed (b/se)**	**Pooled (b/se)**	**Random (b/se)**	**Fixed (b/se)**	**Pooled (b/se)**	**Random (b/se)**	**Fixed (b/se)**
Distance to health facility	0.006	0.006	0.036	0.006	0.007	0.034	0.007	0.007	0.027**
	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.02)	(0.01)	(0.00)	(0.01)
Literacy	0.055	0.055		0.070	0.070		-0.228	-0.228	
	(0.43)	(0.43)		(0.44)	(0.44)		(0.47)	(0.51)	
Age of household head	-0.013	-0.013	0.038	-0.013	-0.013	0.055	0.000	0.000	0.039
	(0.01)	(0.01)	(0.06)	(0.01)	(0.01)	(0.05)	(0.02)	(0.01)	(0.03)
Sex of household head	0.281	0.281	5.120	0.309	0.309	0.470	0.429	0.429	1.415
	(0.39)	(0.39)	(3.08)	(0.40)	(0.53)	(3.65)	(0.42)	(0.56)	(1.75
Distance to mosquito	-0.046	-0.046	-0.111	-0.049	-0.049*	-0.064	-0.061*	-0.061*	-0.063
breeding place	(0.03)	(0.03)	(0.08)	(0.03)	(0.03)	(0.06)	(0.04)	(0.02)	(0.03)
Iron roofed dwelling	-0.723**	-0.723*	-7.261*	-0.739**	-0.739*	-7.955*	-1.149**	-1.172**	-6.155**
house	(0.35)	(0.35)	(2.92)	(0.36)	(0.40)	(2.62)	(0.48)	(0.44)	(1.40)
ITN interventions	0.013	0.013	-1.584	-0.287	-0.287	-8.425*	-2.278***	-2.278****	-4.161***
	(0.21)	(0.21)	(0.79)	(0.71)	(0.89)	(3.35)	(0.73)	(0.55)	(0.76)
Constant	5.207****	5.207****	2.505	5.289****	5.289****	5.599	5.069****	5.069****	3.526
	(0.90)	(0.90)	(5.77)	(0.88)	(0.94)	(5.65)	(0.90)	(0.92)	(2.72)
Model Test (Prob>chi2)	0.035	0.171	0.122	0.028	0.144	0.074	0.000	0.000	0.007
Number of Obs.	76	76	76	76	76	76	76	76	76
R^2			0.834			0.872			0.961
Hausman			0.0247			0.0063			0.0000
Breusch & Pagan		1.40			0.40			0.2628	

Lagrangian multipliers test	

Note: Significance levels * 0.10; ** 0.05; *** 0.01; **** 0.001
b refers to parameter estimates; se represents standard errors corrected for clustering at household level

Table C2a: Model 1 under fixed effects estimation with ordinary and robust standard errors (Log of direct malaria cost at household level was the dependent variable)

Independent Variables	***ITN-household size ratio***		***ITN-Household Ratio Dummy (1=0.5 and above, 0=otherwise)***	
	b/ordinary se	b/robust se	b/ordinary se	b/robust se
Distance to health facility	0.034(0.02)	0.034(0.02)	0.026(0.01)**	0.026**
Age of household head	0.055(0.05)	0.055(0.09)	0.039(0.03)	0.039
Sex of household head	0.47(3.65)	0.47(3.32)	1.415(1.75)	1.415
Distance to mosquito breeding place	-0.064(0.06)	-0.064(0.16)	-0.063(0.03)	-0.063(0.1)
Iron roofed dwelling house	-7.955(2.62)**	-7.955(2.84)**	-6.151(1.4)**	-6.151(0.79)***
ITN interventions	-8.425(3.35)*	-8.425(5.61)	-4.161(0.76)***	-4.161(1.9)*
Constant	5.599(5.65)	5.599(6.82)	3.526(2.72)	3.526(3.26)
Model Test (Prob>chi2)	0.074	0.06	0.007	0
Number of Obs.	76	76	76	76
R^2	0.872	0.872	0.961	0.961

Note: Significance levels * 0.10; ** 0.05; *** 0.01; **** 0.001
b refers to parameter estimates; se represents standard errors corrected for clustering at household level

Table C2b: Model 1 under random effects estimation with ordinary and robust standard errors (Log of direct malaria cost at household level was the dependent variable)

Independent Variables	***ITN-household size ratio***		***ITN-Household Ratio Dummy (1=0.5 and above, 0=otherwise)***	
	b/ordinary se	b/robust se	b/ordinary se	b/robust se
Distance to health facility	0.006(0.004)	0.006(0.004)	0.007(0.004)	0.007(0.004)
Literate household heads	0.07(0.44)	0.07(0.44)	-0.228(0.51)	-0.228(0.5)
Age of household head	-0.013(0.01)	-0.013(0.01)	0(0.01)	0(0.01)
Sex of household head	0.309(0.53)	0.309(0.4)	0.429(0.56)	0.429(0.45)
Distance to mosquito breeding place	-0.049(0.03)*	-0.049(0.03)*	-0.061(0.02)**	-0.061(0.03)**
Iron roofed dwelling house	-0.739(0.4)*	-0.739(0.37)**	-1.149(0.44)***	-1.149(0.44)***
ITN interventions	-0.287(0.89)	-0.287(0.67)	-2.278(0.55)****	-2.278(0.61)****
Constant	5.289(0.94)****	5.289(0.88)****	5.069(0.92)****	5.069(0.84)****
Model Test (Prob>chi2)	0.144	0.016	0.000	0.000
Number of Obs.	76	76	76	76

Note: Significance levels * 0.10; ** 0.05; *** 0.01; **** 0.001
b refers to parameter estimates; se represents standard errors corrected for clustering at household level

Table C3: Test for Multicollinearity for model 2 under OLS estimation

Variable	VIF	1/VIF
Own labour supply	1.85	0.540169
Hired labour	1.73	0.579378
Literacy	1.45	0.690767
Male headed household	1.4	0.713263
Own oxen	1.34	0.747218
Distance produce market	1.29	0.77389
Land market participation	1.24	0.808657
Labour days lost	1.22	0.818831
Fertilizer (kg)	1.21	0.8275
Distance produce market	1.17	0.853107
Credit participation	1.15	0.872439
Own irrigation plot	1.14	0.879438
Mean VIF	1.35	

Note: the results show no multicollinearity in the model as all VIF values are less than 10 (Gujarati 1995Gujarati 1995)

Appendix D: Calculations

D1. Effects of doubling current ITN coverage on direct costs of malaria

a) $Amount\ of\ direct\ costs\ to\ inccur\ per\ household = \dfrac{Unit\ ITN\ coverage * Mean\ direct\ costs\ of\ malaria}{Doubled\ ITN\ coverage * Cost\ reduction\ rate\ by\ unit\ ITN\ coverage}$

b) $Amount\ of\ direct\ costs\ to\ inccur\ per\ household = \dfrac{0.10 * ETB78.39}{0.64 * 9.4.} = ETB1.23$

c) $Amount\ of\ direct\ costs\ saved\ per\ household = ETB78.39 - ETB1.23 = ETB77.16$

d) $Percentage\ direct\ costs\ saved = \dfrac{ETB1.23}{ETB78.39}(100) = 98.4\%$

D2.1 Current hidden costs of malaria

a) $Mean\ hidden\ costs\ per\ tsimdi\ of\ land = Mean\ number\ labour\ days\ households\ loss\ due\ to\ malaria *$
$Marginal\ effect\ of\ one\ labour\ day\ loss\ on\ value\ of\ productivity$

b) $Mean\ hidden\ costs\ per\ tsimdi\ of\ land = 11.99 * ETB43.45 = ETB520.97$

c) $Percentage\ hidden\ costs\ of\ malaria = \dfrac{Mean\ hidden\ costs\ per\ tsimdi\ of\ land}{Mean\ value\ of\ crop\ yield\ per\ tsimdi\ of\ land}(100)$

d) $Percentage\ hidden\ costs\ of\ malaria = \dfrac{ETB520.97}{ETB46330.75}(100) = 11.25\%$

D2.2 Effects of doubling current ITN coverage on hidden costs of malaria

a) $Number\ of\ labour\ days\ saved\ per\ household = \dfrac{Doubled\ ITN\ coverage * Marginal\ Effect\ of\ Unit\ ITN - household\ size\ ratio\ (\beta)}{Unit\ ITN - household\ size\ ratio}$

b) $Number\ of\ labour\ days\ saved\ per\ household = \dfrac{0.64 * 1.76}{0.1} = 11.264$

c) $Percentage\ hidden\ costs\ saved = \frac{Number\ of\ labour\ days\ saved}{Mean\ number\ labour\ days\ households\ loss\ due\ to\ malaria}(100)$

d) $Percentage\ hidden\ costs\ saved = \frac{11.264}{11.99}(100) = 93.9\%$

e)

$$Amount\ hidden\ costs\ saved\ per\ tsimdi\ of\ land = Number\ of\ labour\ days\ saved * Marginal\ effect\ of\ one\ labour\ day\ loss\ on\ value\ of\ productivity$$

f) $Amount\ hidden\ costs\ saved\ per\ tsimdi\ of\ land\ per\ household = 11.264 * ETB43.45 = ETB489.42$

g) $New\ mean\ hidden\ costs\ per\ tsimdi\ of\ land = (11.99 - 11.264) * ETB43.45 = ETB31.54$

Appendix E: Study Questionnaire

E1: Malaria Questionnaire

Name of Enumerator: ____

Name of Household Head: _______________________ Sex: _____________

Name of person interviewed: ______________________Sex: _____________

Date: ____

Household Location

Zone: ____

Woreda: ____

Tabia: ____

Kushet: ____

Household No: ____

GPS Coordinates: ____

Part II: Malaria situation of the area

101. Have you ever heard of disease called malaria (Agoba)? 1.Yes 2.No → **Section 2**	**102**. What is the main cause of malaria that you know? DO NOT PROMPT (Only one answer) 1. Working in the sun 2. From being in the rain 3. From getting cold 4. From drinking dirty water 5. From another person 6. From mosquito bites 7. Other (Specify) 99. DK	**103**. Have you ever seen or heard malaria educational messages from any source? 1. Yes 2. No **→Q.106**	**104.** From which source was the information? (Tick all which apply)	**105.** What messages(s) did you see or hear? Circle all which apply	**106.** Do you think malaria can kill a person? 1. Yes 2. No
107. Are you aware of any way(s) to prevent malaria? 1. Yes 2. No **→Q.109**	**108.** What is the best way to prevent yourself/family from malaria (Agoba)? 1. Sleeping under bed nets 2. Avoid being bitten by mosquitoes 3. Prophylaxis 4. Use of coils 5. Avoiding cold 6. Avoid being too long On the sun 7. Drinking clean water 8. Keep household surrounding clean 9. Closing windows at night 10. Others 11. Nothing → **109** 99. DK				

104.

	Source	***Yes***	***No***
A	Radio	1	B
B	News paper/Magazine	1	C
C	Posters/Notices	1	D
D	Friends	1	E
E	Parents	1	F
F	Health Worker	1	2
G	Govt Official	1	2
H	Church/Mosque	1	2
I	School	1	2

105.

	Message	**Yes**	**No**
A	Prevention	1	2
B	Treatment	1	2
C	Transmission	1	2
D	ITN	1	2
E	Others	1	2

Section 1: Household Malaria situation

Household Member (Name) From Head to youngest person	**109.** Has ……ever been attacked by malaria? 1. Yes 2. No **→Go to Next person**	**110.** When was the last malarial attack? 1. 1 week ago 2. 1 Month ago 3. 2 months ago 4. 1 year ago 5. Others 99. DK	**111.** Where did s/he get treatment? 1. Pharmacy 2. Drug shop 3. General merchandise 4. Tradition healer 5. Public hospital/PHC 6. Private Hospital/clinic 7. Community trained attendant 8. Did not treat (remove s/he from Q.113; then next person)	**112.** Time taken to walk to the source of treatment s/he attended (minutes)	**113.** What treatment (s) did s/he receive? (check medical form) Circle all which apply 1. Traditional medicine 2. Nivaquine 3. Chloroquine 4. Fansidar 5. Quinine 6. Mephaquine 7. Coartem 8. Aspirin 9. Other (specify) 99. DK	**114.** Total amount spent for treating the last malarial episode in Birrs (Transport, medical fees, drugs and unplanned dietary change)	**115.** Frequency of malaria attack within the last 12 months (No of attacks)	116 No. of days didn't work because suffered from malaria or nursed malaria patient	**117** No. of hour the house hold memb er work in a day	**118** Amount House hold member earn when work on labour market for a day **(Birr)**	**119.** Freque ncy of malari a attack within the last 3 months (No of attacks)
1	1 2	1 2 3 4 5 99	1 2 3 4 5 6 7 8		1 2 3 4 5 6 7 8 9 99						
2	1 2	1 2 3 4 5 99	1 2 3 4 5 6 7 8		1 2 3 4 5 6 7 8 9 99						
3	1 2	1 2 3 4 5 99	1 2 3 4 5 6 7 8		1 2 3 4 5 6 7 8 9 99						
4	1 2	1 2 3 4 5 99	1 2 3 4 5 6 7 8		1 2 3 4 5 6 7 8 9 99						
5	1 2	1 2 3 4 5 99	1 2 3 4 5 6 7 8		1 2 3 4 5 6 7 8 9 99						
6	1 2	1 2 3 4 5 99	1 2 3 4 5 6 7 8		1 2 3 4 5 6 7 8 9 99						
7	1 2	1 2 3 4 5 99	1 2 3 4 5 6 7 8		1 2 3 4 5 6 7 8 9 99						
8	1 2	1 2 3 4 5 99	1 2 3 4 5 6 7 8		1 2 3 4 5 6 7 8 9 99						

Section 2: Mosquitoes

201. Are you currently using any method (whether commercial or traditional) to protect your household from mosquitoes?

1. Yes→**Q.203**
2. No

202. Why don't you protect your household from mosquitoes?

1. I don't have money
2. I don't have time
3. Protective materials are not available here
4. I can't be bothered
5. Gov't's duty
6. Others (specify)

99. DK

203. Methods used to prevent mosquitoes by your household? (Tick which apply)

		Yes	**No**
A	Bed nets	**1**	**2**
B	Insecticide sprays	**1**	**2**
C	Clearing areas around	**1**	**2**
D	Closing windows/doors at night	**1**	**2**
E	Lighting fire in the house	**1**	**2**
F	Using coils	**1**	**2**
G	Apply mosquito repellents on skin	**1**	**2**
H	Use traditional plants	**1**	**2**
I	Use cow dung	**1**	**2**

204. For the method with direct costs mentioned in Q.207, how many times do you have to use per month (except for bed net)

Method	# use per month
B	
F	
G	
H	
I	

205. Cost per unit of the method used in the past 12 months

Method	Cost (Birr)
B	
F	
G	
H	
I	

206. Think about the methods to protect against mosquitoes Q.207 above. Which one is most suitable for your household?

1. Bed nets
2. Insecticide sprays
3. Cleaning areas around
4. Closing windows/doors at night
5. Lighting fire in the house
6. Using coils
7. Mosquito repellents
8. Traditional plants
9. Use cow dung
10. Other traditional Methods (specify)
11. Other commercial methods (specify)

99. DK

207. Where is the main mosquito breeding place in this area? ***(Don't read out options-just tick appropriately)***

		Yes	No
A	Swamp	1	2
B	Rice field	1	2
C	Forest	1	2
D	Ponds	1	2
E	Micro-dam	1	2
F	Others (Specify)	1	2

208. How far is it from your homestead (one way walk in minutes)?

Section 3: Bed nets: Section A. Ask Q.302 –HCB6 only to Households who currently use bed nets

301.	302.		303.	304.	305.	306.	307.
Does your household have any bed net? 1. Yes 2. No →**Section B**	When and where was the source? **A. When** Month year 1. Jan ………. 2. Feb…..……. 3. Mar ………. 4. Apr............ 5. May ……… 6. Jun ……… 7. Jul……….. 8. Aug……… 9. Sep………. 10. Oct……… 11. Nov…….. 12. Dec……..	**B. Source (s) of bed nets** Gov't 1 NGO 2 Bought 3 Friend 4 Other 5 **C. Cost per net from sources above** Gov't …………. NGO…………... Bought……….. Friend………..…. Others………..….	How many bed nets are there in total? …………….…	How many sleeping beds / mats do you have? ……… ………	If Q.304 and Q.305 are unequal in number, Why don't you have nets on all the beds? Circle all possible answers	Whose beds are fitted with bed nets? 1. Household head 2. Spouse 3. Bed shared with spouse 4. Children 5. Visitors 6. Others	Did you personally use a net last night? 1. Yes →**Q.309** 2. No

	305.	**Yes**	**No**
A	Gov't didn't supply adequately	1	2
B	No where to buy additional nets	1	2
C	Bed nets are too expensive	1	2
D	Not interested in putting them on every bed	1	2
E	Only children need nets	1	2
F	Only adults need nets	1	2
G	Some beds are not occupied	1	2
H	I don't know how to fit the net on all beds	1	2

310.	311.	311.	312.	313.
Why didn't you use a net? 1. They are few 2. It is too hot 3. Mosquitoes still bite through the net 4. It takes time to tuck the net @ night 5. Difficult to tuck in 6. Suffocates me 7. Other (specify)	What is the main reason to use a bed net in your household? One answer only **To Prevent**: 1. Mosquito bites 2. Malaria 3. Mosquito annoyance 4. Other (specify) 99. DK	How did you obtain your bed net(s)? Multiple answers possible 1. Was/were given free 2. Bought it/them 3. Can not remember 4. Other (specify)	If bought, where did you obtain/buy net? 1. A shop 2. A pharmacy 3. A drug shop 4. A health centre	How many times do you wash your bed nets? …….x a week …….x in 2 week …….x a month …….x in 2 months …….x in 3 months …….x in 6 months …….x in a year

Household current bed net use distribution

Household member (old to young)	HCB1 Does …… uses bed net 1=Yes 2=NO→ HCB4	HCB2 Since when did s/he start using bed net? M =Month Y=Year	HCB3 How many times had s/he suffered malaria? HCB3A 12 months before starting to use a bed net →HCB5	HCB3B 12 months after using net (if less than 12 months in use, specify the time period) →HCB5	HCB4 For non bed net users, how many times does s/he suffer malaria attack in a year on average?	HCB5 Has there been any change in frequency of malaria attack since he started using bed net? 1=Yes 2=No (Stop) 3=DK (stop)	HCB6 How do you see the frequency of her/his malarial attacks since started using the net? 1=reduces 2=increases 3=No change
1	1 2	M Y				1 2 3	1 2 3
2	1 2	M Y				1 2 3	1 2 3
3	1 2	M Y				1 2 3	1 2 3
4	1 2	M Y				1 2 3	1 2 3
5	1 2	M Y				1 2 3	1 2 3
6	1 2	M Y				1 2 3	1 2 3
7	1 2	M Y				1 2 3	1 2 3
8	1 2	M Y				1 2 3	1 2 3
9	1 2	M Y				1 2 3	1 2 3
10	1 2	M Y				1 2 3	1 2 3

Section B. Ask Q.314 – 318 only to respondents who currently not using bed nets in their households

314. Have you ever personally used a bed net?

1. Yes
2.No→Q.317

315.Why are you not using bed nets nowadays?

		Yes	No
A	I'm not bothered by mosquitoes		
B	Feel uncomfortable under a net	1	2
C	Too expensive	1	2
D	Nets are hot	1	2
E	I don't know where to buy from	1	2
F	Malaria not serious nowadays-	1	2
G	Does not protect against malaria	1	2
H	Malaria is a recent disease here	1	2

316. Why have you never used a bed net?

		Yes	No
A	I'm not bothered by mosquitoes		
B	Feel uncomfortable under a net	1	2
C	Too expensive	1	2
D	Nets are hot	1	2
E	I don't know where to buy from	1	2
F	Not aware of Bed net → Q. 409	1	2
G	Malaria is a recent disease hear	1	2

317. From your own opinion, how much do you think a net should cost (Birrs)?

……………Birr

99. DK

318. What do you think are the problems associated with sleeping under a bed net?

1. Too hot to sleep under
2. Mosquitoes still bite through
3. Disorganises you from getting up at night
4. Deprives you from air
5. I fear getting poisoned
6. Other (specify)

99.DK

Section 4: Insecticide Treated Bed nets (ITN)..............FOR HUSBANDS (male respondents)

401 Have you ever heard of ITN? 1. Yes 2. No →**Q.408**	**402.** From where was the information? 1. Friend/family 2. Health professional 3. Posters 4. Radio 5. Newspaper 6. Can't remember 7. Other (specify) **IF DON'T HAVE BED NETS GO TO 409**	**403.** Have you ever treated your bed net insecticide? 1. Yes 2. No →**Q.408**	**404.** What were the reasons for treating bed nets? 1. To kill mosquitoes 2. To make the net stronger 3. To repel mosquitoes 4. Prevent malaria 5. Others (specify) 99.DK	**404** How many times have you treated your net for the past 12 months? ……….. ………….. .	**405.** After how long should the bed nets be retreated? Every------times a month Every--------times a Year 99. DK	**406** How much did it cost for each treatment …………Birr	**407** Total cost of treatment for all the number of treatments made…… ……… ………… ….Birr	**408.** Where do you get ITN from this area? 1. Shop 2. Pharmacy 3. Health centre/clinic 4. Market 5. Other (specify) 99. DK

409: EXPLAIN THESE STATEMENTS FIRST TO A RESPONDENT INORDER TO ANSWER QUESTIONS BELOW (Q.409-Q.413); SHOW THE PICTURE OF A BEDNET ALSO TO THE RESPONDENT (SEE NEXT PAGE).

I am now going to explain to you what an Insecticide Treated Bed net (ITN) is. This explanation will help you to answer the following questions that I am going to ask you. A treated bed net is almost like any other ordinary bed net. The only difference is that it is treated with insecticides. These insecticides are safe to human being, but effectively kill and repel the mosquitoes. This will protect the person sleeping under the bed net against malaria and other insects like bedbugs and cockroaches. The treatment is done by dipping a clean net into a recommended dosage of chemical insecticide solution until it is completely wet. The wet net is then dried on a clean surface. Re-treatment can be done twice or more times a year depending on how frequently the net is washed.

Think about the costs of malaria burden to your household (in terms of costs of treatment, lost time, pains (sufferings) and any other costs due to sickness); number of bed nets available to your household; and your household expenditure to be met in the near future,

409A. Are you willing to offer any cash to have this additional bed net if somebody is to supply?

1. Yes→**Q.411** 2. No 99. DK

409B. What if I ask you to purchase a lottery ticket that costs 1 Birr to win this bed net for your household; given that this organisation
will supply 50 bed nets for your village (Kushet)?

1. Yes→**Q.412** 2. No 99. DK

409C. What if I ask you to sacrifice some of your labour time to work for this bed net?

1. Yes→**Q.413** 2. No 99. DK

410. A. If no or DK in Q.409A, Why are you not willing to offer any cash to have this bed net? **All which apply**

1. No money at the moment 2. I don't like using nets 3. Its government role 4.My household has enough bed nets
5. Malaria is not a serious problem here 6.Not aware of this method 7.I don't believe this method is effective 8. Others (specify)

410. B. If no or DK in Q.409B, why are you not willing to purchase this lottery ticket to win this bed net? **All which apply**

1. I have no money at the moment 2. I don't like using nets 3. Its government role 4.My household has enough bed nets
5. My religion does not allow gambling 6. Malaria not a serious problem here 7.Not aware of this method
8. I don't believe this method is effective 9. Others (specify)

410. C. If no or DK in Q.409C, Why are you not willing to offer your labour to have this bed net? **All which apply**

1. I have no time 2. I don't like using nets 3. Its government role. 4. My household has enough bed nets
5. Malaria is not a serious problem here. 6. Not aware of this method. 7. .I don't believe this method is effective.
8. Others (specify)

411. We would like to determine the maximum amount that you are willing to pay per additional bed net for your household?

411A. If yes in Q.409A, Are you willing to pay 15 Birr for a bed net?

1 = Yes 0 = No→**Q.410C**

411B. What if the price is 30 Birr would you be willing to pay? **(ALL GO TO Q.411D)**

1 = Yes 0 = No

411C. What if the price is 7.5 Birr, would you be willing to pay? **(ALL GO TO Q.411D)**

1=Yes 0=No

411D. What then, is the maximum amount you are willing to pay for a bed net? -- Birr

412. If yes in 409B, what then, is the maximum number of tickets you are willing to buy in order to increase your chances of winning this bed net (Given that one ticket = 1 Birr)?---tickets

413A. If yes in Q409C, what maximum amount of time can you offer per day to work for a bed net?-------------------------------------hours

413B. How many days can you offer then for a bed net?-- days

E2: Household Questionnaire

MASTERS PROGRAM: 2010 NOMA FELLOWS		
NORWEGIAN UNIVERSITY OF LIFE SCIENCES		
IN COLLABORATION WITH MEKELLE UNIVERSITY		
HOUSEHOLD QUESTIONNAIRE		
The information collected will be used for research purposes. It will be treated as confidential and will not be used by tax authorities or others to assess the need for food aid or other assistance.		
Zone		
Woreda		
Tabia		
Kushet		
Household ID		
Name of household head		
Distance to woreda town (walking minutes)		
Distance to local market (walking minutes)		
Distance to primary school (walking minutes)		
Distance to secondary school (walking minutes)		
Distance to all weather road (walking minutes)		
Distance to transporatation service (walking minutes)		
Distance to health center (walking minutes)		
Distance to grain mill		
Distance to nursery site		
Distance to protected water source(walking minutes)		
Distance to tap water(walking minutes)		
Enumerators:		**Dates interviewed**
First interview:		
Second interview:		
Third interview:		

Farm household survey: Household characteristics								
Woreda:		Interviewer:			Household number:			
Tabia		Date of interview:						
Kushet		Household head name:						
Household composition in 2002 (E.C.)								
Household members		Religion:						
MNo:	Name	relationship	Sex	Age	Education	Skills	Occupation	Presence
1		Head						
Codes:	Relation to household head: 1=wife, 2=child, 3=grand child, 4=brother, 5=sister, 6=hired labour, 7=other, specify							
Sex: 1=female, 2=male.					Age: Years.		Skills: specify	
Education: 0=illeterate, 1=read and write, 2= elementary, 3= church education, 4= secondary, 5=others.								
Occupation: 0=dependent, 1= student (in school), 2=watch after animals, 3=housewife, 4= farming								
5=hired labourer, 6=off-farm activity, 7=Tabia/kushet official: specify, 8=other: specify.				PA/village official:specify				
Presence: Months staying in the household during last 12 months								
Do any of the household members live outside the village this year (EC 1995)?							Yes	No
Name		Place	Purpose		Since when	Coming back when		

HOUSEHOLD NAME:_________________________________						HH id:_______________		
Farm household survey: Household Expenditures								
Expenditure on farm inputs EC 1994-95								
Item	Quantity	Own prod.	Purchased	Price	Unit	Tot. Expend.	Where bought	source of cash
Seed, teff								
Seed, wheat								
Seed,maize								
Seed, barley								
Seed, sorghum								
Seed, chickpea								
Seed, Millet								
Seed, Fava bean								
Seed, pea								
Seed, Latyrus								
Seed, others								
Seed, vegetables								
Seed, Pepper								
Other tree seedling.								
Fertilizer: Urea								
Fertilizer: DAP								
Herbicide								
Pesticide								
Tools/equipment								
Manure								
Hired oxen								
Animal salt								
Animal medicine								
Animals bought								

Animal feed:								
Grass								
crop residue (hay stover, etc.)								
Unit: 1) kg; 2) Shember; 3)Minilik; 4) mishe; 5)others. Specify								
Where bought: 1: from neighbour, 2: within kushet, 3: local market, 4: woreda market, 5: trader visiting village								
Source of cash: 1: ownsavings, 2:formal credit, 3:informal credit,4:sale of own production, 5:sale of assets,6: other specify.								
Have you obtained credit to pay for farm inputs or for farm investments? 1) YES, 0) NO. A69 If yes, give details for the 3 last years:								
Source	Year	Purpose		Amount	Repayment conditions			
					Frequency	Duration	Interest	completed
Have **you over the last 3 years received credit for** Nonagricultural investments								

If **you want, are you able to obtain credit for**	Yes/No	Source	Max amount	Interest rate	Duration	Comment	
a. Investment							
in farm inputs							
in oxen purchase							
in other business							
b. Consumption							
c. Family events							
						Yes=1	No=0
If you have already received credit for some purpose, are you able to obtain more loans before paying back what you have already obtained? Yes\no							
Are you member of a credit association?							
If yes, do you prefer to get credit on individual basis?							
Has any member in your credit group defaulted?							
If yes, what were the consequences?							

Does any one in the HH save/put money in any of the following?		
DECSI		
Equb		
Edir		
Nearby Bank		
At home		
Others,specify		

HOUSEHOLD NAME:______________________________					HH id:________________						
Farm household survey: Household Consumption Expenditures (last year)											
Commodity	Quantity			Quantity	Where	Per	Price	Unit	Own prod. Cons. Value	Cash Consump. Expenditure	Total Value of Consumption
	Own Prod	Free food	FFW	Bought	bought		Birr				
Teff											
Wheat											
Barley											
Maize											
Sorghum											
Millet											
Faba Bean											
Latyrus											
Chick Pea											
Pea											
Linseed											
Lentile											
other, specify											
Fruites											
Banana											
Mango											
Papaya											

Avocado											
Guava											
Vegetables											
Pepper											
Cabbage											
Onion											
Potato											
Tomato											
Other vegetables											
Garlic											
Coffee											
Spices											
Quantity: Number of units. Per: 1:week, 2:month, 3:season,4: year.											
Unit: 1:Kg, 2:pieces, 3:sheets,4:litre, 5:bags, 6:bundles 7:others, specify 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 neighbour, 2: within Tabia 3: local market, 4: distant market, 5: trader visiting village											

Farm household survey: Household Consumption Expenditures (continued)											
Commodity	Quantity Own Prod	Free food	FFW	Quantity Bought	Where bought	Per	Price Birr	Unit	Own prod. Cons. Value	Cash Consump. Expenditure	Total Value of Consumption
Beef											
Sheep											
Goat											
Chicken											
Eggs											
Milk											
Butter											
Sugar											
Cooking oil											
Salt											

Tea											
Clothing											
Shoes											
Blanket/bedsheet											
Umbrella											
Soap/Wash.p.											
Fuelwood											
Kerosene											
Batteries											
Mobile phone											
Radio											
Corrugated iron											
Furniture											
Travel/Transport											
School fees											
School books etc.											
Health/Medicine											
Income tax											
Land tax											
Religious contribution											
Ceremonies											
Jewelry											
House rent											
House construction											
Cigarettes/Tobacco											
Electricity											
Wood materials											
Leisure (drinks, candies, lotteries etc.)											
Quantity: Number of units. Per: 1:week, 2:month, 3: season ,4: year.											
Unit: 1:Kg, 2:pieces, 3:sheets,4:litre, 5:bags, 6:bundles 7:others, specify 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 neighbour, 2: within Tabia 3: local market, 4: distant market, 5: trader visiting village		

HOUSEHOLD NAME:_______________________________					HH id:_______________									
Farm household survey: Crop Selling Activities														
Crop	**Kushet**				**Local market**					**Woreda market:**				
	Qty	Price/ unit	Month sold	Income	Qty	Price/ unit	Where?	Month sold	Income	Qty	Price/ unit	Where?	Month sold	Income
Teff														
Wheat														
Barley														
Maize														
Sorghum														
Millet														
Oats														
Faba Bean														
Latyrus														
Chick pea														
Lentile														
Linseed														
Pea														
Pepper														
Potato														
Tomato														
Banana														
Mango														
Papaya														
Avocado														
Guava														
Pepper														
Cabbage														
Onion														

Carrot														
Tomato														
Garlic														
Coffee														
Eucalyptus														
Means of transport to the different markets:							Local market:			Distant market:				
Frequency of visit to the different markets:				(Per month)			Local market:			Distant market:				

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

Farm household survey: Livestock Selling Activities EC 2001-02														
Animal/	**Village Market**				**Local Market**					**Distant market**				
Product	Qty	Price/ unit	When sold	Income	Qty	Price/ unit	Where	When sold	Income	Qty	Price/ unit	Where	When sold	Income
Cattle														
Milking cow														
Other cows														
Oxen														
Heifer														
Bulls														
Calves														
Sheep														
Goats														
Horses														
Mules														
Donkeys														
Chicken														
Butter														
Milk														
Meat														
Eggs														
Skins														
Animal dung														
Honey/Wax														
Reasons for selling livestock last year?														
1	To cover food expense						4	To cover land tax						
2	To cover clothing and schooling expenses						5	Others. Specify						
3	For wedding and other social expenses													

Farm household survey: Livestock Selling Activities EC 2001-02															
Animal/	**Village**				**Local Market**					**Distant market**					
Product	Qty	Price/ unit	When sold	Income	Qty	Price/ unit	Where	When sold	Income	Qty	Price/ unit	Where	When sold	Income	
Cattle															
Milking cow															
Other cows															
Oxen															
Heifer															
Bulls															
Calves															
Sheep															
Goats															
Horses															
Mules															
Donkeys															
Chicken															
Butter															
Milk															
Meat															
Eggs															
Skins															
Animal dung															
Honey/Wax															
Reasons for selling livestock last year?															
1	To cover food expense														
2	To cover clothing and schooling expenses														
3	For wedding and other social expenses														
4	To cover land tax														
5	Others. Specify														

Farm household survey: Other Sources of Income 2001 -02 E.C)									
Source	Input quantity	Input costs	Who earned	Where /to whom	When/Period	Quantity	Price/Wage	Income	Years of Experienc e
Hiring out oxen									
Hire out labour									
Labour exchange									
Assistance received									
Assistance given									
Rent out land									
Employment									
Cash support									
Migrant income									
Remittance Income									
Assistance from relatives									
Government Transfers									
Gifts									
Sale of firewood									
Sale of Handicraft									
Sale of beverages									
Petty trade									
Grain mill									
Other business/services									

Source	Number of months/ yr worked	how many person in the hh	Who earned (hh member id)	Input quantity (toal labor mandays)	Outoput Quantity (food in kg or days of work) per year		price/wage (price of wheat per kg or daily payment rate of CFW		Total income
					unit	quantity	unit	price	
Food for Work									
Food Aid									
Cash for Work									
OFSP(Other Food Security Program)									
Employment: permanent job locally, Hire out labour: temporary job locally, Migrant income: temporary job outside community member by household Remittance income: Money sent by relatives permanently living elsewhere									

What durable commodities and implements does the household have?									
Household Assets	Number now	Year bought	Number bought	Price	Current value	Need replacement (# of years)		Implements Owned 1998 EC	Source of cash
		Latest	last year						
Farm inplements									
Plough									
Donkeycart/ horsecart									
Plough parts									
Hoe									
Sickle									
Hammer									
Ax									
Spade									
Wheelbarrow									

Other production assets:									
Irrigation equipment									
Irrigation well									
Irrigation pump									
Pond									
Assets									
Furniture									
Radio/cassetplayer									
Wrestwatch									
Bicycle									
Stove									
House with iron roof									
Hut									
Kitchen house									
toilet*									
Jewelry									
Mobile phone									
Source of cash: 1:Sale of output, 2:Remittances, 3:Credit, 4:Sale of food from FFW, 5:Sale of livestock, 6:Savings, 7:Others, specify									
*Whether the household has toilet or not should be verified by the interviwer									

HOUSEHOLD NAME:________________________________		HH id:_____
Farm household survey: Food security and Coping strategies		
What were your priority in responses (coping strategies) when you faced drought?		
Activity	Response to income fluctuations (Rank=Priority 1)	
Sell animals		
Sell trees		
Obtain food through Food-for-Work		
Obtain cash through Cash-for-Work		
Withdraw children from school		
Search for employment elsewhere in Ethiopia		
Rely on existing off-farm income sources		
Borrow money from relatives		
Borrow money from other sources		
Use cash/bank savings		
Assistance from relatives		
Reduce expenditure on clothing		
Reduce expenditure on:		
Other, specify:		
Is there any changes in your strategy to cope with food insecurity as compared to 8-10 years ago?		
If yes, explain why/how:		
How strong is your social network (extended family) in terms of providing help in case you face serious problems (e.g. drought, sickness, income failure)? Explain:		

E3: Plot Level Questionnaire

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

Does the household have a land certificate? 1=Yes 0= No If yes, Year (EC) of receiving the certificate:__________
Land certificate information (copy information from land certificate), If no, why no certificate? 1=Did not collect it, 2=No land at that time, 3=Too small land, 4=Land was not registered, 5=Tabia did not give me, 6=Lost it, 7=Other, specify

Registration number on certificate:____________
Full name (owner):________________________________Sex of owner: _______________
Is owner current head of household? Yes No If no, relationship between listed owner and hhhead: HHhead is…………………

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

Plot No.	The name of the place where the plot is located	Distance (minutes)	Soil depth of the plot (Deep=1, medium =2, or shallow= 3)	Plot size in Tsimdi	Measure dplot size in Tsimdi	The plot is Adjacent to…..	GPS Coordi-nates	Alti-tude (Eleva-tion)	Origin of plots	Who decide on plots	Who work on plots
						E: ________N: ______ W: ________S: _______					
						E: _________N: ______ W: ________S: _______					
						E: _________N: ____ W: ________S: ______					

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

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

Plot No.	The name of the place where the plot is located	Distance (minutes)	Soil depth of the plot (Deep=1, medium=2, or shallow=3)	Plot size in Tsimdi	Measuredplot size in Tsimdi	GPS Coordi-nates	Alti-tude (Eleva-tion)	Origin of plots	Who decide on plots	Who work on plots

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

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

Household Name:	Household Id. No.:	Interviewer:

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

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

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

Household Name:	Household Id. No.:	Interviewer:

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

Plot No.	Plot Name	Irrigated? 1=yes, 0=no	Soil Type	Soil Depth	Slope	Land quality	Weed infestation	Susceptibility to erosion	Degree of soil erosion /degradation
Codes: a) Soil type: 1. Baekel, 2. Walka, 3. Hutsa, 4. Mekeyih, Soil depth: 1.Shallow, 2. Medium, 3. Deep									
Slope: 1. Meda, 2. Tedafat (foothill), 3. Daget (midhill), 4. Gedel (steep hill)									
Land quality: 1. Poor, 2. Medium, 3. Good, Weed infestation: 1. High, 2. Medium, 3. Low									
Susceptability to erosion: 1. High, 2. Medium, 3. Low, 4. None Degree of degradation: 1. Highly degraded, 2. Degraded, 3. Moderately degraded, 4. No degradation									

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

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

No: Number of Visits
Who: Persons visited the plot: 1= Husband, 2= Wife/female head, 3= Husband and wife, 4= Husband and Son,
5= Others, specify __

Land market participation

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

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

Household No.:	Interviewer:	
HH name	Data of Interview:	
Kushet:	Woreda:	
Tabia:	Zone:	Who decides

2006 plot no	Plot Name	Land rental markets								Byproducts, who get them?			Responsibilities					
		Contract	Type	Duration	If duration>3 yrs, specify	Payment	Advance payment	Paid when	Cost-sharing arrangement	Crop residues	Manure	Grasing	New SWC	Maintain SWC	Pay land tax	Contract type	Crop choice	Share rate/ Rent

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

Duration: 1. 1 year, 2- 2 years, 3. 3 years, 4. >3 years, specify……………., 5. Open ended.
Payment: Fixed rent: cash amount, Sharecropping: Share of output to the landlord (Code: 1. 50%, 2. 33%, 3. 25%, other, specify:……………………
Advance payment: Cash amount in sharecropping contracts.
Paid when: 1. Before cultivation, 2. After harvest, 3. Other, specify:…………………..
Costsharing arrangement: 1. Landlord pays fertilizer and seed, 2. Landlord and tenant share cash input costs, 3. Other, specify:……………………………
Byproducts, who gets them/Responsibilities/Who decides: 1.Landlord, 2.Tenant, 3.Shared, 4. Open
Crop choice: 1. Landlord, 2. Tenant, 3. Follow follwing crop rotation system (specify): ………………..

Crop production and input use

Plot no.	Sub-plot	Sea-son	Plot Name	Crop grown	Area planted	crop output Kg	Seeds		Manure in Kg	Urea in Kg	Dap in Kg	Herb and pesticide Birr	Number of labor man days					Oxen
							Type	Kg					Plow-ing	Weed-ing	Harvest-ing	Thresh-ing	hired labor	

Season: 1=Meher (rainy season, 2=Dry season 1 (irrigated land), 3=Dry season 2 (irrigated land)
Crops grown: C1. Barley, C2. Wheat, C3. Teff, C4. Maize, C5. Millet, C6. Sorghum, C7. Field pea, C8. Bean, C9. Linseed, C10. Lentil, C11. Hanfets
Vegetables: V1. Onion, V2. Potato, V3. Tomato, V4. Letus, V5. Cabbage, V6. Carrot, V7. Pepper, V8. Others
Perennials:P1. Orange, P2. Banana, P3. Eucalyptus. P4. Guava, P5. Papaya, P6. Coffee, P7. Others, Specify…………..
Seed type: 1. Improved, 2. Local, 3. Others, specify
Oxen: 1. Own oxen, 2. Shared oxen, 3. Oxen exchange with labour, 4. Borrowed oxen, 5. Rented oxen for cash, 6. Other, specify: