Addis Ababa University
School of Graduate Studies

VALUING THE HEALTH DAMAGES FROM WATER RELATED VECTOR BORNE DISEASES, AND MICRO ECOLOGICAL SETTINGS OF IRRIGATION:
A Case Study of Wonji Cane Plantation Irrigation Scheme

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YITAGES MENGISTU

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirement for the Degree of Master of science in Economics

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Acknowledgement

First of all I would like to thank the omnipotent and omnipresent God with out whose help my work would remain a dream.

My special thanks extend to EDRI (Ethiopian development and research institute), which provided me financial support, so that I could conduct this vast comparative research. The support has had a remarkable role in my work.

I would also like to thank Dr Mohammud Yusuf, whose all rounded support and assistance from the start of the research work to the end has been really valuable to me. Moreover, my thanks go to Dr. Tavis Barr and Dr. Munohar Rao advisors of the thesis; with out whose continuous advice this work would have been unbearable.

Last but not least, my thanks go to my families who have tolerated the inconveniencies, and hard ship, during my study. The moral and professional support I got from Tesfu Alemu, Negash Kebede, S/r Atsede Tesfa Mariam, and w/o MuluAlem Tamire is also worth mentioning.

TABLE OF CONTENTS

List of Tables

List of Appendices

Abbreviations

CSA= central statistics agency

EPA = Environmental protection Authority

EPI= Expanded program of immunization

LIMDEP = limited dependent

RBC= Red blood cell

SNNP= south nation nationality and people

WHO = world health organization

ABSTRACT

Malaria and Schistosomiasis is the most prevalent water related vector born diseases, and their impact both in epidemiological or monetary terms are enormous. These impacts are further intensified when irrigation project is instigated. They are endemic health problems, unless and otherwise in the area under investigation.

The present study conducts an objective assessment of the health damages incurred by households due to malaria and schistosomiasis in wonji cane plantation, and also over look the attributes of irrigation exposure over and above with similar comparative area (Zeway) by using statistical probability of odds of a disease.

Health production function was adopted for valuing the damages from mosquito bite and cercaria infestation, based on the theory of utility maximization behavior on aversion and illness. The predicted probability of observing illness in a household was used to estimate the damages in monetary terms. Primary data with a sample of 200 and 300 households were deployed from Wonji and Zeway respectively. This enables as to derive treatment cost and wage loss pending from the illness and to arrive at the total cost of illness. That is birr 288.65 and 83.03 for representative household and 57,172.50 and 16,439.94 birr per year for sampled households for malaria and schistosomiasis respectively, and irrigation peculiar health damages was estimated and became 9,966.24 birr per year for both illnesses in a sampled household in Wonjicane plantation.

Accordingly health education through electronics media, wage income, educational attainment of the head of the household is the key determinant for aversion decision and malaria illness. Unexpectedly, the role of bed net in malaria illness is positively related and insignificant, but significant only on aversion. The significant variables for schistosomia illness and defensive behavior are wage income, non-wage income, illiteracy, knowing the symptoms, and unavailability of potable water at household level.

The health damage cost at household level and for representative samples are enormous. Therefore, the study suggests that the government has to assess diseases impact not from epidemiology point only, but also to the economic cost aspect, which is crucial both at micro and macro levels. Moreover, the government should Provide appropriate tap water at all times, special health education at school level, adequate distribution of bed net that can be supported with follow-up, and compensation for the opportunity cost they incurred when irrigation is implemented.

CHAPTER ONE

INTRODUCTION

1.1Background

Ecological change affects human health and well being in different ways from various sources. Development of water resources project (irrigation) as a remedy for rapid population growth, land degradation, erratic rainfall, and declining per capita income etc. is the one and the major source, which disrupts the ecology and consequently creates principal infectious diseases, which are the core health problems in developing countries. In this respect, agricultural water use in general and irrigation in particular affects both environment and health. From an environmental perspective, water maintains a host of natural ecosystem. On the other hand, withdrawal of water through irrigation can reduce the flows of fresh water needed to sustain natural resource areas, and drainage flows from irrigated fields can disturb the ecological balance by carrying excess chemical, nutrients and pollutants in to the ecosystem and allowing emergence of flora and fauna due to local climate change.

Disease is the out come of interaction between man and environment in which the role played by other animals as vector or intermediate host in suitable environments are of a particular importance as other factors. The natural environment and human activities and behavior influence the occurrence and intensity of many human diseases in various ways. Climate, soil, hydrographic conditions, humidity, vegetation, limits or precludes the survival of agents, vectors, and reservoirs, since most of them can live only in certain ecological zone (kloos.H, 1988).

Aron.J, J.A. Patz (2001) stated that unlike most non infectious diseases, for which a component of the environment serves as the actual exposure (example, toxins, temperature extremes, and radiation), the role that the environment plays in infectious diseases is to mediate the extent of infection by altering the abundance of pathogens or the frequency and nature of infectious contacts. Different environmental variables are more or less important depending on the mechanism of transmission of each infectious agent. In general, the transmission agents that are water borne, food borne, vector borne or air borne or have an animal reservoir tends to be more strongly influenced by environmental variables.

According to Cairncross,S. , R.Feachem(1983) there are six identifiable ecological consequences of irrigation which affect mosquito and fresh water snail population. These include:

1. Simplification of habitat
2. Increased surface water
3. High water table
4. Changes in water flow
5. Micro climatic change towards wetter and cooler condition
6. Human population change

Following this, the health repercussion of irrigation has both benefit and health risk. Amongst the human health benefits are improved diets and incomes via increasing total out put and improving marginal productivity of factor inputs, and subsequent improvement on health status. Other benefits obtained from irrigation can be better facilities for feeding and watering the domestic livestock, which again improves diet and income.

To its adverse effects however, it leads to change in water flow, increased surface water, and formation of high water table. As a result the microclimate turns wetter and cooler, and consequently increases human settlement. This in tern creates a fertile ground for intermediate host and disease causing organisms (pathogens) to breed and disseminate. More over, irrigation increases the frequency of people in to contact with water, as a result, water related vector borne disease would most likely occur. These include: malaria, schitosomiasis, lymphatic Filariasis, onchocerciasis and Japan encephalitis. The most prevalent health problems that upsurge huge burden to the dwellers in the catchments areas of irrigation projects in particular are malaria and schistosomiasis. Consequently, it hampers wellbeing and economic growth
(Cairncross.S. , R .Feachem,1983) .

1.1.1 The Concept of Health

Health is a difficult concept to define. In the modern literature of health promotion, health is defined as having two distinct dimensions namely positive health (well-being) and negative health (ill health. The positive dimension of health consists of the qualitative aspects and human life in general, and is strongly associated with the concept of "fitness". The negative dimension is determined by the presence of disease, illness, deformity, unwanted states, injury, disability and handicap. A different and widely used positive model of the definition health is that of WHO's. It is a "state of complete physical, mental and social well being and not merely in the absence of disease and infirminity". This definition stresses that to be healthy means something different from just not being ill. In recent years, this statement has been amplified to include the ability to lead a socially and economically productive life) (Meseret shiferaw and Haile Fenta, 1990).

While health is a broad concept, disease is relatively simple to define and conceptualize. The words "disease" "illness" and "sickness" are loosely interchangeable but are better regarded as not wholly synonymous (see on appendix 7).

There are two basic epidemiological assumptions regarding human disease. These are:

1. Human disease does not occur at random i.e., there are patterns of occurrence in which some behavioral and environmental factors increase the risk of acquiring a particular disease.

2. Human disease has casual and preventive factors that can be identified through systematic investigation of populations in different places or at different times. Thus, identifying these factors create opportunity for prevention and control of diseases in human population either by eliminating the cause or introducing appropriate treatment (Yemane, 2005).

The continuous (dynamic) interactions between man and nature for survival and the disruption of the ecosystem when the ecosystem from its equilibrium may result in subsequent health damage as stated in 1.1.

1.1.2 The Concept of Ecology

Ecology is very much a science of complex interconnections, of population level analysis, environmental impacts on organisms, and change. Infectious disease can be thought of as part of largely (human ecology) in which human social systems, economic interaction with the environment, and life styles represent some of many domains of interaction that influence risk. To reduce the risk, whether immediate or long term, whether locally, or globally, will require ecological conceptualization that accompanies detailed understanding of pathology and physiology (Aron L.J., J.A. patz, 2001).

Environmental variables are often grouped in to two broad categories: abiotic and biotic. Abiotic factors are primarily physical or chemical and include elements such as temperature, water or precipitation, relative humidity, atmospheric gases, wind and solar radiation. Biotic factors, on the other hand, involve living plants and animals, and can be grouped phylogenetically or functionally. While conceptually useful, the distinction between abiotic and biotic categories is blurred and can be misleading because extensive interdependence exists between them. Abiotic change such as unusual precipitation results in creation of biotic factors such as mosquito population due to improved breeding habitat. Moreover, ecological changes may occur at spatial scales ranging from centimeters to continents and over time period of days to mellinea (AronJ.L., J.A. Patz, 2001).

The manner in which such temporal and spatial variation affect the ecology of infectious disease depends on characteristics of each pathogen and its mode of transmission. This is essentially the major health constraint in developing countries like Ethiopia.

1.1.3 The Concept of Water resources Development (Irrigation) and Its Dilemma

According to Adekolu-john.O.E et al (1993) irrigation, dams, and fresh water fisheries are indicators of a development process. The rate at which they are built in a country may outstrip the capacity of the health care system to monitor the introduction, spread or aggravation of water related vector borne diseases. Since most of these projects don't have an adequate health component, the magnitude of the problem can only be understood in terms of growth.

Water impoundment schemes can be graded as large, medium, or small, and their numbers have been increasing over time. During the 1960s and 1970s, 202 large dams were built in Africa; in the 1980s, 131 more were added (Hunter.M.J., 1993). Regarding Ethiopia, before the 1960s, there were 3 dams and 2 decades later 5 more were built.

In Africa, where the size and growth population is high, only 30% of the land is suitable for food crops dependent on rainfall. Given the food and energy demands for the worlds increasing population, especially for the developing world, it appears inevitable that more land will be irrigated to balance growth of food production and food demand.

At global level, irrigated agriculture is a major human use of land water resources. About 70% of the water drawn from rivers, lakes and aquifers is used in agricultural production. By 1990, there were about 40 million hectares of irrigated fields, but by 1998, this has increased to more than 271million hectares, with much of the increase occurring after 1990s (Urama.U.K., I. Hodge, 2004).

According to Urama.U.K.,I.Hodge (2004), specifically government and policy makers in sub Saharan Africa countries have continued to support to the transfer of prime agriculture from less intensive rain fed traditional cropping systems to intensive irrigation systems understanding that irrigation increases total crop out-put per hectare via double cropping and that it also improves the marginal productivity of factor inputs. These all are intended to bring about sufficient house hold food production and improved nutritional status.

As agriculture is the main stay of these countries, and implementing such developmental irrigation project to augment the sector is mandatory. At the same time, it may positively be associated with the emergence and aggravation of water related diseases like malaria and schistosomiasis. And this ill effect may hamper the production severely and can limit the attainment of basic development objectives, unless multi-sectoral approach is used from project feasibility to whole project life to alleviate the dilemma of water resources development.

1.2 Statement of the problem

How do ecology changes affect health and how much does ill health cost? Water related vector borne diseases are most likely to be found in areas where irrigation has established for the reason that alteration of the aquatic and local ecology. Amongst 30 or more water based and water related diseases; malaria, schistosomiasis, lymphatic filariasis, and onchocerciasis have been taken as the major health problems. Particularly malaria and schistosomiasis take the lion share on the prevalence and impose their impact not only on health, but also on socio economic ramifications. Their major health importance is very remarkable because; they cause death or sever disability, large proportion of population at risk become ill, they are particularly difficult to control certainly once they become wide spread or they are endemic, and the resulting ill health lasts long.

Wonji cane plantation is one of the eldest cane plantations implemented to produce raw input (sugarcane plant) for sugar cane factory. It was started with foreign share company in 1954, and has increased its contribution in the economy through increasing the plantation size over time. Despite, its contribution in the economy, malaria and shistosomia became the major health treat besides as duration of the project has been increased (lengthened), the prevalence of the diseases has also increased. Literature also supports this. In wonji-Shoa sugar estate the prevalence of S.mansoni was less than o.5% from its opening in 1954 until 1964, but by 1984, it had reached 19.4% Above all, malaria is the most widely spread and prevalent water related vector borne disease through out the country except at very high and very low altitudes. It is also rampant in water resources project areas (Ahmed z., 1993). Recent source from wonji hospital morbidity stastics, malaria is the first among the ten top diseases and schistosomiasis accounts the prevalence rate of 42% and 26% in 20005 and 20006 respectively.

Although mortality due to malaria is higher in children, the morbidity levels on the youth; which constitute the dominant factor inputs in the agricultural sector of the economy is enormous; that make the problem much worse. Regarding schistosomiasis, it is a chronic health problem and its cumulative effect before diagnosis and its low relative severity may predispose in to bad prognosis.

Apart from their epidemiological impact (i.e., morbidity, depleting and mortality) they induce paramount negative economic repercussion at micro and macro levels. In this respect, the rural poor in endemic or/and epidemic areas are extensively exposed and urge appropriate treatment in return. To accustom this they expend more, shifting their constrained income from consuming non-health into health services. Consequently, the already existing poverty may escalate.
On the other hand, absence from productive activity either when household own or members of the household sick has an impact on productivity especially on wage laborers and even when s/he recovers from her/her illness, efficiency in productivity will be reduced due to debilitating effect. Moreover, the seasonal variation in the occurrence of out break (epidemics) in case of malaria may precipitate difficulty in timely planting and harvesting and can result in massive loss. Due to the relation of irrigation and the stated diseases, it obstructs implementing such projects that are the most viable remedies in alleviating the existing food shortage problems. Therefore, this is not with out opportunity cost.

Despite their lion share of epidemiological impacts, very scant was done for valuing the health damage cost; these were in Tigray and Oromia region using contingent valuation method on prevention aspect and human capital approach in cost of illness method especially for malaria. The loss incurred in relation to medical expense on defensive activity such as early treatment and prevention, lost wage, disutility arising from illness etc., its demographic morbidity impact, and the increase in prevalence over time and absence of quantified figure in monetary terms increase the need of appropriate quantifications. This study therefore, will first try to correlate behavior and illness using utility function and adopting health production function one of the components of willingness to pay in the health economic literature, and will try to explore both treatment and wage loss cost of the most prevalent diseases (malaria and schistosomiasis) burden at household level using probability technique on the epidemiological findings and other measurements.

1.3 Significance of the Study

Health conditions affect the pace of development and the level of well being attained. Human knowledge and skills are taken as capital, and negative health (ill health) depreciates this capital. If this is so, the health status is a fundamental component for economic growth since it has direct impact on productivity and efficiency of imputed labor.

Malaria and schistosomia illnesses occurrence/aggravation are the major obstacles for irrigation project development to attain food self-sufficiency and to achieve at least the minimum nutritional requirements on that particular area and nation wide. In Ethiopia where agriculture is the principal sector of the economy and where food self-sufficiency is in adequate, using rain-fed traditional method of farming may worsen the problem with the existing trends of population growth. Therefore, intensive small and large irrigation farming is one of the remedies.

With the exception of epidemiological investigation on health ground, the economic impacts of diseases haven't yet quantified adequately due to the absence of well-developed model and professionals in the area; hampered to remain at its infancy. Taking this in to consideration, the study attempts the first trial on estimating the health damage cost, adopting health production function as a preliminary work that would serve as a benchmark for others to evaluate the scenario of relevant disease in a wide research design at regional and national levels.

1.4 Scope of the Study

The implementation of irrigation project either small or large, has an inevitable influence on the emergence or aggravation of malaria and schistosomia. Although the problem persists in all water recourse development schemes Wonji is selected among the existing projects; due to its proximity to the capital, the existence of active prevention program supported by research, and it is the first and the most significant cane plantation both in terms of economic contribution and health burden. Last but not least, the study only concentrates on this area owing to time constraints.

1.5. Objectives of the Study

The general objective of this study has to do with valuing the health damages from water related vector born disease and micro ecological irrigation setting. The specific objectives include:

1. To explore the relation of decision behavior (aversion) and illness and to assess the associated risk factors.

2. To derive the predicted probability of observed illness in each household survey in the study.

3. To probe household treatment cost of illness and wage loss due to illness on malaria and schistosomiasis
4. Estimate excess cost of irrigation micro ecological changes on malaria and schistosomiasis.

1.6 Limitation of the study

The study includes tangible cost and excludes the intangible cost i.e., pain, grief, suffering, and associated utility. But this may have an important impact, which depends on the nature of the diseases. In addition, it only quantifies the treatment cost and wage loss, assuming s/he is self-employed. The study also assumed that; attributable percent was approximated using average percentage of the prevalence attribute as incidence as incidence attribute. Employment rate data from CSA includes child labor, which may erode the reliability of wage loss estimation.

1.7 Hypothesis

The research assesses empirically the validity of epidemiological theory which states that:

Irrigation Scheme intensifies malaria and schistosomia occurrence and/or aggravation.

- H_O: Odds of a disease are equal both in irrigation exposed and non-exposed areas
- H_A: Odds of a disease in irrigation exposed are greater than non irrigation areas

CHAPTER TWO

Related Literature Survey

This chapter consists of three headings; the first includes the association of irrigation, ecology, and water related vector borne diseases, the second comprises theoretical literature survey and the third holds empirical literature.

2.1 Reviewing Direct and Indirect association of Irrigation, Ecological change, and Emergence of Malaria and Schistosoma, and their Vectors

2.1.1 Irrigation and Ecological Disruption

Despite the fact that, irrigated agriculture contributes the lion's share to the world's food supply, the establishment creates radically new ecological regime and new pattern of infectious disease. New disease may be introduced but more probably diseases already present will also undergo change in their epidemiology and prevalence. Mosquito breeding in fields of irrigated crops, such as rice is exacerbated by continuous irrigation, by insufficient weeding, and by careless practices such as leaving fallow paddy field flooded and allowing irrigation channels to become overgrown (Caincross. S.,R. Feachem, 1983).

Change in the characteristics of the ecosystem represented by irrigation, and the territory exposed to its influence occur more rapidly. In the first changes due to retention: the flooding of territory; the rise in water level, the submersion of the terrestrial flora and fauna, and the forced departure of people and animals. Other changes following irrigation projects exploitation are an increase in the area covered by water; the development of swampy regions and lagoons on surrounding terrain lower than the lake or in the fringe of cultivated land, as a result of the rise in the ground water level; and some modification of the micro climate with generally more Constant humidity through out the year and increased isolation (Hunter. M.J., 1993).

Depending on their ecology, certain mosquito species may disappear or remain confined to small territories untouched by development. Other species may find more favorable conditions increased water surface; favorable physical, chemical or nutritional factors and reduced numbers of predators, allowing the vectors' abundance to increase and enhancing their ability to transmit diseases. Both the extension of the aquatic habitat and the state of the ecosystem at a certain stage of eutrophication may favor the establishment of multiplication of snail species acting as intermediate host for schistosomes (Hunrter.M.J., 1993).

The major inevitable health risk entails the spread of vector habitats for example; a recent study in Ethiopia showed a seven fold increase in malaria among about 7,000 children under 10 years living with in 3 km radius of small dams, compared with children living outside mosquito flight ranges (Listorti.A.J., M.F.Doumani, 2001)

Table2.1: Environment changes and recognized effects

Environmental change	Diseases	Path way effects
Dams, canal, irrigation	Malaria	Increased breeding site of mosquito
	Schistosomiasis	Increased snail host habitat, human contact
Deforestation and new habitation	Malaria	Agricultural intensification

Source: Aron. L.J., A.J. Patz, 2001

2.1.2 Ecological Approach to Disease

In Epidemiology the occurrence and distribution of diseases are studied against the background of various circumstances in man's total environment; physical, biological and social. This is an ecological approach to disease; disease cannot be attributed to the operation of one factor. The requirement that more than one factor be present for disease to develop is referred to as multi causation. According to this concept an agent of disease may be considered to be a necessary but not sufficient cause of disease because suitable conditions of the host and the environment must also be present for disease to develop. Factors affecting the development of disease can be divided in to three groups. These are agent, host and environment

1. Agent of Disease (etiological factors)

2. Host factors (intrinsic factors). These include:

   a) Genetic

   b) Age

   c) Sex

   d) Ethnic group

   e) Immunity

   f) Inter current or pre- existing disease

   g) Religion

   h) Behavior

3. Environmental factors (Extrinsic factors). These include:

   a). Biological environment which includes

   - Plants and animals
   - Vectors that transmits diseases
   - Reservoir of infection

   b). Social environment

   - Socio economic status
   - Culture

   c). Physical environment

   - Culture Temperature, light, air, humidity, rainfall, altitude, radiation, chemical agent, irrigation, contamination of water body etc.

It is the interaction of these three sets of factors, which determines whether or not disease develops (Meseret shiferaw and Haile fenta, 1991).

2.1.3 Ecological Change and Emerging Diseases

Infectious diseases have recently been grouped not by their usual habitat, mode of transmission, or type of reservoir, but by virtue of being newly recognized or reappearing with increased incidence or severity. Scientific and popular attention has been directed toward these so-called emerging diseases, which are newly recognized syndromes, diseases appearing in new areas, or infections with more sever or less easily treated symptoms. Most experts recognize that ecological changes, including those that results directly from human social and economic behavior, play a major role in the emergence of infections diseases (Lake et al. 1993; Roizman, 1995 cited in Aron.L.J., J.A.Patz, 2001), Smith et al.1999 cited in Pattanayak.K.S., C.G.Corey 2003) environmental factors attributes 70 to 90% of the risk of malaria.

a) Foundations of the Emergence of Disease

Infectious diseases may be considered emerging if they can form to one or more of the following categories:

1) Newly described disease or syndrome recognized it in the past few decades;

2) Expanding distribution of a familiar disease in to a new region or habitat;

3) Increased local incidence of a disease;

4) Increased severity or duration of a disease or increased resistance to treatment

In one-way or another, environmental changes affect the difference categories of emerging diseases.

b) Newly Recognized Disease

Most truly new disease appears when enough people are exposed, often suddenly, to a pathogenic microorganism that it attracts the attention of health providers, epidemiologists, or researchers. Such diseases are new, but the causative agents usually are not. These microorganisms often have existed in the same environment with humans for long periods, occasionally infecting people with out being recognized. At some point, a shift in the type or extent of contact may occur, thus leading to more frequent disease (Anon.L.J., 2005).

c) Expanding Distribution

Long recognized diseases that appear in new regions or habitats or whose foci are locally expanding also may be considered emerging. Emerging disease may increase their distribution involves gradual expansion, usually made possible by human-induced changes in environmental conditions. Various ecological changes such as deforestation, modification of river flow, or dense human crowding may locally influence the geographic pattern of a disease focus. For example, increased regional distribution and incidence of schistosomiasis in Africa have been attributed to the impoundment of river water for irrigation. Altered patterns of water flow, nutrient loads, and vegetation have permitted expansion of complete snail vectors; human contacts with water, including contamination with excrement, may increase as well setting the stage for a larger area and greater human population affected by emerging schistosomiasis.

The distribution of malaria, for example, may be gradually expanding in responses to an increase in average temperatures. Not only are vector mosquitoes able to survive and better reproduce under warmer conditions, but also the development time for the plasmodium parasites in their cold-blooded vectors would be shortened with warmer temperature, there by increasing the amount of transmission.

Table 2.2: Global distribution of malaria and schistosomiasis Associated with water resources development.

Type of disease	Number of endemic countries	Exposed population (millions)	Infected Population(Million)
Malaria	99	2200	275*
Schistosomiasis	74	600	200

Source: Hunter.M.J et al, 1993 * Africa

2.1.4 Factors Affecting the Distribution of Water Related Vector borne Diseases and their Vectors

2.1.4.1 Factors affecting the Distribution and Abundance of fresh water Snail and Schistosomia species

In Ethiopia, no comprehensive study correlating the geographic distribution of snails with the physical environment of the country has been made. However, the little available information with the general factors known about the influence of physical, chemical and biological factors as follows (Kloos, 1989).

a) Altitude and Temperature

Altitude doesn't seem limiting in it self, but exerts an influence through temperature. B.pfeifferi to date has not been recovered from areas below 700 meter and above 2,850 meter altitudes, while Bulinus species are found between 300 to 2,850 meter and Bulinus abyssinicus is confined to altitude below l, 000meter.

Temperature on the other hand, is an important factor in limiting the distribution of snails. High temperature reduces egg lying by a atrophying the albumin gland and ovotestis and repressing the female gonadal tissue. Low temperature retard the rate of growth, reproduction, respiration and oxygen consumption forcing snails to hibernate. Temperature exerts its indirect influence on snails by controlling the rate of photosynthesis, the rate of bacterial decomposition, and amount of minerals and dissolved oxygen, growth of micro flora and aquatic vegetation. The most favorable temperature for survival of snails is between 22 ^{0}c to 28 ^{0}c. While B. abyssinicus is confined to lower and middle Awash Valley that experience annual mean temperature ranges of 28 ^{0}c to 31 ^{0}c.

b) Rainfall flow rate and slit

The population density of snail hosts is highly associated with the amount of rainfall and topography of the area. In Ethiopia there exists a pronounced association between altitude and rainfall; therefore areas between 600 to 2,500 m receive 1,000 to 1,400 mm. In eastern Ethiopia, rainfall decreases toward the lowlands until it is less than 200 mm along the red sea cost, the lower Awash valley and the Ogaden. High water current has a determinant effect on the physiology of snails, primarily by washing away the growth factors. It also clears off emergent and floating vegetation and sand or silt particles that serve as source of food and gizzard components.

c) Vegetation and Food

The distribution and abundance of snails is associated with the potential of water bodies to support aquatic and sub aquatic vegetation growth, which in turn is dependent on the types of substratum, speed, turbidity and depth of water bodies. Often a firm mud substratum with silt and detritus provide favorable condition for macrophytic plant growth. This gives the snail population protection from the unfavorable conditions such as strong light, high temperatures, and floods and provides sites for egg laying and serves as food sources. Aestivating snails, although some become buried in mud, Prefer to bed under the base of vegetation. There they are provided a microhabitat with high level of humidity enabling to survive using the dry seasons.

Snails can locate their desired food items either by chance as they discriminately browse or by use of chemoreceptors suited behind and slightly below the tentacles. Chemicals released by plants might glide snails to more appropriate types of niches, but the type of plant for the particular species seems to be equally important.

d) Irrigation Scheme

Agricultural irrigation systems provide the greatest potential for increased populations of arthropod and snail vectors of parasitic disease. In 1950 lands reclamation was began in the Rusizi valley in Burundi. By the time the malaria and schistosomiasis control program was established in 1996, the number of cases of schistosomiasis has increased 30- fold (FAO, 1987a; Gray sells, 1990 cited in Hunter.M.J. et al, 1993).

The middle Beles irrigation project located south west Lake Tana (Ethiopia) done in 1986 on school children in 29 localities showed that up to 68% of those aged 10 to 14 were infected with schistosomia mansoni.

2.1.4.2 Factors Influencing the Distribution and Abundance of Plasmodium species and its Vector Mosquito

Malaria reveals the relationship between ecosystem damage and human health in several ways. Changes in land use, manipulation of water use, and variation in climate influence the distribution and abundance of mosquito vectors of this disease.

The most common malaria in Ethiopia is p.falciparum, which is responsible for the extensive, and severe epidemics and next to this species is p.vivax, while the remaining is very rare.

Environmental factors related to intermediate host (vector) and the pathogens are the major one affecting the epidemiology of malaria. These include:

a) Atmospheric Temperature

Because of variable body temperature of mosquito, high or /and low temperature affect the life cycle development of plasmodium parasite in the mosquito. Hence, temperature below 15 ^{0}c and above 32 ^{0}c is detrimental to the parasite.

b) Relative Humidity

It affects the longevity of mosquitoes and hence, dehydration in hot and arid environment reduces their life expectancy.

c) Pattern and Amount of Rainfall

Intensity and duration of rainfall may determine the extent of malaria seasons. Heavy rain may damage or flush out larvae or may lead to formation of new breeding sites.

Many mosquito species depend on the availability of water. The 1st three stages of mosquito life cycle (egg, larvae, and pupae) are aquatic. Consequently, mosquito abundance and the transmission of many mosquito borne pathogens can be affected by hydrologic variability, in particular, fluctuation in the water cycle that alters the availability of suitable aquatic habitation.

According to (Drotman.P.D., 2005) rainfall has two principal influences on the mosquito life cycle:

1) The increased near surface humidity associated with rainfall, enhance mosquito flight activity and host seeking behavior and,

2) Rainfall can alter the abundance and type of aquatic habitats available to the mosquito for ovi position.

The 1st influence can increase mosquito abundance by alternating the reproductive cycle, which requires mating, host seeking, and blood feeding flights. The 2nd influence, however, has less certain consequences. Rainfall increases the wetness of soil near the surface and can expand saturated low land areas. As a result the most, humid habitats preferred by many mosquito species, such as swamps and floodwaters may increase abundance. This change may favor an increase of mosquito species composition, abundance, and age structure may then lead to an increase in local disease transmission.

However, the availability of suitable mosquito habitats is not a simple linear function of rainfall. Surface wetness depends on number of environmental conditions others than precipitation including antecedent wetness, soil type and rate of evapotranspiration. Furthermore, excessive rainfall can eliminate some mosquito populations by flushing larval habitats. Other mosquito species can benefit from drought conditions such as when streams dry up and pools more suitable for ovi position from in river beds, or when standing waters become eutrophic with increased organic content, which provides additional food for mosquito larvae.

d) Man made Environmental damage

Economic activities (investment) such as irrigation may create favorable environment for emergence of malaria and can also transform endemic character in to epidemic one.

Several studies have examined how water management practices (e.g., irrigation, damming) affect anophelene density and malaria incidence. Surface water or ice-cultivated land was associated with rice paddy fields; and in Peru, irrigation around villages and houses played a role in determining human malaria risk. In Tanzania, Anopheles arabiensis densities were 4 times higher in villages with rice cultivation.

Although the effects of irrigation and water control are clearly important for many disease systems natural surface water viability is likely an even greater determinant of vector density and mosquito borne diseases transmission rates. However, because monitoring surface water has traditionally been difficult, relatively few studies explored these relationships. In Uganda, malaria incidence among children was associated with the proximity of their homes to swamps and streams that served as mosquito breeding site.

2.1.5 The Nature and Characteristics of Malaria and Schistrsamiasis

2.1.5.1 The Nature and Characteristics of Malaria

Malaria is a febrile illness characterized by fever, chillness, headache, sweating, anorexia, joint pain, spleenomegally, and varying degrees of anemia. Malaria is caused by a protozoan parasite that completes its complex cycle of development alternating between human hosts and mosquitoes of the genus anopheles; the biting of human hosts by mosquitoes is the mode of contact that permits transmission from human to mosquito and back to human (Aron L.J., et al. 2001).

There are four protozoan parasites of red blood cells of malaria. These include:

1. Plasmodium falciparum
2. Plasmodium vivax
3. Plasmodium ovale
4. Plasmodium malaria

Regarding vectors, there are about 42 species of the genes Anopheles have been reported. Of these, the following four are the most important and these also include:

1. Anopheles gambiae
2. Anopheles funestus
3. Anophleles nili
4. Anopheles pharoenosis

The incubation period ranges 12 to 30 days, for P.falciparum and P.malaria respectively.

a) Life cycle of Malaria

Human infection begins when a female anophelene mosquito inoculated plasmodial sporozoites from its salivary during a blood meal. Then, sporozoites move to the liver cells (pre erythrocytic cycle), the transformed merozoites enter the RBC (asexual erythrocytic) stages and also changed in to gametocytes. When anophelene mosquito bites such infected individuals, the parasite gets an access to complete its life cycle (sexual stage). It has been reported secondary schizony may occur in P. vivax and P.ovale organisms, which remain quiescent in the liver until a later time. Once the RBCs and reticulocytes have been invaded, the parasites grow and feed hemoglobin.

b) Methods of malaria Diagnosis. The method includes:

1. Clinical manifestation

The chief symptom of malaria illness is fever, periodic bouts of which tend to alternative with days of less or no fever. The classical paroxysm of fever eight to twelve hours, typically in three stages: cold shivering rigor, burning dry skin and ranching sweat that lowers the temperature and also has headache, cough, nausea, vomiting, abdominal pain, poor appetite, and thirst.

Late stages the symptom may be worsen thus drowsiness, convulsion, shock, and coma; sever anemia, hemoglobin urea, jaundice, renal failure and respiratory distress.

2. Microscopic Method

This is definitive method of diagnosing malaria, and includes both thin and thick blood film.

c) Malaria Prevention and Treatment

Anti malaria drugs are classified as the stage of malaria against which they are effective. These drugs are often referred to as tissue schizonticides, blood schizonticides, gametocytes and sporoticides, and prevention includes:

1. Prevent mosquitoes from biting humans (screening, bed nets, insect repellents etc.)
2. Prevent breeding of mosquitoes (drainage, filling, DDT spray etc.)
3. Destroy mosquito larva (larvicide, oiling water surface, predatory fish etc.)
4. Eliminating the parasite in the human host (early treatment and diagnosis)
5. Protect susceptible host (chemoprophylaxis)

2.1.5.2 The Nature and Characteristics of Schistosomiasis

Schistosomes belong to the supper family schistosomtoidea, and are elongated and separate sexes. The major species that infect man are S.mansoni, S.haemotobium and S.japonicum. But the rest have minor importance.

Intermediate host of S.mansani belong to the genus Biomphalaria and four species groups are recognized, and all species of Biomphalaria are suitable to certain strains of S.mansoni. The main intermediate host of S.mansoni in Ethiopia is Biomphalaria pfeifferi, which is widely spread though out the high lands, and B.sudanica is also incriminated in some specified regions such as Lakes of Zway and Awassa in the rift valley. While intermediate hosts of S.haematobium belong to the genus Bulinus except in India and Portugal. B.abyssinicus and B.africanus are the only two species found naturally transmitting S.haematobium in Ethiopia (Shibru, et al. 1989).

a) Life Cycle of schistosomiasis

The adults of S.masoni are found in the mesenteric veins of the portal system, and the adults of S.haematobium are found in the vescical, prostatic and uterine plexus of venous circulation of the definitive host. When eggs of schistosomiasis excreted with stool and urine, with in a week time an embryo will be formed and when it gets the right medium (water) it hatches in to ova then in to miracidium and when it gets susceptible appropriate fresh water snail vector, it will convert in to cercaria and adult worms finally infect the man through body contact of infective water (Portal of entry). The adult worms may live for about 25 years but average life span is 3-8 years(Tedla Shibru 1989).

b) Clinical Manifestation of Intestinal Schistosomiasis

The initial and early manifestation are diarrhea with or with out blood and mucus in the stool. There may be associated abdominal cramp, tenusmus, flatulence, anorexia and general ill health. These symptoms are non-specific and subside simultaneously after a variable period. Patient also reports fatigue and inability to perform daily routine functions. The chronic stage (hepatic phase) manifests early with enlargement of the liver due to parasite induced glaucomatous lesions, and bleeding from esophageal varicies may however be the1st clinical manifestation of this phase. In late stage, typical fibrotic changes occur along with liver function deterioration, and the onset of ascites, hypoalbuminemia, and defects in the coagulation.

c) Clinical manifestation of Urinary schistosomiasis

The clinical manifestations of S.haematobium infection occur relatively high percentage of individuals up to 80 % infected with S. haematobium have disurea, frequency and haematuria.

d) Methods of Diagnosis of Schistosomiasis

The standard methods in use at present for diagnosing human schistosomiasis are generally divided into three:

1) Parasitological method

Detection of the characteristics eggs of the schistosome species under the microscope, which is cheap and simple means of diagnosis. Microscopic egg detection methods for intestinal schistosomiasis include; direct smear, sedimentation and kato-thick smear. And for urinary schistosomiasis is urine sedimentation, centrifugation, filtration and miracidal hatching test.

2) Sero-immunological diagnosis

This test includes; immunological method, the intradermal test, serological test and enzyme immuno linked sorbent assay (ELISA).

3) Clinical method

This method includes common clinical manifestation (signs and symptoms of an illness)

e) Treatment of Schistosomiasis

The treatment with uncomplicated schistosomial infections can be handled at out patient level with anti schistosomial drugs. These include: Antimonial compounds (antimony sodium tartarate, sodium antimonial glulconate, and stibo captate antimony sodium dimmer cap to succinate, and non-antimonial compounds (Lucanthone hydrochlodride, hycanthone, and niridazole), and latest drugs include metrifonate oxamniqine, praziquantel.

f) Prevention of Schistosomiasis

Schistosomiasis is mainly a rural occupational disease affecting primarily people engaged in agriculture; it is particularly significant to Ethiopia where agriculture is the dominant sector. Schistosamiasis is a multifaceted problem and can be understood properly if seen only from various points of view. The different epidemiological patters encountered in schistosomiasis are due to the interplay certain basic factors involved. As a result, there is a close relation ship, between the way of life in rural areas and the availability of economically feasible prevention measures. In taking such measure one has to consider socio economic variables, habits, and attitudes of the local people, coupled with other general public health measures such as provision of save water supplies and reduction in molluscan population (Getachew Tilahune et al.1989).

2.2 Reviewing Theoretical Literature Survey

2.2.1 Health, Productivity and Environment

According to Herrin, N.A., L.P.Rosenfield (1988) disease can delay people from work, reduces efficiency, draws on the tight family budget, disturbs the existing pattern of family activities, and cause a lot of changes in the day-to-day family management. For agricultural communities, these effects are aggravated by socio economic factors such as strong and extensive social relations, excessive use of family labor, dependence on almost one source of income (agriculture) and small saving margins.

It may be argued that some components of family welfare may be maintained at the expense of others (domestic services). However, diseases will eventually affect other factors outside of agricultural out put alone. For instance, it is possible to have a situation where by, in spite of disease prevalence, agricultural out put doesn't fall. In that case, family members may be compensating for the loss in labor by reducing their leisure consumption and /or drawing on labor that normally goes to non-agricultural activities (schooling, domestic household services etc.).

It may also be noted that, even in the absence of compensation for labor lost due to disease, agricultural out put may not fall. This is likely to be the case when, for instance, the disease cases are not concurrent with the seasonal labor requirement.

According to kloos et al. (2006) expansion of water resource is a key development strategy in Ethiopia in many arid areas, where fast population growth, high arable land population density and subsistence agriculture dependent entirely on rainfall have resulted in household food insecurity. In less arid ecological zones, agriculture development has focused on expansion of cash crop farming with further development of large-scale irrigation for sugar cane, cotton and fruit plantations. Large dams are also under construction for the purpose of hydropower generation to meet growing industrial and domestic electricity needs.

Potential hazards to health including malaria have been well documented in studies of water development projects in Ethiopia. In addition to the need to asses social, ecological, and health issues as well as economic and technical factors when planning such project has paramount role.

The 1993 proclamation of Ethiopia for establishing the environment protection authority (EPA) and the subsequent impact assessment (EIA) guide lines gave the timely support needed to link planning with impact assessment. The magnitude of the malaria/ water development problem was quantified in a prospective study in Tigray in 1997, in which malaria incidence under 10 children was found to be seven fold greater in near dam villages at similar altitudes but three to four kilometers distance from dams. Subsequent studies also documented that micro dams not only create abundant mosquito breeding sites but also induces micro climate changes including elevation of minimum atmospheric temperature and diminution of daily maximum temperature that favor mosquito development (Kloos,etal.2006).

2.2.2 Health Damage Cost

The most obvious effects of ill health are immediate subjective suffering of the person, who becomes ill, injured, or dies and sympathetic grief of his or her family or friends. The full consequence of adult ill health, however, go beyond this direct suffering and include effects that harm society indirectly over longer periods through production, earnings, investment, consumption, and reallocation of labor (Feachem, 1992).

Cost of illness studies measure the economic burden of a disease and estimate the maximum amount that could potentially be saved or gained if a disease were to be eradicated. Knowledge of the costs of illness can help policy makers to decide which diseases need to be addressed first by the health care and prevention policy.

A cost of illness study may be conducted from several different perspectives, each of which includes slightly different costs. These perspectives may measure costs to the society, the health care system, third party payers, and participants and their families. Each perspective provides useful information about the cost to the particular group. Example, at household level the medical cost is out-of-pocket costs and morbidity costs is lost wage/household production (szucs, et al.

cited in Segel, 2006). Therefore, the difference in approach explains most of the different in costs.

Generally, there are two major approaches in estimating cost of illness. These include direct and indirect costs. Reference to this study, household is used as a perspective and hence cost of illness implies treatment cost and wage loss. Epidemiological survey of an illness embodied with probability was used to capturethere costs.

2.2.2.1 Direct cost of illness

The direct cost of illness, i.e., expenditures on medicines, health services, and other defensive goods and services, provide an indication of individual welfare loss. The welfare cost of these direct expenditures to the individual is the foregone utility resulting from the shift in expenditure patterns. To pay medical expenses for the illness, the individual must take money out of saving or reduce consumption activities there by losing the utility of consumption and saving activities. However, though the amount of money spent on medical care entails an equal drop in consumption or savings for the individual, the same is not true at the societal level. Direct expenditures don't correspond to a drop in income or consumption for the economy as a whole, they simply constitute a reduction of economic activities, with some sectors of the economy actually benefiting from increased economic activity (health service sector). In fact, all defensive expenditures (prevention), medical expenditures (treatment cost) are registered as positive addition to national income.

At societal level, direct expenditures for medical care stimulate economic activities in some sectors of the economy, producing welfare gains in those sectors, and stifling economic activities and welfare in other sectors. There are loser and gainer from direct expenditures; these numbers don't correspond to a simple drop in societal welfare. So, though the direct costs of illness measures individual costs, simply summing these costs don't result in an accurate measure of societal costs (Jefferson.T., et al. 2000).

Another problem arises due to in accuracies in hospital diagnostic data and the fact that expenses not be attributed to the correct illness. Similarly, a number of illnesses might be grouped under one diagnostic code making it impossible to decipher individual expenses. One more difficulty with many of the large data sets in that, they typically assume the same charge for all types of physician services, when in fact a visit to the physician for a routine physical check up does not cost the same as a visit for the cancer case.

2.2.2.2 Indirect Cost

Countries like Ethiopia, because of family unity; disease will have an effect on the whole family irrespective of whether the affected person is a child, an adult, and a working or non-working family member. If for example, disease attacks the working members, its effect will be directed by delaying him (her) from work; otherwise it will manifest it self indirectly through the nursing of an afflicted child. We note that the distinction between these two effects may have a bearing on health policy; for instance, in case of heavy indirect loss of labor, health strategies could be tailored to cater to non-working family members (children and elderly). We measure the effects by tracing disease cases across children and adults separately. Others that are not relevant to this research including shadow effect, debilitating effect, qualitative effect and multiplier effect were left for interested readers on other economics reference materials.

Most studies of the economic impact of malaria have based their estimates on the amount of time lost by the sick person (or the career in case of child and other member illness) multiplied by some value of a day of work.

Saver born et al. (1995) cited in Chorpa.K., Kumbar.A.S. (2004) Provided a detailed specification of the wage rate method of assessing the time cost of illness. The time cost was defined as the sum of opportunity cost of wage foregone by the sick individuals due to illness, and the opportunity cost of healthy household members time spent on treating or attending to the sick person.

Shortcomings of Wage rate Method

a) At times of the year when there is underemployment or unemployment, substitution may be feasible with out any consequent loss of out put.

b) Estimates based on the average wage rate may also be an over estimate of the actual gains because the increase in labor supply would not be accompanied by changes in other factors of production.

Information on sickness was collected on; Current sickness, Sickness during two weeks period for malaria due to its acuteness of the illness and, Sickness during a year period for schistosomiasis because of its chronic nature of the illness.

There are two alternative strategies, which are used to collect cost data:

1. The incidence method
2. The prevalence method

Most cost of illness studies uses prevalence-based approach for estimating costs. Prevalence based cost estimate includes all costs related to a condition to the prevalent population over a given time period, usually a year. Prevalence based cost of illness are useful primarily for quantifying and highlighting the burden of a particular disease. EPA is currently interested in understanding and quantifying the burden of diseases associated with environmental exposure on prevalence based (Chorpa.k., Kumbar A.S., 2004)

The incidence method, relies on from their onset to their disappearance for what ever reason (usually cure or death), while the prevalence approach costs all cases in a short period irrespective of the stage they are at. The incidence strategy is more precise but it is usually used only for those diseases, which have short duration. The prevalence strategy relies on more assumptions, but only practicable way to cost chronic diseases (Jefferson.T, et al. 2000).

Diseases were usually recorded as reported by the respondents. To help identification of a disease, the interviewers were, however, supplied with checklist with major symptoms of malaria and schistosomiasis. The present study is limited to the analysis of sickness, diseases, treatment and medical costs of the person currently a live, and doesn't deal with mortality.

The intention of comparative study in this paper is to elicit whether irrigation local ecological change has real impact on emergence or / and aggravation of malaria and schistosomiasis and then to approximate the health damage cost of such intervention activities.

In health economic literature, analysts have used four primary methods for empirical estimation of willingness to measures.

1. The household production function method
2. The compensating wage method
3. The contingent valuation survey method
4. The hedonic price method

Among those methods, this paper adheres to the health production function only. The household health production function method for measuring willingness to pay is built on the observation that households continually make decisions involving the allocation of income and time between health enhancing goods and activities and other goods and activities. In addition to expost health care consumption items, like prescription medicines and surgeries, exante or preventive items, like diet, exercise, work, and leisure choices also affect health status. The household production function recognizes that health is not simply an exogenous variable, but that individuals can and do make decisions attempting to influence their own health status.

a) Strength of the model

The health production method assesses the relation of an individual behavior and illness. Therefore, it tries to capture the interrelation between the two, and then estimate the health damage cost using probability method. Moreover, it avoids the problem of using accounting cost as economic cost, and it also avoids the problem of hypothetical market bias.

b) Weakness of the model

This method only includes tangible cost and excludes the intangible cost such as pain and grief. Therefore, it does not help to estimate the appropriate cost, which characterize with sever illness. The rest methodologies i.e., hedonic, contingent valuation, and compensation wage method are not used in this paper. Thus, interested party can read from other relevant environment and resource valuation books.

2.3 Reviewing Empirical Literature Survey

2.3.1 Burden of Malaria

Malaria represents the lion's share more than 1.1million deaths and 2.4 million people are at risk. More than 90% of the estimated 300 to 500 million malaria cases worldwide occur in Sub-Saharan Africa. Malaria may annually cost African countries more than 1% of GDP, initial estimates of direct costs (proxy to treatment and prevention cost) indicate that the disease places a major economic burden on households, which spend significantly on malaria prevention and treatment. Losses on productivity and out put are substantial but not yet fully quantified.

The disproportionate burden of malaria in Africa can be largely attributed to the abundance of three species of mosquitoes that are very efficient at transmitting malaria (Anopheles gambiae, Anopheles arabiensis and Anopheles funestus). The ability of malaria vectors in Sub-Saharan Africa to breed in temporary pools with out vegetation, such as foot print filled with rain water is key to the exceptional, persistence of malaria in the continent (Aron L.J., J.A.Patz, 2001).

Malaria is not only one of the major health problems in Ethiopia but has also socio economic importance. Most of the malarious areas in the country are fertile, hence development activities cannot be under taken without effective malaria control programme. Its untoward impact on the economy is far greater than many other communicable diseases, because the peak transmission periods coincide with the planting and harvesting seasons (Meseret shiferaw and Haile fenta, 1990).

According to these scholars, about 75% of the surface area of the country, which is known to be below 2,000 meter in altitudes, is favorable for transmission of malaria and approximately 64% of the population is at risk of infection. The most devastating malaria epidemics were occurred in 1958, which affected 3 million people with 150,000 deaths. Three major epidemics similar in character to the 1958 but of lesser intensity have occurred since then at intervals of 8 years in 1965, 1973 and 1981-82. The occurrence of such epidemics was associated with climatological changes, which favored the insect vector.

The social and economic consequences of the diseases are sobering, with a large number of people kept from work by depilating illness, resulting in low productivity. Recent study with different method of cost estimation in malarious village in northern Ethiopia showed that the average number of work days lost reported during a malaria episode was 18 for an adult. The average cost of illness per episode (direct and indirect) for adults ranged from 46 to 151 birr (average income household ranges 58 to196 birr). A community based cross sectional study undertaken in Butajira woreda in 1998; 13.7% of households were ill during a two-week recall period and malaria accounted for 26% of the illness during this period.

Study of subsistence farm households in western Ethiopia also showed that, malaria had a significant impact on total revenue, reducing average income by 24 to 45 % depending on the criteria used to define a malarious case (kloos et al. 2006).

2.3.2 Impregnated Bed net Distribution in Ethiopia

In 1996 a pilot community financing scheme for insecticide treated bed nets was introduced, initially it was well accepted in malarious areas of the western Tigray low lands, as judged by 78% household coverage and 58% cost recovery. Knowledge about the purpose of insecticide was acceptable after community education; yet net reimperignation rates never exceeded 64%. Since 1998, impregnated bed net use has been adopted through out Ethiopia as a major control strategy. No nationally compiled data are available about number of nets distributed, household coverage and net impregnation rates. However, community reported problems include lack of acceptance in communities without a tradition of net use, poor community participation because of required payment, improper use of nets, frequent net damage without repair, and poor participation in re impregnation (kloos, et al.2006).

2.3.3 Impact of Schistosomiasis

Past studies on the economic and social impact of schistosomiasis and other helmentic infections have focused mostly on direct effects. Although there is increasing evidence that schistosomiasis involves also indirect social and economic effects, not only on individuals but also on households and communities and whole societies. Direct effects of schistosomiasis on man include reduced work capacity and incomes, due to morbidity, debility and mortality

Methodology for comprehensive and reliable measurement of the impact of schistosomiasis or the benefit of its absence on individuals and community is lacking. In this regard, (Kasim E.A.1980 conducted studies in Sudan cited in Kloos et al. 1989), 18% reduction in work capacity among cane cutters with measurable organ damage, are widely seen in schistosomiasis infections, especially in chronic cases. Indirect effects also include economic and social adjustment made by infected and debilitated individuals and communities in regard to daily activity patterns, such as recreation and foregone healthy years of life. Failure to precisely measure the impact of schistosomiasis on local and national economies is due primary to three reasons (Kloos, et al, 1989):

1. Schistosomiasis is usually chronic in nature, expressed by cumulative morbidity, leading to mortality increases only after years of infection.
2. People in low-income areas not only experience multiple infections with different parasitic and microbial organisms, but also malnutrition.
3. Methodology for comprehensive and reliable measurement of the impact of schistosomiasis or the benefit of its absence on individual or communities is absent.

2.3.4 Effects of Malaria and Schistosomiasis on Labor Productivity

According to Herrin.N.A., L.P Rosenfield (1986) in general, it has been found that, there are about a total of 9,741working hours loss due to malaria(complete absence) and reduced the normal work efficiency of 1,307 working days (days spent in agriculture debilitated tenants). The breaking down of this lost working hour in to direct and indirect losses (table2.3), which also shows the proportion of these losses and their seasonal intensity. It is clear from the table that malaria caused a total loss of 9,741 working hours. Out of these, 87% attributed to the direct effect of malaria, where as the remainder 13% is due to the indirect effect. Moreover, the table also indicates that, 55% of the direct loss is from men; and 92% of the indirect loss is from adults. Finally, the table indicates that 95% of the total loss is from adults; 13% of which is caused indirectly through nursing other family members.

Besides confining people to bed, malaria weakens them for a number of days before and after medication. Because of urgent need of labor, especially during critical agricultural operations, tenants may rush to work even before they completely recover from malaria. For the microscopically diagnosed 256 cases, it was found that, the number of days spent in work before complete recovery is 1,307. The reduction in efficiency is attributed to the debilitating effect of malaria It is found that the efficiency (productivity) of such tenants, on average, reduced by 50%.

Table2.3: seasonal distribution of illness; direct and indirect impact on men, women, and children

Season	Direct			Indirect			Total
	Men	Women	Children	Men	Women	Children	
June-July	1152	529	340	63	372	110	2556 (26)
August-October	1571	1259	72	286	163	-	3351 (34)
November-march	1818	1505	-	65	65	-	3661 (36)
April-may	72	91	-	-	-	-	163 (2)
Total	4613 (48)	3384 (35)	412 (4)	600 (6)	600 (6)	110 (1)	9741 (100)

Source: Herrin.N.A. L.P.Rosenfield, 1996, ( ) stands for percentages

Malaria may not affect all family members at a time, but random, therefore affected family members may compensate for the loss in agricultural labor. Research indicated that an affected family member has compensated 10,222 working hours to agriculture. This constitutes 62% of the total loss in labor due to malaria and schistosomiasis. Hence, agricultural out put may be maintained, at least partially despite the prevalence of the disease.

2.3.5 Impact of Malaria and Schistosomiasis on Household Expenditure

Household expenditures on malaria consist of two main components; this includes expenditure on malaria (mosquito nuisance) prevention, and expenditure on treatment. With respect to malaria prevention, the measure includes mosquito coils, aerosol sprays, bed nets, and mosquito repellents. They are used to very differing degrees in different areas and by different households. Bed nets are widely used, and WHO also strongly recommends.

Table2.4: Monthly per capita expenditure by households on prevention activities

Country	Per capita expenditure
Malawi	0.05
Tanzania	0.7
Zaire (urban)	0.94
Cameroon (urban)	2.08
BurkinaFaso (rural, high season)	0.09
BurkinaFaso (high season)	0.89

Source: Flessa.U.et al (2006)

Table 2.5: Monthly per capita expenditure on malaria related treatment by households

Country	Per capita expenditure
Malawi (all)	0.39
Ghana (rural)	0.61
Cameroon (urban)	3.84
BurkinaFaso (urban high season)	1.13

Source: Flessa.U., et al (2006)

Household expenditure on malaria related treatment includes out of pocket expenditures for the treatment fees for drugs, transport and the cost of nuisance at a distant health facility.

The available data (table 2.4) on monthly per capita household expenditures on malaria related treatment, which ranged between $0.05and $ 2.08 per person, equivalent to between $0.23 and $15 per household. Table2.5 also over views existing data on monthly per capita house hold expenditure on malaria related treatment, which lies between $0.39 and $3.84 per person, equal to beetween$1.79 and $ 25 per household.

According to Flessa.U., et al (2006) the over all economic cost of malaria, based on extrapolations from case studies in four countries (Burkina Faso, Chad, Congo, and Rwanda) the total direct and indirect cost in 1987 was estimated to be 791 million, 2.34 per capita and 0.6% of the Sub Saharan African countries gross domestic product. But notice that the results were based on many assumptions and approximation, and the methodology for valuing indirect costs has all the problems associated with wage rate method.

Moreover, based on rapid assessment method, on focus group discussions and interviews to prevent high and low estimates for days lost from morbidity, decreased productivity, and value of production loss by economic sector, urban, and rural populations and sex of Kenya and Nigeria. It was estimated that the total annual value of malaria related production loss was 2-6% of GDP in Kenya and 1-5% in Nigeria, and 3-14% and 1-8% of work days lost in Kenya and Nigeria respectively.

The cost of single treatment of non resistant and resistant malaria is $0.10 and $60 respectively for the drugs alone and mosquito nets costs $2 per year and prophylaxis costing $1 per person per year, while single dose treatment of schistosomiasis requires a cost of about $1 (Hunter. M.J., 1993).

Regarding sectoral estimations, 58% and 50% of losses were in the agricultural sector, and 7% and 10% in the industrial sector in Kenya and Nigeria respectively. Total household costs as a percentage of annual income for rural small farmers amounted to 8.8-17.6% in Kenya and 7.2-10% in Nigeria. These figures for agribusiness laborers in Kenya were 0.8-5.2%, and the urban self-employed in Nigeria was 11.2-18.7%.

2.3.6 Period of Illness (morbidity days) due to Malaria and Schistosomiasis

According to Hunter.M.J. et al. (1993) in acute malaria, each episode of P. falciparum infection requires at least 7 working days to recover from the illness. With appropriate management, this may be reduced to 4 to 5 days. However, in recurrent malaria the frequency depends on the effectiveness of the original treatment, the risk of re-infection as measured by vectors density and the immune system of an individual.

Studies in Philippines and Ghana on Schistosomiasis indicated that 26 to 42 days lost per year due to S. japonicum and 4.4 working days lost per year due to S. haematobium respectively. In

Madagascar, 50% of people reported as unable to work had evidence of urinary schistosomiasis, and remained out of work for 10 days.

Among cane workers infected with S. mansoni absenteeism was found to be twice as compared to non infected workers. Of those infected and developed hepatomegally, 33% have esophageal varicies. Once it has started to bleed, this tends to recur, leading to the loss of 3 to 4 months a year either in inpatient or out patient base. Other study conducted in Zimbabwe, a reduction in exercise capacity of at least 12% was found in children with S. heamatobium infection. Recovery occurred one month after treatment. Similar study in Kenya also showed that a 7% to 10% reduction in exercise capacity was found in children with S. haematobium infection. Last but not least, the disease may lead to total incapacity and death in up to 30% of untreated person and due to an increased risk of chronic liver disease and squeal, and total incapacity may occur.

Table2. 6: periods of illness caused by malaria

Country	Period of time lost
Burkina Faso (factory)	3.5 days
Tanzania	1.16 days per person per year
West Africa	4.2 days per episode 3 work days lost per person per year
Gezira, Sudan	6 days of disability, plus 5 at 50% productivity

Source: Flessa.U., et al (2006)

According to Flessa.U. et al (2006) showed that malaria accounted for 28 % of total illness episodes. People spent less on malaria to other diseases and malaria had a low direct cost burden on the house hold economy. The estimated indirect and direct cost per household per year represented 6%, and 3% to 4.7% of household proxy income respectively. This indicated a household indirect cost was higher than direct cost irrespective of the valuation methods used. Household health care spending was directed more on productive members of a household such as adults and the household head. Regarding income level, richer households had a higher expenditure on health compared to the poor; however a regressive cost burden was found among poor households.

CHAPTER THREE

Description of the Study area and Methodology

3.1 Wonji Cane Plantation Irrigation Scheme (Description of the Intervention area)

Wonji cane plantation is found in eastern Shoa zone of Oromya region 17 to 29 km away from south of Nazareth and occupies a total area of 11,118.3 ha, but the plantation consists of 5,917 ha net area. The plantation has 13 campuses with population size of 22,635 in 4,527 households. It consists of basic necessities such as, school and health post and potable water. The residents are mainly engaged on daily labor in the plantation, and once when they served for longer period in the plantation, they would be transferred to sugar factory as a privilege. Major production in the area is cane plantation and on individual bases some household produces honey in their homestead and milk cattle rising outside the campus.

The topography of the area is 1,500 m above sea level with a temperature ranges from 15 ^{0}c to 27 ^{0}c, and rain fall is 750 L on average per year, and humidity level is 85.1%, 45.6%, and 43.4% for 6, 12, and 18 hours respectively.

Since it is the eldest plantation where most research on irrigation and water related vector borne diseases were conducting and intensive intervention was undertaken especially on schistosomiasis. Furthermore, malaria stood first among the ten top diseases in the area (wonji hospital report) made Wonji cane plantation to be selected.

3.2 Description of the Comparative area (Zeway)

Zeway is located 160 km away from Addis Ababa, and found in eastern shoa zone of Oromya region. It consists of two kebeles (01 and 02) ,and each kebele is further sub divided in to 10 and 12 ketenas respectively. The number of the residents estimated was about 35,576. Major activities of the residents are laborers in different plantation and factories in the surroundings, merchant, civil servant, and local "beer" and "Areke" makers etc.

The topography of Zeway is 1,640 m above sea level with minimum and maximum average temperature of 13.6c^{0} and 26.7c^{0} respectively, and humidity level is 62% at 18.00 and rainfall is 738.1 mm annually.

The metrological similarities and the foundation of appropriately recorded full metrological data, and the significance of malaria prevalence among top ten diseases in the town (stood first) contribute much in area selection. Furthermore, the similarities in prevention activities undertaken by the household to prevent malaria, and the existence of schistosomiasis in Zeway Lake make zeway to be selected as a comparative area.

3.3 Methodology

The study mainly focuses on the health damage cost of malaria and schistosomiasis at household level and also investigating the relation between irrigation ecological setting and emergence and/or aggravation of these diseases vis-à-vis with out irrigation. Moreover, the analysis of some key variables requires both descriptive and econometric method using STATA and LIMDEP.

The specific approach used in this research was the predicted probability of observing illness and other statistical probabilities in each household were derived, and then the cost of treatment and the wage loss from illness were estimated. Most re search was done using contingent valuation method, while revealed preference method is almost untouched. This study therefore, tried to apply the objective type of assessment stated in the health economic literature i.e. health production function. This permits for the joint determination of health and behavior and captures the effect of behavior on health, since it considers health and behavior as interrelated variables by assuming the other health determinants remain constant.
However, excess risk of irrigation on malaria and schistosomiasis aggravation vis-à-vis non-irrigated area was captured with attributable percent, holding other factors similar.

On the bases of a household health production function approach, an economic evaluation of the health effects of changes in micro ecological status due to water resources development project (irrigation) give emphasis to the changes in individual behavior stemming from the noticeable ill-fated effects on the individual's utility. In this regard a model of valuing the damages from malaria and schistosomiasis based on individual's utility maximization behavior from consumption of all other goods and maintenance of health status subject to a budget constraint and production function of health status. Consequently, the probability of illness of a household would be estimated (treatment cost and wage loss).

3.3.1 Measurement of Irrigation Exposure Risk

Attributable percent

An attempt was made on determining the health damage cost of irrigation setting as opposed to non irrigated area, Wonji-Shoa cane plantation and Zeway town respectively, which other wise are interested by the same community(income level), and enjoy the same physical environmental conditions using attributable percent.

3.3.2 Methodology for Determining Health Risk factors

Health may be considered as a commodity that directly contributes to utility (i.e. sickness causes disutility). Good health can also contribute to utility by increasing productivity, making time available for market activities, and decreasing costs of prevention and treatment of illness. Health, outcomes, however, is not necessarily exogenously determined because the household can combine time, money and knowledge to improve and maintain their health. Thus, health can be conceptualized, like other goods, as the out put of household 'health production function' (Gross man 1972b, Akins et al.1985 cited in Pattanayak.K.S., C.G.Corey. 2003). A household can thus be viewed as maximizing utility comprising of desirable goods, including 'self produced' health given an income constraint and the health production constraint.

The estimation of health cost of malaria and schistosomiasis on Wonji Shoa cane plantation irrigation project scheme at household level and approximating (quantifying) the net irrigation ecological impact on health in monetary terms is the main goal. The study therefore, concentrates on the change in individual behavior arising from the apparent adverse effects and individuals' utility. A health production function to obtaining the risk factors for malaria and Schistosomiasis illness based on the theory of utility maximization behavior for estimating the probability of illness for a household was used.

Economic aspect of the model

A utility of U= U (X, L, S)

Where, X, is expenditures on all non- health related goods, at p= 1

L, is leisure per period

S, is time spent ill (number of days sick)

Assumptions

1. The first derivatives: $U_X > 0$ $U_L > 0$, $U_S < 0$, and
2. The second derivative: $U_{XX} < 0$, $U_{SS} < 0$, $U_{LL} < 0$

The household derives (maximizes) utility from consumption of X and L, where as utility is minimized (causes disutility) when individuals sick (S). Time spent ill (S) is formulated as a function to malaria and schistosomiasis exposure (E) and defensive behavior (D) to reduce the likely hood of illness. Therefore, the Gross man household *health production function* was adopted and specified as:

$$S = S(D, E).$$

Assume, $SD < 0$, $SE > 0$, and S_{DD}, $S_{EE} < 0$

Here, no differential in utility is allowed because of variation in the intensity of illness due to the existence of different plasmodium and schistosomiasis species and different route of entry and involved organs damage.

The individual maximizes his utility subject to time and budget constraint. So,

$I + w(T - L - Td - S(Td, E)) = X + EdTd$

Where, I, is total non- labor income, w, is the wage rate, T, is total time, Ed, is expenditure on defensive activities on exposure Td, is time spent on defensive activities, X, is expenditure on non-health related goods and S, is transformed in to a function as time spent in defensive activities and exposure to mosquito bite and contaminated water body with schistosomiasis and is characterized as a function of S (Td, E).

Econometric estimation

The econometric estimation of health production function can be set up taking two functional equations formulated from utility maximization point; the optimal time spent ill and defensive activities in turn are:

$S = S(Td^*, E)$	(Time spent ill) .... Equation one (EQ_1)
$Td^* = Td^*(w, I, E, Ed)$	(Defensive activity)....Equation two (EQ_2)

3.3.3 Model Specifications

Health production function: A health production function of this kind can be estimated using cross section data on illness and defensive behavior as functionally specified above and can be transformed in to reduced econometrics model as given below. These are:

$Y_1^*=X_1B_1+\Upsilon_1R^*+e_1$ (defensive behavior with associated determinants)..........Equation three (EQ_3)

$Y_2^*= X_2B_2+ \Upsilon_2R^*-\delta Y1^*+e_2$ (Illness with associated determinants)..... ......Equation four (EQ4)

a) For Malaria case

Where, Y_{1*}, is the dependent variable (EQ1) and endogenous explanatory variables (EQ_2)

Y_2^*, is the dependent variable

R^*, is a vector of unobservable risk factor for malaria occurrence {unobservable individual characteristics, agent factor, biological factors, susceptibility of the host}.

Υ_1, is the coefficient of risk

X_1, is vector regressor of observable individual characteristics {wage rate/month, educational attainment of the head of the household, out of pocket expenditure for prevention and treatment}, and vectors of behavioral factors {number of bed net used by the household, the level of understanding on the identification of symptoms of the illness}

e_1, e_2, is random error term

This equation is specified based on binary dependent variables, and if Y_{1*} is greater than 0, the household will engage in defensive activities, other wise is zero. Like wise, if $Y_2^*$is greater than 0, the household reports the illness, otherwise 0.

X_2, is a vector of observable individual characteristics {wage rate/month, and educational status of head of household, out of pocket expenditure for prevention and treatment} and a vector of behavioral factors {attitudes of acquiring information, quantities of bed net used at household level, knowing or not knowing the early symptoms of malaria}.

R^*, is a vector of unobservable individual characteristics, biological factors, agent factors, susceptibility of the host and the vector,

Υ_2, is the coefficient of risk.

The error terms in both equations EQ_3 and EQ_4 are assumed to be independent of each other and unobservable risk factors absorbed in to the error terms.

$v_1 = \Upsilon_1R^*+e_1$ and $v_2=\Upsilon_2R^*+e_2$

Assuming that X_1 and v_1 are independent, a probit regression of observed defensive behavior (EQ_3) yielded consistent estimates. However, a probit regression of the illness (EQ_4) ended up with in inconsistent estimates because of the correlation between defensive behavior and the error term v_2 explained by regressors' correlation. Introducing proxy of Y_1* of (EQ_3) i.e. the explanatory variables in equation (EQ_5), this avoided the problem, and hence, Y_{2*} becomes as:

$Y_2^* = X_2B_2 - X1\ (\delta B1) + [(-\Upsilon_1+\Upsilon_2)\ R^* + e_1+e_2)]$ ....EQ_5

The error terms of EQ3 and EQ_5 are correlated. Its implication is that the probability of becoming ill is not independent of defensive activity. Therefore, one can estimate EQ_3 and EQ_5 jointly as bivariate probit model with the assumption that v_1 and v_2 are normally distributed, and finally establish the econometric model of the form;

$Z_{i1}=b_1`x_{i1}+e_{i1}^*$ .... (Defensive behavior) $Y_{i1}=1$ if $z_{i1}>0$

$Y_{i1}=0$, otherwise

$Z_{i2}=b_2`x_{i2}+e_{i2}^*$ .... (Illness) $Y_{i2}=1$ if $z_{i2}>0$

$Y_{i2}=0$, otherwise

(ei_1, ei_2) BVN $[0, 0, 1, 1, \rho]$

Where, Zi_1, is the dependent variable = aversion on malaria illness

$b1'$, is the vector of the coefficient of the explanatory variables

Z_{i2}, is the dependent variable = malaria illness

bi2' is the vector of the coefficient of explanatory variables

e_{i1} and e_{i2} are error terms

The error terms are assumed normally distributed with mean and variance (0, 1) respectively. Monetization of the health damages due to treatment cost, and work days lost will be undertaken using the probability of illness P(s).

Impregnated bed net is the current most appropriate prevention method and avoiding water body contact is the least cost and feasible method of preventing Schistomiasis illness.

b) For Schistosomiasis case

Regarding schistosomiasis, the same methodology and equations were employed from malaria case, except the behavioral risk factors. These factors are vector regressor of X_1 i.e. observable individual characteristics {wage rate/month, non wage income, educational attainment of the head of the household, out of pocket expenditure}, and vectors of behavioral risk factors {Absence of tape water at household level, the level of understanding symptoms of the illness}. Therefore, one can read about model specification stated above in malaria case as a reference to reduce ambiguity.

3.3.4 Determining of Health damage cost Estimation with Probability

The model estimated above is able to deriving estimates for the predicted probability for observing illness at household level. The univariate predicted probability in this case is the probability of observing malaria and schistosomiasis illness. The cost of illness is bifurcated into cost of treatment and wage loss.

a) For malaria case

C_m=fs x pe xλ ($\mu Ch\phi$ ch + $\mu a\phi a$ + $\mu s\phi s$)......... (1)

Where; Cm is treatment cost malaria fs, is average family size, Pe is out of pocket expenditure, λ,is the average predicted probability of a household being affected, $\mu Ch\phi ch$, $\mu a\phi a$, $\mu s\phi s$,is the probability of being a child, adult and older people being ill respectively and was affected in the household.

W_l= $\lambda\mu a\phi a$ x Fs x md x Er x w ....(2)

Where; wl is wage loss due to illness, λ is the average predicted probability of a household being affected, $\mu a\phi a$ is the probability of an adult being ill, fs is average family size of the household, md, average man days lost, Er is employment rate, w is average daily wage rate.

b) For Schistosomiasis case

C_b= fs x pe xλ ($\mu Ch\phi ch$ + $\mu a\phi a$ + $\mu s\phi s$)................ (4)

Where; Cb is treatment cost of schistosomiasis; fs, is average family size, Pe, is out of pocket expenditure, λ, is the average predicted probability of a household being affected, $\mu Ch\phi ch$, $\mu a\phi a$, $\mu s\phi s$,is the probability of being a child, adult and older people being sick respectively and was affected in the household.

W_l= $\lambda\mu a\phi a$ x Fs x md x Er x w ....(5)

Where; wl is wage loss due to illness, λ is the average predicted probability of a household being affected, $\mu a\phi a$ is the probability of an adult being ill, fs is average family size of the household, md, average man days lost, Er is employment rate, w is average daily wage rate.

After getting cost of illness, one has to check the significance of the difference before setting the net impact of irrigation. This study, therefore, used the attributable risk percent of average prevalence rate at household level of the two comparative areas. It is the difference of the group exposed to the risk factor - the risk in the group not exposed to that risk factor.

3.3.5 Data Source and Type

Irrespective of the study areas, the data source of this study is primary and cross sectional that was collected through structured questionnaire, and secondary data was also rarely used. Random sampling and EPI method was employed for sampling in Wonji and Zeway respectively.

Moreover, relevant information were gathered from journals, and books at AAU; faculty of medicine, faculty of business and economics. In addition, statistics office publication, Wonji hospital and Zeway health center statistical records were approached, and other reference books, journals and Internet sources from external sources were revised as a supplementary.

3.3.5.1 Data Limitation

The Ethiopian labor law constitutions signify that one can be legally employed at the age of 18 years and above. Following this, the age stratum for this research was designed in to three major sections for ease of data analysis. However, the secondary data for employment rate obtained from Central statistical agency was prepared with out considering the constitution abide. It has included child labor greater than 10 years who were self employed. Therefore, the employment rate estimated at different level became markedly high. This intern has escalated the wage loss estimated up ward; hence it needs reconsidering if the problem arises. On the other hand, unavailability of sample frame in the comparative area (Zeway) non probability sampling was used, which may not be the most appropriate to obtain representative sample from the population.

3.3.6 Survey Design

The survey was planned to capture the health damage cost at household level, and also verifying excess risk of irrigation in aggravation of malaria and schistosomiasis vis-à-vis non-irrigated area in monetary terms. For the reason being, Wonji cane plantation is the eldest cane plantation among others that were found in Ethiopia, where the problem is more prominent, its administration convenience, and its proximity to Addis Ababa gave way to be selected for investigation. Furthermore, the comparative area was selected based on its metrological similarities and the availability of full metrological registered data, and the characteristics of the illness (especial emphasis on malaria).

3.3.7 Sampling Procedures

In Wonji cane plantation, samples were selected in two stage sampling method, where random sampling at campus level and proportional sampling at house hold level. Where as, in zeway town, there are two kebeles, and those kebeles were stratified in to 22"ketenas" based on administrative and socioeconomic characteristics. But due to absence of sample frame, purposive sampling at "ketena" level, and EPI method at household level were used to get sample for the survey.

EPI method is one of the most popular spatial sampling methods adopted by WHO for use in low income countries, named after the expanded program of immunization.

The EPI method can be described as follows: a number of clusters are chosen with a probability proportionate to their size and then an equal number of selected households are surveyed in each of the selected clusters. In each chosen clusters the EPI method selects a location near the center of the community, a random direction, and a random household along a chosen direction pointing out ward from the center of the community to its boundary. In subsequent steps, the closest household (door to door) the iterations are repeated until the required number of household is surveyed (Bostoen and chalabi, 2006).

To familiarize the characteristics of the sample to Wonji, this study considers the socio economic status of the residents in Zeway town before sampling was undertaken. Therefore, among those "ketenas", six were selected purposively that characterize low socioeconomic status particularly in terms of their household income level, which was identified by the city administration.

Among 13 campuses in the wonji cane plantation with a population size of 22,635 and 4,527 households, six campuses were randomly selected and all planned sample were obtained (only two missing samples observed). Those sampled households accommodate a total population of 1,080. On the other hand in Zeway town, 12 incomplete samples were obtained and rejected from the sample and hence 188 and 288 samples were taken for computational purpose among the intended sample size of 200 and 300 respectively.

3.3.8 Methods of Data Collection

The designed structured question was aimed to obtain the required information and is mainly composed of three major sections. The first section includes socio economic characteristics of the household and the second comprises of the cost and behavior of the head of the household in the illness and the last holds about morbidity of the illness and the risk associated to the illness. The original question was translated in to Amharic in such a way that it has become easily understandable for the enumerators to collect the required data.

To collect and conduct this survey 10 enumerators were used in both survey areas. The enumerators were selected with their rank of academic performance and experience, hence, ESLCE point of 2.4 was used as a benchmark and moreover, university students were on vacation and were participated to this survey. Intensive one-day training was given to them on the area of data collection techniques and the approach intended during interviewing the household in particular and to catch up clear idea in general.

Pre testing was conducted two weeks before the actual survey was undertaken, and minor correction on the design of the questionnaire was done. The enumerators were sent to collect the survey on weekend time to obtain appropriate information.

Most of the information at household level was obtained from the head of the household, and in rare case the representative was used, and morbidity information was taken from the victim for adults and elderly, where as, in case of morbid child, the mother was taken as a representative to obtain appropriate information.

3.3.9 Fieldwork

The fieldwork of the survey was undertaken between October1/10 to15/10 /2006. Since most of the samples were daily laborers and civil servant that the best days of getting the head of the households were Saturday and Sunday. This is aimed to avoid the risk of absence of the head of the households and to save time, money and energy. Over all respondents were very much cooperative in responding on the question asked by the interviewers. Therefore, the planned survey was successfully accomplished.

3.3.10 Methods of data analysis

The data collected was coded and compiled on excel and were processed using STATA, version 9 and LIMDEP (limited dependent variable) to attain the econometric analysis of the paper.

3.3.10 Limitation of the Study

The study assumed other determinants of health remain constant and the victims are self-employed. The probabilities estimated for the illness became very low that might reduce its application to approximate treatment cost for endemic diseases. Besides that, the study used proxy of employment rate of that of eastern shoa. Finally, elicitation of irrigation induced health cost was quantified using prevalence rate, which may be more appropriate when attributable percent was intended to use. Large-scale studies on cohort studies are demanded to obtain the attributes of irrigation

CHAPTER FOUR

Findings of the Survey: Results and Discussion

This chapter presents the results obtained from the survey in to two major sections; descriptive and econometric method of analysis.

4.1 Descriptive and Econometric Analysis of Malaria

4.1.1 Descriptive Analysis of the Survey Data in Wonji Cane Plantation

Among 200sampled households interviewed, 198 (99%), and 194 to 198 (97-99%) were used for analysis for malaria, and schistosomiasis respectively.

a). Household Characteristics

The demographic structure of the sampled households include 532 (49.25%) < 18 years, 542(50.18%) between 18-60 years and 6 (0.5%) above 60 years.

Educational attainment of head of the households was categorized in to four levels for analytical purpose. Those who cannot read and write classified as illiterate, and constitute (15%). Those who write and read, and formal education of 1-6 are under primary education level and incorporate (45%), and both junior (7-8) and secondary high school (9-12) were grouped under secondary education level (35%). Those attending any tertiary education (>12) were considered at one group as tertiary education level and 5% were found to be from this group.

Migration characteristics of the head of the households' cover 36% migrant, and 64 % non-migrant. More important from epidemiological point of view is the cross tabulation of migration and malaria illness. Thus, out of the total migrant, only 14(32.55%) were sick and among those non-migrant 29(67.4%) were ill with malaria. This is unexpected from epidemiological theory and may be explained that, the migrant might came from malarious areas.

The family size varies from single household to15 with average family size of 5.34. This signifies that the variation (range) and the magnitude in the sampled households are not small.

b). Malaria Situation and Its Impact

Respondents of the households were asked if any member of the family has been sick with malaria in two weeks time, from those sampled households, 40 (20 %) were responded affirmatively.

The results of the survey also indicated that 100% of the morbid due to malaria got treatment from modern health care services. Among those diseased, 13 (30.23 %) got diagnosis and treatment on clinical basis, while the rest was treated with definitive diagnosis (microscopic examination). This assures the certainty of the survey on malaria illness. The efficacy of the treatment was assessed with the prognosis of their illness. Therefore, 12 (27.9 %), 28 (65.11 %) and 3 (6.97%) was very good, good and not improved respectively. Mortality was not reported through out the survey time in the sampled households.

From those diseased with malaria 25(58.13 %) were females and 18 (41.87 %) were males. More over, 19 (44.18 %) were less than 18 and 24 (55.81 %) were between 18-60 years. No case was reported above 60. According to membership responsibility when living in the household the illness reported was 9(20.93%), 12(27.9), 1(2.32%), 16(37.2%) and 7(16.27) for head of the household, house wife, house maid, student and children under 5 respectively.

The average morbidity days for both sexes were 6.5 per episode, while clustering in sex, the average morbidity days were 6.6 and 8.6 days /episode for females and males respectively. This variation may be due to females carry on the burden of their families in the household. There fore, they return to their formal work as early as possible.

There are about 324 nets were found in the sampled households. The minimum and maximum nets found at household level were 1 and 5 respectively, and the average number of net per household was1.62, and 0.3 per head. The net household coverage was found to be 51%, while including other methods reached 85%. This figure is less than that was found on other study done in Ethiopia (78%).

4.1.2 Results from Econometric estimation

4.1.2.1 Bivariate probit model: Results and discussion

This study manages the treatment needed before running the regression as follows. Pertaining to heteroscedastisity, which is the common problem in cross sectional data (see appendix4), but the soft ware captured this problem. Correlation was also checked with a rule of thumb measurement i.e. correlation coefficient > 0.8 were excluded.

Table 4.2.1: Description of explanatory variables

Variable	Description of the variable
Edhhhi	Educational attainment of the head of the household Dummy variable 1 if illiterate,0 otherwise
Edhhhsh	Dummy 1 if completed secondary and high school education 0 otherwise
Edhhht	Dummy 1 if join tertiary level,0 otherwise
Pihhh	Income of the head of the household in birr
Nbnah	Number of the bed net at household
Masoi	Information on malaria from mass media source Dummy 1 if true,0 otherwise
Msmi	Knowing the major symptoms of malaria illness 1 if s/he knows, 0 otherwise
Nmsmi	Not knowing at least three of the major symptoms of malaria illness Dummy 1 if doesn't know,0 otherwise
Hesoi	Information source on malaria prevention from health institution Dummy 1 if yes, otherwise0

Source: own survey hypothesized and selected variables, 2006

Creating barrier between the definitive and intermediate host is the most prevalent and recommended (WHO) form of practice is using impregnated bed net, where distributed with subsidized cost by the government. Briefings of the independent variables whether they are continuous or discrete were given in table 4.2.1.

Table 4.2.2 provides the results from the specification that was finally chosen for further analysis. To start with the model specification, Wald chi^2 statistics revealed that, the variable chosen has a good explanatory power. Moreover, the likelihood ratio test of $\rho=0$, chi^2 also gave the results for rejecting the null hypothesis (see appendix 4), implying the specification is appropriate and it is also appropriate to model jointly on seemingly bivariate probit. The dependent variable for equation (1) is malaria illness; it takes the value 1 if the household reports at least one episode of malaria illness in two weeks time, otherwise 0. For equation (2) the dependent variable is aversion on malaria using impregnated bed net, it takes a value of 1 if the household reports undertaking aversion, otherwise it takes the value 0.

In equation (1) malaria illness was regressed on a set of explanatory variables. Hence, the role of mass media information (health education) is highly significant and is positively related. This underlines that information source through electronics media plays considerable impact on malaria illness. This is observed through their frequent reporting of the illness as early as possible when the household members sick. Moreover, the variable is also significant determinant on the decision to undertake defensive activity.

Interestingly, the expected variable (the quantity of impregnated bed net) available at household level has become insignificant, and the sign is positive, which is the reverse of the existing epidemiological theory.
This may be due to the number of nets required at household level with respect to family size and sleeping patterns of the household members may not be proportional, and population movements in the area may have also perverse effect. Besides, I witnessed that in the area, some households keep the net idle if not proportional with the sleeping pattern of their family members and re impregnation was not timely under taken.

Income is significant as a determinant of malaria illness and is negative. Household who are in better economic status have access to information and be able to adopt better method consequently, reduce malaria illness. Besides, it has also significant impact on the decision to under take defensive activity.

Equation (2) Education level of the head of the households at tertiary level **has positive** relation with the aversion of malaria, and is very significant. This indicates the **more the heads** of the household learns, the better would be the defensive measure they undertake. The role of health education through mass media in malaria prevention is also highly significant and positively related. As the frequency of health education through mass media increases, the aversion does. The quantity of net availed at households has a significant and positive impact as well. This implies that the aversion behavior is explained with net distribution in the household.

Table 4.2.2: Seemingly Bivariate probit result

Equation (1) =malaria illness

ndependent variable	**Coefficient**	**Robust Std. Err.**	**z**
Edhhhi	-.6979429	0.43	1.39
Edhhhsh	-.1164601	.2313842	-0.50
Edhhht	-.5512118	.5537532	-1.00
Pihhh	-.001035	.0004612	-2.24**
Nbnah	.146341	.1174236	1.25
masoi	1.425455	.223093	6.35***
Nmsmi	-.0904692	.2108828	-0.43
Cons	-2.442077	.5069497	-4.82 ***

Equation (2) =aversion on malaria

Independent variable	Coefficient	Robust Std.Er	z
Edhhhi	.3509751	.4195199	0.84
Edhhhsh	.1446989	.2556061	0.57
Edhhht	.947077	.3398084	7.50***
Pihhh	.0009266	.0005352	1.73*
Nbnah	.2088837	.1252843	1.67*
Masoi	.9931299	.2567289	3.62***
Cons	.1166849	.3034437	0.38

Source: own survey, 2006 * significant level at 10%, ** at 5%, and ****at 1%

Number of obs = 197

Wald chi2 (13) = 77.92

Log pseudo likelihood = -170.47207

Wald test of rho=0: chi2 (1) = 2.78036

4.2 Descriptive and econometric analysis of malaria at Zeway

4.2.1 Descriptive Analysis of Impact of Malaria

From a total of 300 sampled households interviewed 288(96%) were complete, and used for analysis purpose.

Malaria illness distribution on age strata was found to be 62.5% for age less than 18, 37.5% for 18-60, and nil above 60.This indicates that children are more vulnerable than any other age groups. This may be due to their low level of immunity or they may not be well protected by their parents. Morbidity according to their responsibilities as a member of the households, the head of the households' comprise5.88%, house wife, 20.58%, housemaid 8.82%, student and children under 5, 32.35% each. All reported cases got treatment from modern health institutions, which is a promising step to reduce mortality if not morbidity. Concerning the methods of diagnosis, 1 (2.94 %) was treated clinically, while the rest was treated with definitive diagnosis (microscopic examination). The prognosis after treatment was very good for 50% and good for 47.05%, and not improved for 2.95% fro the total reported cases.

4.2.2 Econometrics result

4.2.2.1 Bivariate probit Model: Results and Discussion

Table 4.2.3 shows the results from the specification that was finally chosen for further analysis. The dependent variable for equation (1a) is malaria illness; it takes the value 1 if the household reports at least one episode of malaria illness in two weeks time, otherwise 0. For equation (2a) the dependent variable is aversion on malaria using impregnated bed net, it takes a value of 1 if the household reports undertaking aversion, otherwise it takes the value 0.Imperignated bed net Creates barrier between the definitive and intermediate host, which is the most prevalent and recommended (WHO) form of practice, where distributed with subsidized cost by the government.

The table also represents finally selected variables for further analysis. To begin with model specification, the explanatory variables are best suited for explaining the dependent variables i.e. the power of explanatory variables and model fitness (Appendix4) and the correlation of explanatory variables as usual (>.8) were checked and excluded. There fore, it is appropriate to regress the model again with seemingly unrelated bivariate probit.

Equation (1a) was regressed on different variables. One of the variables is education attainment of the head of the households, illiteracy only significantly and positively determines malaria illness, and correspondingly this variable has negative effects on the decision undertaken for defensive activity. This implies that when the head of the households are illiterate, the higher will be the incidence of the illness; this due to the non-aversion characteristics of the illiterate in malaria prevention. Knowing the major symptoms of malaria illness (at least three) also significantly and positively related with malaria illness. This implies that knowing the symptoms induce one self to report the illness more frequently. The rest variables such as wage income, number of bed net at household level are not significant but the sign is as expected.

Equation (2a) among those regressors on aversion (table 4.2.3), the quantity of bed net was very significant determinant and affects the aversion positively. Most of the prevention was under taken with impregnate bed net relative to others. More importantly, information obtained from health institution on prevention and modes of transmission is significantly affecting the aversion behavior positively.

Table4.2.3: Seemingly bivariate probit

Equation (1a) =malaria illness (zeway)

Independent Variable	**Coefficient.**	**Robust Std. Err.**	**Z**
Edhhhi	.6625291	.2710146	2.44***
Edhhhp	.0071817	.3030781	0.02
Edhhht	-.0230917	.2815888	-0.08
Pihhh	.0002642	.0003265	0.81
Msmi	.2599768	.11154	2.33***
Hesoi	-.0396427	.0788193	-0.50
Nbnah	-.0975269	.1212761	-0.80
Cons	-1.559545	.2474761	-6.30***

Equation (2a) = Aversion on malaria

Independent Variable	Coef.	Robust Std. Err.	z	P>|z|
Edhhhi	-.6190569	.3151516	-1.96**	0.049
Edhhhp	.2185059	.2431464	0.90	0.369
Edhhht	.2093591	.2547364	0.82	0.411
Pihhh	.0003141	.0003633	0.86	0.387
Nbnah	1.118025	.193269	5.78***	0.000
Hesoi	.4115013	.1824737	2.26***	0.024
Cons	-.8254665	.2289639	-3.61****	0.000

Source: own survey, 2006, * significant level at 10%, ** at 5%, and ****at 1%

Number of obs = 288

Wald chi2 (13) = 62.36

Log pseudo likelihood = -220.78092

Wald test of rho = 0: Chi2 (1) = 5.23796

4.3 Descriptive Analysis of Schistosomia illness at Wonji Cane Plantation

4.3.1 Impact of Schistosomiasis illness

Only one reported schistosomiasis case was found at the time of survey, in spite of in the presence of schistosomiasis in the lake zeway around town. This indicates that the residents abandoned using lake water either for bathing or laundering purposes. And the study, therefore, considered as nil.

Among 200 sampled households 198 were used for further analysis. Respondents were asked if any member of the family has been sick with schistosomiasis in one-year period of time. From those sampled households, 37 (18.5%) responded affirmatively. The result also indicates that among those reported cases, 13(33.4%) were affected due to occupational exposure. Thus, it was excluded from cost estimation when net impact of irrigation was estimated. According to family member responsibilities, the survey has identified the morbidity level. Thus, 13(33.3%), 5(12.85), 20(51.28%) and 1 (2.5%) were head of the household, housewife, students and children respectively. This indicates that students were the most vulnerable; the possible explanation is that students might have used swimming and bathing as a recreation more frequently than others. The study also revealed that the reasons for using irrigation as a major source of water despite the health problems were due to interruption (46%), absence (22%), and existence of excess fluoride (48%) in potable water provided.

Both children and adults were equally likely affected with the illness before adjusting occupational exposure impact, and there was no morbidity report for age above 60. Morbidity level in sex, 41.02%, and 58.97% were females and males respectively, which is slightly higher for the latter one. This variation may be due to cultural prohibition of females to swim and take bath in an open access vis-à-vis males. And most of the time males are exposed to laborious exercise than females that intern increases frequency of bathing. Hence, the probability of developing the illness is increased. After adjustment has been made, to capture the effect of occupational exposure, the result depicts as follows: The number of household reduced to 26 i.e. 33.3% were excluded aiming to handle the irrigation micro ecological setting impact. Consequently, the proportion of children affected has been increased tremendously to 73.07%. The result also showed that schistosomiasis consumed a total of 354 morbid days per year for the sampled households. The illness required recovering at least 2 days and a month when extended, on average, this became 9.07 days

4.3.2 Econometric Result of Schistosomiasis in Wonji cane Plantation

4.3.2.1 Probit Model: results and Discussion

Table 4.2.4 shows the independent variables explanation and their nature (continuous, discrete) used in the analysis. Following this, bivariate probit regression was attempted but it failed to handle. This was checked with insignificant correlation of the error terms for the illness and aversion. Even though, the respondents were very aware of the illness, they couldn't behave accordingly, and the reason was that the potable water had excess fluoride, which most respondents answered (48%). Thus, they gave higher weight for the illness caused by excess fluoride which they call it" Shakisso" i.e. kyphosis of the vertebral bone than schistosomia illness. Besides, interruption and absence of tape water at household level also have enormous impact (see appendix3).

To handle this, independent probit regression has been undertaken; in this scenario the appropriateness of the explanatory variables was checked with Wald chi2 which is significant to explain the dependent variables and Pseudo R^2 (log likely hood ratio index) is used to measure the good ness of fit (see appendix4). Both supported to fix the regression with independent probit regression.

In equation (1b) of table 4.2.5 below schistosomia illness has been regressed on a set of explanatory variables. It takes a value 1 if an illness in one year time was reported, otherwise 0.

Accordingly, knowing the major symptoms (at least three) is positively related to the probability of reporting the illness and is significant. Thus, identifying the major symptoms of the illness is one of the determinants in explaining the probability of reporting the illness. Thus, knowing the major symptoms increases the probability of reporting the illness by 19.7 %.

Wage income of the head of the households is negatively related to the probability of the occurrence of the illness. A one birr increase in the wage income of the head of the households, the probability of illness occurrence decreases by 0.016 keeping all other variables constant.

Non-wage income is negative and significant (at 5%), which indicates that getting non-wage income is one of the determinants for the probability of disease to occur. Having non-wage income affects the probability of acquiring the disease negatively by 13.01 units.

Equation (2b) stands for aversion behavior on schistosomiasis (dependent). It takes a value 1 if avoid contact with irrigation water, which is the most appropriate and cheapest (zero cost), but due to in applicability of aversion, awareness is used as a proxy.

Knowing the major symptoms of the illness is positively related to the probability of reacting on defensive behavior. It is significant (at1%). Therefore, identifying the major symptoms of the illness is one of the determinants in explaining the probability of reacting on defensive behavior. The implication in epidemiology is that knowing the illness and getting treatment as early as possible is considered as primary prevention. Absence of tape water at household level is significant (at10%) only and positive. Illiterate household head is negative related to malaria aversion and statistical significant at 10%. This implies that being illiterate is one of the determinants of responding negatively on defensive behavior.

Table 4.2.4 Description of selected explanatory variables

Independent variables	Description
Edhhhpi	Education attainment of the head of the household Dummy 1 if illiterate,0 otherwise
Edhhhp	Education attainment of the head of the household Dummy 1 if complete primary education 0 otherwise
Edhhhsh	Education attainment of the head of the household Dummy 1 if complete secondary and high school 0 otherwise
Edhhht	Education attainment of the head of the household Dummy 1 if accomplish tertiary level education 0 otherwise (omitted variables)
Pihhh	In come of the head of the household per month (birr)
Aois	Availability of other income source Dummy 1 if yes,0 otherwise
Comuws	Commonly used water source Dummy 1 if irrigation,0 otherwise
Knmtb	Knowing the mode of transmission of bilharzia Dummy 1 if know,0 otherwise
Timing	Interruption of pipe water Dummy 1 if yes,0 otherwise
Absence	Complete absence of pipe water Dummy

	1 if yes,0 otherwise
Incompa	The ingredient of the pipe water (excess fluorine) Dummy 1 if aware and reject 0 otherwise
Msbi	Knowing at least two of major symptoms of schistosomiasis Dummy 1 if know three and above,0 otherwise

Source: own survey, 2006

Table 4.2.5 Independent probit regression

Equation (1b) = Schistosomiasis illness

Independent variables	Coefficient	Marginal effect	Robust Std. Err.	Z
Edhhhi	-.1479416	-.0340794	.4772555	-0.31
comuws	.2004998	.0469841	.2567194	0.78
Aois	-.7153269	-.1301677	.3859029	-1.85*
Edhhhp	-.3726942	-.0843878	.4154901	-0.90
Edhhhsh	-.2332286	-.0578497	.3874005	-0.60
Pihhh	-.0006704	.0001641	.0003849	-1.74*
Timing	.1543567	.0380006	.2213307	0.70
Incompa	.1798509	.0441205	.2282176	0.79
Msbi	1.212585	.1977079	.4317819	2.81**
Cons	-2.189475		.6087623	- 3.60***

Source: own survey, 2006,

Number of observation = 198

Wald chi2 (10) = 28.16

Log psuedo likelihood = -84.160777

Pseudo R2 = 0.4133

Equation (2b) = Aversion on schistosomiasis

Independent variables	**Coefficient.**	**Marginal effect**	**Robust Std. Err.**	z
Edhhhi	-1.782131	-.4105202	.7470041	-1.66*
Edhhhp	-1.598569	-.2489962	.7627827	-1.47
Edhhhsh	-1.214914	-.1012935	.7295764	-1.50
Pihhh	.0000354	2.97e-06	.0005464	0.06
Timing	.5289309	.0436752	.3697628	1.38
Absence	.8419176	.0492817	.4758096	1.83*
Incompa	.1854523	.0154669	.3467721	0.51
Msbi	1.884866	.3911076	.327512	4.55***
Cons	1.027925		.8330562	0.77

Source: own survey, 2006* significant level at 10%, ** at 5%, and ****at 1%

Number of observation = 194

Wald chi2 (8) = 50.59

Log pseudo likelihood = -42.320415

Pseudo R2 = 0.4337

4.3.3 Hypothesis testing

The hypothesis proposed was that irrigation has a significance contribution on malaria and schistosomiasis aggravation. This paper attempts on whether the survey support or reject this hypothesis. On this ground odds ratio of 2x2 table is used (Fletcher.M., 1992). The null hypothesis states that the observed odds of disease are equal to the expected one, but the alternative hypothesis states that the observed and the expected odds of disease are different (appendix 6).

$Chi^2(1) = 4.027$

The tabulated chi2 at one degree of freedom is 3.84, where as the calculated one is 4.027, which imply that the null hypothesis is rejected, that supports the proposed hypothesis of the study. Irrigation exposure has a significant factor on malaria illness aggravation or their relation is not artifact. Likewise, in the case of schistosomiassis illness, only one reported case was obtained in Zeway, while in wonji cane plantation; there were 39 reported cases from 37 households. Therefore, there was no need to check the significant in odds of a disease.

Both illnesses had significant variation in the intervention and comparative area. Thus, monetization is crucial at this point to elicit the health damage cost from micro ecological settings.

4.3.4 Monetization of the Health Damages of Malaria illness in Wonji Cane Plantation

The probability of observing malaria illness in a household, estimated on an average was 0.4. This probability value with other statistical measures is used to determine the monetized cost of illness of at household level.

Table4.2.6: Probability table of treatment cost of malaria illness

Variable Name	Value
λ	0.4
μch	0.49
ϕch	0.031
μa	0.5
ϕa	0.04
μe	0.006
ϕe	0

Average out of pocket money expended	78.52
Family size (fs)	5.34
Cm= FS X pc Xλ (μchϕch + μaϕa + μeϕe)	140.88birr/ year

Source: own computation of survey, 2006

Table 4.2.7: Wage loss due to malaria illness

Variable name	Value
Average size of the house hold (Fs)	5.34
Average man days lost (md)	6.06
Probability of an adult being ill λμaϕa	0.0082
Rate of employment (ER)	47.6
Average daily wage rate (w)	12birr
W_l = λμaϕa X FS X md X Er X W=	147.87 birr/year

Source: own computation of survey, 2006

Treatment cost and wage loss of a representative household on average was 140.88 and147.87 birr per year per year respectively. Health damage cost for a representative household was 288.75 birr per year, and for representative sampled households, 57,172.50 birr per year.

Comparisons of the two costs in this case may not have significant variation, but it supported the theoretical and empirical evidence that wage loss is greater than treatment cost in spite of the methodology of estimation. The reason may be, Treatment cost has unilateral implication where as bilateral for wage loss. Only the sick person has taken treatment as compared to wage loss that may include the sick and the "caregiver", which may increase the monetized value. Even at aggregate level, when the expenditure on the illness increases, the income generated on the health service sector also increases. This therefore has a positive impact in the economy at macro level. But the loss in wage, which has bilateral negative impact in the economy, is very important at societal level as compared to treatment cost. Therefore, when impact assessment is needed, treatment cost is important at household level as compared to wage loss, while at societal level wage loss is more important than treatment cost.

4.3.5 Monetization of the Health Damages from Schistosomiasis Illness in Wonji Cane Plantation

The probability observing schistosomia illness at household level, on average be estimated is 0.19. After incorporating this and other statistical measures, cost of health damages would be approximated.

Table4.2.8: Probability table of treatment cost of schistosomia illness

Variable Name	Value
λ	0.19
μch	0.49
ϕch	0.037
μa	0.5
ϕa	0.035
μe	0.005
ϕe	0
Average out of pocket money expenditure	86.28 birr
Family size (fs)	5.34
$Cm = FS \ X \ pcX \ \lambda \ (\mu ch\phi ch + \mu a\phi a + \mu e\phi e)$	3.11 birr

Source: own computation of survey, 2006

Table4.2.9: wage loss due to schistosomiasis

Variable name	Value
Average size of the house hold (Fs)	5.34
Average man days lost (md)	7.94
Probability of an adult being ill $\lambda\mu a\phi a$	0.0033
Rate of employment (ER)	47.6
Average monthly wage rate (w)	12 birr
$W_l = \lambda\mu a\phi a \ X \ Fs \ X \ md \ X \ Er \ X \ W$	79.92 birr

Source: own computation of survey, 2006

Health damage cost of a representative household was birr 83.03, and for the representative sampled households is birr 16, 439.94. This amount of money lost yearly, but didn't show the over all impact in the campus.

4.3.6 Monetization of Irrigation Ecological Settings

The irrigation micro ecological setting attribute for malaria and schistosomia illness was checked with chi^2 (1) and it was found to be statistically significant (see appendix 6). To dissect the irrigation micro ecological impact vis-à-vis without irrigation in monetary terms, the attributable percent was used.

Regarding to schistosomia illness, in one-year recall period, there was only one-reported cases in comparative area (zeway). Therefore, the monetized cost of schistosomiasis in Wonji cane plantation after adjustment of occupational impact was used to determine the probability of the illness (see appendix 5). Consequently, a representative household has incurred net cost of birr 21.90 per year due to irrigation ecological setting on schistosomiasis occurrence or aggravation, and about 4,336.20 birr per year for representative sampled households. On the other hand, the irrigation impact on malaria was approximated with attributable percent, taking in to account the odds ratio of the illness in the two areas.

Average percentage of positive response at household level to total sampled households for malaria illness was 20.20 % and 11.11% for Wonji cane plantation and Zeway respectively. Incidence attributes of irrigation micro ecological settings was the difference, 18 households reported the illness in excess of the comparative area. Irrigation ecological setting impact on malaria incidence quantified and approximated was on average birr 5,197.50 per year for the sampled households.

Aggregating the total average cost of illness (treatment cost and wage loss) for the two illnesses were approximated and has been birr 73,565.44, while the aggregate net effect of irrigation ecological setting was birr 9,533.70. This sum of money is the effect of irrigation micro ecological settings in Wonji cane plantation for sampled households only. Therefore, This figure designates the monetized epidemiological impact of illness (malaria and schistosomiasis) aggravation following irrigation scheme.

CHAPTER FIVE

Summary, Conclusion and Policy Suggestions

5.1 Summary and Conclusion

The assessment of available literature on the economic impact of malaria and schistosomiasis is clearly indicated that no study could be highlighted as models of good methodology. Therefore, different approaches were implemented based on the perspectives of the study. The present study can be considered as a preliminary work on the objective assessment (revealed preference) on health damage cost elicitation through the investigation of the effect of individual characteristics and decision behavior on illness due to water related vector born diseases adopting 'health production function'.

In Ethiopia where rainfall is becoming scarce and erratic, irrigation plays important roles in producing inputs for agro processing industries and maintaining food self-sufficiency and reducing tied food aid. However, it is not without demerits. Thus, it predisposes to water related vector borne diseases, which are the major health threat. Malaria and Schistosomiasis take the lion share.

Health is the basis for efficient job productivity, the capacity to learn, and the capacity to grow intellectually, and physically. In economic terms, it is one of the crucial components of human capital i.e., it is the basis of individual's economic productivity. It is also consumption good; it provides satisfaction by reducing ill health.

The majority (75%) of landmass of Ethiopia is prone to malaria. And the problem is further exacerbated by irrigation scheme. Following irrigation implementation most research indicated schistosomiasis can occur and causes a significant health impact. This in turn has a serious economic repercussion at national level in general and at household level in particular.

The primary data collected were analyzed on descriptive and econometric methods. The special interest of this study is Wonji cane plantation. Therefore, summary, conclusion and policy suggestions mainly refer to it. The descriptive analysis showed that among sampled households, 20% reported the illness with in two weeks recall period. Similar studies with the same recall period of time in Butajira (Garage zone, SNNP) accounted 26 %(Kloos, et al.2006), which supports the magnitude of the figure. From those cases of malaria illness reported, above 95% were identified with definitive diagnosis (microscopic examination) basis, however, the remaining were identified and treated clinically. The efficacy of the treatment with clinical diagnosis was assessed with the patient response after treatment, which showed that above 95% had good prognosis. Therefore, the report of the illness at the time of the survey is genuine.

The family size on average was 5.34, mean while, the variation (range) in magnitude is very high. The distribution of the illness on age strata, which is the important element in cost estimation, is almost equal for both age groups (child and adult) with no report at old age. The result also indicated that the number of days on average needed to recover from their illness was 6.5 per episode. While clustering in sex the average fits for females but slightly extended for males, which is much lesser as compared to other study recently conducted in the village of northern Ethiopia i.e.18 days for adult (kloos, et al.2006). The availability of health post at campus level in the area under investigation may have an input for early diagnosis and treatment.
The comparative area (Zeway) the age distribution of malaria illness was 62.5% and 37.5% for age less than18, and 18 to 60 respectively. Above 97% of reported malaria were treated with definitive diagnosis (microscopic examination), and above 97% the prognosis after treatment were good.

With reference to schistosomiasis, like many other diseases, it is largely caused by human behavior, principally water use practices, which is the key factor in the transmission of the disease. As explained in the methodology part, bivariate probit is the method by which joint effect of aversion behavior and illness were assessed. However, at the point of analysis, it was failed to do so. Therefore, the study presumed to handle this out come with independent probit regression.

Among those sampled households, 18.5 % were responded affirmative. Like wise, as in case of malaria, both age groups were equally likely affected. But had no report in the old age category. The average morbidity days found to be 9.07 days but vary with a minimum of two days to maximum of one-month duration. In this study to capture the micro ecological impact of irrigation settings, occupational exposure was first excluded, and it was found to be 13(33.3%). After adjustment has been made to capture occupational impact, the result indicated that school children found to be the most affected (73.03%), since they might have used swimming and bathing as a recreation more than other age groups.

Before estimating the probability of malaria illness, risk factor for an illness and individual characteristics were examined on a bivariate probit regression and consequently checked the decision behavior on aversion of a household and an illness. Thus, at household level among the explanatory variables regressed for the illness; the role of mass media, income of the head of the household are significant; on the other hand, on aversion aspect, the number of bed net, income of the head of the household, the role of mass media and educational attainment at tertiary level are significant. Nevertheless, the quantity of bed net available at household level is positively related with malaria illness and is insignificant, which is implausible in epidemiological theory. This may be due to the number of net required at household level would be affected with family size, sleeping patterns, and the appropriateness of the net to apply on indigenous sleeping materials. Moreover, on my observation, some households just put it rather than using it until they get proportional number of net to their family sleeping pattern, and periodic re impregnation was not available. These and other factors may erode the negative relation ship expected between malaria illness and the quantity of bed net.

The independent probit regression of Schistosomia illness indicated that wage income and the availability of other income sources and the role of mass media on health education is the significant explanatory variables. On the other hand, the probit regression on aversion; health education on electronics media, absence of potable water at household level are positive determinant and education of the head of the household at primary level determines the defensive behavior of the head of the household negatively.

In particular, this study has given a major emphasis on monetization of health damage cost of an illness, with reference to malaria and schistosomia illness from behavioral and environmental aspect. Based on the probability of observed malaria illness, the health damage incurred on a representative household, cost of treatment estimated on average was birr 140.88 per year, on other study showed that the treatment cost ranged from 46 to 151 birr with different method of investigation (Kloos,et al.2006).

The household treatment costs, as a percentage of annual income is 3.64 percent of the total income. This figure for agri business laborers in Kenya was 0.8 to 5.2 % that supports the findings in this study. Moreover, per-capita household expenditure was found to be 30.11 birr per year.

The remaining impact assessed by this study was wage loss. For this circumstance, using probability and other statistical measures, it was estimated and found to be on average birr 147.87per year per household. This amount of money accounts 6.86% of the income of the head of the household. Other similar study done in Africa indicated 3 to 4.7 % (Flessa.U., et al 2006). The treatment cost is very much lower than the wage loss estimated, which is supported in theoretical literature irrespective of the valuation methods.

Concerning schistosomiasis, the study indicated 354 days lost per year (for the sick and care giver), for all cases of schistosomiasis. Other study in Philippines and Ghana showed 26 to 42 days lost per year for schistosomia japonicum (Flessa.U., et al 2006). On average, it became 9.07 days per episode. The health damage cost found to be birr 82.83. Treatment cost is less than wage loss. However, the figure for treatment cost is very low as compared to malaria. This might be the low number of reported cases for one-year period of time, or the model may not be appropriate for chronic illness like schistosomiasis.

The result of the study showed that the treatment cost of malaria in the representative household, was on average 140.88 birr per household annually. Wage loss has constituted birr 147.87 per head per year. The health damage cost became 288.65 birr per year per household. It represents 6.86% of the mean annual income per head. This is diverted mainly from consumption. These aggregate costs for sampled households on average would be birr 57,152.70. On the other hand, Schistosomiasis has imposed a significant influence on household expenditure i.e., 83.03 birr per year per household, despite the intervention on vector control. The representative sampled households' loss birr 16, 439.44 per year. The health damage cost for the two illnesses became birr 73,592.14. Therefore, the burden is quite high and more marked for the low-income group, which was used in this survey.

The other objective of this study is to estimate the additional cost of micro ecological settings of irrigation in monetary terms, and found to be birr 9,534.64 for sampled households for both illnesses. From aggregated health damage cost of the two illnesses the proportion of schistosomia illness accounted one quarter only, whilst in the case of irrigation ecological setting, it accommodated one half of the aggregated cost.

5.2 Policy Suggestions

Most research is familiar with policy implications that could help in decision-making process. Therefore, this study proposes the following suggestions that have been extracted from the results.

a) People are aware, how they acquired and can prevent malaria illness. This implies aversion behavior and malaria illness is interrelated and has been not independent. However, the result indicated that, their interdependences were not strong, and it requires another similar investigation before generalizing the role of behavior on malaria illness. Therefore, even if the behavioral role seems weak, exhaustively exploiting this factor is the best remedial measure at the present status and other externalities.

b) The information distributed from mass media on mode of transmission and prevention methods has played key role in malaria illness and prevention. . Therefore, increasing the intensity of transmission on health education, which will be endorsed with appropriate methodology and time, is vital to create awareness in the community.

c) According to the result of this study, bed net is a crucial element on malaria prevention, whereas not for an illness. This implies that there is a gap in the application of bed net. Therefore, it requires further work up to narrow the gap between distribution and application of the net to achieve a reduction in an illness.

d) The residents of the Wonji cane plantation have not responded appropriately to avert for schistosomia illness, though, they know the mode of transmission and prevention method. This is because of interruption, incompatibility and unavailability of tap water at household level (descriptive analysis). Therefore, it requires short time response to avoid such social, economical and health problems through provision of compatible potable water on continuous basis, which is very significant in morbidity reduction through avoiding water body contact.

e) School children are the most vulnerable for schistosomia illness when the impact of occupational exposure has been taken off. This indicates that the irrigation impact after excluding occupational exposure is more importantly observed on children less than 18. Therefore, the administration of the plantation has to work hand to hand with school administration and health bureau to accommodate health education in the school.

f) The result of the study also showed that the treatment costs for both illnesses were lower than the wage loss. Therefore, demarcating the health policy at macro and micro level to enrich the burden of the illness at household or societal level has paramount role. When wage loss is more significant as compared to treatment cost, macro health policy is vital to reduce the impact through mass prevention, such as vector control, through creating physical barrier (net) etc. Contrary to this, micro health policy is very much required when the burden of the disease on treatment cost is significant relative to wage loss. This can be handled with subsidizing prescribed treatment and investigation of an illness.

g) With reference to the variation of the two costs, it is more significant for schistosomia illness as compared to malaria. Therefore, health policy maker has to identify the characteristics of the illness (acute or chronic) before setting policies and allocating budget either for treatment or prevention. Moreover, for those policy makers again before setting macro or micro health policies to address the burden of the illnesses, the target group has to be identified and weighted to use the scarce resource optimally before setting policy issues.

h) The irrigation impact for aggravation of schistosomiasis and malaria have been estimated i.e. 4,336.20 and 5,197.50 birr per year respectively. This amount of money is the health damage costs from irrigation ecological setting for sampled households only. Taking this into consideration, irrigation development bureau has to work horizontally with others, starting from feasibility study through out its implementation of irrigation project to reduce the negative impact of irrigation on health.

i) Malaria illness requires much attention in general, and particular emphasis has to be given for Schistosomiasis when irrigation development scheme is initiated.

Finally this cost estimation at first, a preliminary work, small-scale study, and also time bounded as a constraint. Thus this may not depict the total cost of the illnesses at societal level, and irrigation ecological setting health damage estimation also requires total catchment area investigation. Therefore, this study will serve as a base line for others to study health damage cost of illness and irrigation on large-scale.

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Appendices

Appendix 1: Descriptive table of malaria in Wonji cane plantation malaria in Wonji cane plantation

Table1: population sampled in Wonji cane plan cane plantation

Age	Number	Percentage
<18	532	49.525%
18-60	542	50.185%
>60	6	0.55%

Table2: malaria morbidity in age in two weeks time

Age	Number	Percentage
<18	19	44%
18-60	24	56%
>60	-	-

Table3: Distribution of malaria in sex

Sex	Number	Percentage
F	25	58.13%
M	18	41.87%

Table4: The distribution of morbidity according to the responsibility of the family

Description	Number	Percentage
Head of the household	8	18.6%
Housewife	12	27.90%
Housemaid	1	2.32%
Student	15	34.88%
Children	7	16.27%

Table5: Methods of diagnosis

Methods of diagnosis	Number	Percentage
Clinical	13	30.23%
Definitive	30	69.77%

Table6: Prognosis after treatment

Prognosis	Number	Percentage
Very good	12	27.9%
Good	28	65.11%
Not improved	3	6.97%

Table7: morbidity day's computation

-Total morbidity days=275 days /2 weeks -Average morbidity days for both sexes=6.54 days/episode -Total morbidity days for females=173 days/ 2 weeks time -Total morbidity days for males = 119 days/episode -Average morbidity days for females=6.64 days/episode - Average morbidity days for males=8.6 days / episode

Table 9: Family distribution

Description	Number of family
Maximum family size	15
Minimum family size	1
Average family size	5.34

Table10: migration characteristics

Description	Number of household	Percentage
Migrant	72	36%

Non migrant	128	64%
Total	200	100%

Table11: Relation of illness and migration

Description	Number	Percentage
Migrant and sick	14	32.55%
Non migrant and sick	29	67.45%
Total	43	100%

Appendix2: Descriptive table of malaria in Zeway town

Table12: malaria distribution with age strata

Age	Number of cases	%
< 18	20	58.82%
18-60	14	41.18%
> 60	0	-

Table 13: morbidity with responsibility as a member

Description	Number of cases	%
Head of the household	2	5.88%
Housewife	7	20.58%
Housemaid	3	8.82%
Student	11	32.35%
Children < 5	11	32.35%

Table 14: Morbidity with sex

Sex	Number of cases	%
Female	22	64.7%

Male	12	33.3%

Table15: methods of diagnosis

description	Number of cases	%
Clinical	1	2.94%
Definitive	33	67.16%

Table 16: Prognosis after treatment

Description	Number of cases	%
Very good	17	50%
Good	16	47.05%
Not improved	1	2.95%

Appendix3: Descriptive table of Schistosomiasis in Wonji cane plantation

Table17: morbidity days due to schistosomiasis

Description	Number of days
Minimum	2
Maximum	30
Average	9.07
Total	354 per year

Table18: Occupational exposure due to schistosomiasis

Description	Number of affected	Percentage
Employed in the plantation	13	33.4%
Only household	26	66.6%

members		
Total	39	100%

Table14: Morbidity in age due to schistosomiasis before adjustment

Description	Number of cases	Percentage
<18	20	51.28%
18-60	19	49.72%
>60	0	-

Table 19: morbidity in sex

Description	Number of cases	Percent
Female	16	41.02%
Male	23	58.97%
Total	39	100%

Table20: distribution of illness according to their duties in the household

Description	Number of cases	Percent
Head of the household	13	33.335%
House wife	5	12.85%
Student	20	51.28%
House maid	0	0 %
Children	1	2.5%

Table21: Reasons not to avert properly

Description	Number of house hold	%
Interruption of potable water	92	46%
Absence of potable water	44	22%
Existence of excess fluoride in potable water	96	48%

Table 22: Adjusted schistosomia cases with age distribution

Age	Number of cases	percentage
<18	19	73.07%
18-60	7	26.93%

Appendix 4: Econometric tests

I. Bivariate probit for malaria in Wonji cane plantation

1.<u>Test of Heteroscedasticity</u>

Among the important methods used to test the presence of heteroscedasticity, this study used the loglikelyhood ratio (LR) test. The assumption suggested for testing the null hypothesis of homoscedasticity is as follows:

λ_{LR} =2[log Lu-LogLr]: where

Log Lu is the value of un restricted log likely hood function and Lr is the value of restricted log likely hood function

λ_{LR} has X^2 (n) distribution with n degree of freedom where n is the number of independent restriction. If calculated is greater than tabulated, reject the null hypothesis (homoscedasticity) , other wise the reverse is true.

<u>Before robust</u>

λ_{LR} =2[log Lu-LogLr]

= 2[-166.59377+ 180.286]

=27.584

<u>After robust</u>

λ_{LR} =2[log Lu-LogLr]

=[-170.187+180.386]

= 20

The tabulated X^2 at 13 degree of freedom is 22.3621 at 95 % level. Comparison before and after robust indicated that it was heteroscedastic before robust which implies reject the null hypothesis (i.e. heteroscedsticity was the problem). While after robust it became hmoscedastic, which implies the heteroscedastic problem, is captured.

2). Correlation test

As shown below (variables nbnah and expend and Masoi and Hesoi have correlation), which is above the assumed rule of thumb measurement (>0.8). There fore, Expend and hesoi are removed before running the regression.

4) Model specification: Wald chi^2, and Wald chi^2 (13)=77.92 and the critical value at 13 degree of freedom= 22.36, this implies that the explanatory variables well explains the specification.

5) The correlation of the error terms of the two equations was checked as follows: the null hypothesis $\rho=0$, the critical value at 90% level is 2.70, while the calculated one is 2.78. Therefore, the null hypothesis was rejected, it is appropriate to estimate with the sprit of seemingly unrelated bivariate probit model.

II. Bivariate probit for malaria in zeway

3) Heteroscedasty test

Among the important methods used to test the presence of heteroscedasticity, this study used the loglikelyhood ratio (LR) test. The assumption suggested for testing the null hypothesis of homoscedasticity is as follows:

λ_{LR} =2[log Lu-LogLr]: where

Log Lu is the value of un restricted log likely hood function and Lr is the value of restricted log likely hood function

λ_{LR} has X^2 (n) distribution with n degree of freedom where n is the number of independent restriction. If calculated is greater than tabulated, reject the null hypothesis (homoscedasticity) , other wise the reverse is true.

λ_{LR} =2[log Lu-LogLr]

= 2[-220.98+290.69]

= 139.42

The critical value of the chi2 at 13 degree of freedom is 23.68 at 95% level. Therefore, the calculated chi2 is greater than the tabulated, implying the null hypothesis (homoscedasticity) is rejected i.e. heteroshedasticity is the problem

4) Model specification: Appropriateness of the model is checked as usual with Wald chi^2 (13) = 63.11, while the critical value at 13 degree of freedom at 95% level is 22.36. Therefore, the explanatory variables have a good explanatory power.

III. Probit regression

1) Correlation test of equation (1a)

In this model, the correlation coefficient is below the assumed rule of thumb measurement (<0.8). Therefore, there is no correlation problem.

2) Heteroscedasticity test for equation (1a)

The existence of heteroscedasticity in probit model was checked with log likely hood ratio test as above in bivariate case.

λ_{LR} =2[log Lu-LogLr]: where

Log Lu is unrestricted log likelihood ratio and Lr is restricted log likely hood

λ_{LR} =2[-44.9972+84.1607]

= 72.32

The tabulated chi2 at 9 degree of freedom at 95% level is 16.92 while the calculated was 72.32. Therefore, the null hypothesis is rejected (the model has heteroscedastic problem).

3) Appropriateness of the model was checked using Wald chi2. Waldchi2 (9) at 95% level is 19.62 and the calculated is 28.16. Thus, the regressor has explained the dependent variables. Moreover, the psuedoR2 (log likely hood ratio index) is used to measure the goodness of fit of the probit model. If it is 1, it implies perfect fit. A value approach to 1 indicates improvements of fit. In this case the result is 0.4133.

3. Heteroscedasticity test for equation (2b)

The existence of heteroscedasticity in probit model was checked with log likely hood ratio test as above in bivariate case.

λ_{LR} =2[log Lu-LogLr]: where

Log Lu is unrestricted log likelihood ratio and Lr is restricted log likely hood

λ_{LR} =2[-42.32+74.66]

=32.34

The critical value of the chi2 at 8 degree of freedom is 16.92 at 95% level. Comparing the results of the tabulated and the calculated showed that the calculated is greater than the tabulated implying that the null hypothesis is rejected i.e. the model has heteroscedastic problem

4. The fitness is checked with log likely hood ratio index (LRI) or psuedo R2. Therefore, for this probit model it is 0.4337.

Appendix 5: Probability schistosomiasis illness after removing the impact of occupational impaact

Variable Name	Value
λ	0.13
μch	0.49
φch	0.036
μa	0.5
φa	0.013
μe	0.005
φe	0
Average out of pocket money expenditure	86.28 birr
Family size (fs)	5.34
Cm= FS X pcX λ (μchφch + μaφa + μeφe)	1.44 birr

Variable name	Value
Average size of the house hold (Fs)	5.34
Average man days lost (md)	7.94
Probability of an adult being ill λμaφa	0.00085
Rate of employment (ER)	47.6
Average monthly wage rate (w)	12 birr
Wl = λμaφa X Fs X md X Er X W	20.46birr

Total cost of health damages per household = 21.90 birr

21.90x 198=4,336.2 birr per year for sampled households

Appendix 6: Hypothesis testing

In order to demonstrate the existence of an association between a disease and an exposure is real or spurious. The null hypothesis states that no real difference in the prevalence rate of malaria and schistosomiasis in irrigation exposure vis-à-vis non-irrigation, holding other factors constant. As shown below set up two 2x2 tables, one showing the observed results in terms of the actual number of people in each category, and the other, the expected results (the results one would expect if there is no difference between the two groups.

Observed

Disease (columns); Exposure (rows)

43	1037	1080
32	1310	1342
75	2347	2422

Expected

Disease (columns); Exposure (rows)

19	1061	1080
56	1286	1342
75	2347	2422

$$Chi^2 = \frac{[\text{observed-expected}]^2}{\text{Expected}}$$

$$X^2(1) = \left(\frac{\frac{43 \times 1310 \quad - 19 \times 1286}{32 \times 1037 \qquad 56 \times 1061}}{\frac{19 \times 1286}{56 \times 1061}} \right)$$

$Chi^2(1) = 4.027$

After setting the two tables, before comparison is set degree of freedom (df) can be calculated with the following formula:

df= (number of rows-1) x (number of columns-1)

In this case the degree of freedom became 1, and the significant was calculated with chi2 (1). The tabulated at 5% level is 3.8, and the calculated is 4.0. Accordingly the null hypothesis is rejected i.e. Irrigation exposure has a significant impact.

Appendix 7: Definition of key terms

Ecosystem - the fundamental unit of ecology, comprising the living organisms and non-living organisms that interact in a defined region.

Catchment area- region, which may be well or ill, defined, from which the clients of a particular health facility are drawn

Cercaria is the final, free swimming larval stage of trematodeparasite

Definitive host (primary host)- are hosts in which the parasite attains maturity or passes its sexual stage.

Disease- is disorder of body function

Endemic disease- the constant presence of a disease or infectious agent with in a given geographic area or population group.

Environment- all that which is external to the individual human host and can be divided into physical, biological, social, cultural etc., any or all of which can influence health status of population.

Host- a person or other living animal including birds and arthropods that affords subsistence or lodgment to an infectious agent under natural condition

Illness- is a subjective state of the person who feels aware of not being well.

Infectious disease- is an illness due to a specific infectious agent or its toxic products that arises through transmission of the agent or its products from an infected person, animals, or reservoir to a susceptible host either directly or indirectly through an intermediate plant or animal, host, or inanimate environment.

Infestation is the state of being invaded or over grown by parasite

Intangible cost-usually the cost of pain, grief, and suffering and loss of leisure time

Intermediate host (secondary host)- are those hosts in which the parasite passes its larval or asexual stage

Morbidity- any departure, subjective or objective from a state of physiological or psychological well being, and can be measured person who were ill; the illness that the person experienced; the duration of the illness

Mortality rate- a rate expressing the proportion of a population who die of a disease, or of all cases.

Pathogen- organisms capable of causing disease

Sickness- is a state of social dysfunction

Symptom of an illness is an indication of a disease especially experienced by the patient.

Vector – insect or any living carrier that transports an infectious agent from an infected individual or its wastes to a susceptible individual or its food or immediate surroundings. The organisms may not pass through a developmental cycle with in the vector.

Water related vector borne disease is those diseases transmitted by water related disease transmitting agents, also called vectors or intermediate hosts.

Appendix 8: Questionnaire (English version)

Questionnaire

1. Date of the interview (date/month/year)..
2. Name of the enumerator... signature.....................
3. Reason for non-interviewing (in case)...
4. Period of time spent in interviewing...
5. Date of check up...

6. Authorized person permitted...

7. Name of supervisor.. Signature ....

Area identification

1. Region............................
2. Zone........................
3. Woreda.....................
4. Campus/ kebele................

Part one: House hold characteristics

1. Name of the respondent..
2. Sex of the respondent (put X mark): male ☐ Female ☐
3. Address of the respondent..
4. Are you the household's head? (Put X mark) Yes ☐ No ☐
5. If yes, move to question 8 and 9

6. If no, who is the head of the household...................
7. What is the relation to the head of the household? (Put X mark)

1. Wife ☐	4. Sister ☐
2. Son ☐	5. Brother ☐
3. Daughter ☐	6. Others (specify) ....

8. Age of the head's of the household...

9.Occupation of the household (put X mark)

1. Farm laborer [ ]
2. Factory worker [ ]
3. Office worker [ ]
4. Local beer or tella maker [ ]
5. Others...

10. Educational level of the head's of the household (put X mark)

1. Illiterate [ ]
2. Read and write only [ ]
3. Elementary (1-6) [ ]
4. Junior (7-8) [ ]
5. Secondary (9-12) [ ]
6. Tertiary (>12) [ ]

11. Size of the household....................

12. Are you migrant in this area? Yes [ ] No [ ]

13. The wage of the head of the household /month...................................

14. Is there any source of non-wage income? (Put X mark):

Yes [ ] No [ ]

15. If yes, specify the type of the resource and the amount in Birr/ month

1. Assistance..
2. Farm activities..
3. Part time work...
4. Remittance...
5. Others (specify)...

16. Is there an irrigation scheme in your locality (Put X mark)

Yes [ ] No [ ]

Part two: Health Cost of illness

i) Malaria case

17. How do you identify malaria infection clinically from others acute febrile illness? (Put X mark)

1. Fever ☐
2. Sweating ☐
3. Shivering ☐
4. Poor appetite ☐
5. Sever headache ☐
6. Thirst ☐
7. Joint and back pain ☐
8. Nausea and vomiting ☐
9. Not known ☐

18. If so, is there any family member(s) who have developed such symptoms in the last 2 weeks time? (Put X mark)

Yes ☐ No ☐

19. If yes, go to **part three (i)**
20. If No move to **part two (ii)**

21. Have you taken any preventive actions on malaria to reduce the risk of malaria illness (Put X mark) Yes No ☐ ☐

22. If yes, what actions have you taken to prevent malaria illness (fill in the table below)?

Defensive strategies	Frequency	Quantity	Unit price	Total cost

23. If No, reason out...

24. What is the amount of money you expend in one

25. What actions have been taken by the government or non-government body in the area to prevent malaria? ....

Part two:

<u>ii) Schistosoma case</u>

26. How do you identify schistosomiasis illness (intestinal and / or urinary) clinically from others gastro intestinal problems? (Put X mark)

1. Diarrhea with / without blood and mucous ☐ 5. Ascities ☐

2. Abdominal cramp ☐ 6. Disurea ☐

3. Tenusmus ☐ 7.Suprapubic pain ☐

4. Anorexia ☐ 8. Haematuria ☐

27. If so, is there any family member(s) who have developed schistosoma symptom in the last one-year period (Put X mark)

Yes ☐ No ☐

28. If yes, go to <u>part three (ii)</u>

29. Does your family have any contact of irrigation for bathing or laundry purpose either brought at home or in its canal (Put mark)

Yes ☐ No ☐

30. If yes, why you do that..

31. Do you know the mode of transmission of schistosomiasis (Put X mark)

Yes ☐ No ☐

32. Do you know the prevention methods of schistosomiasis (Put X mark)

Yes ☐ No ☐

33. If yes, which method(s) you apply (fill in the table below)

Defensive strategies	Frequency	Quantity	Unit price	Total cost

34. How did you compensate the lost working days due to schistosomiasis illness (Put X mark)

1. Hired off laborers ☐
2. Covered by sick leave only ☐
3. Covered by other family members, friends, relatives ☐
4. Not covered ☐

36. Which prevention methods you are provided with (underline)

(Health education, provision of tape water, providing protective attire, other)

Part three:

i) Malaria Morbidity record Sheet

1. Would you specify the number of your family affected by malaria......................

2.Name...Sex(M/F)Age.........

Religion...

3. Major/ role /Duties in the household

(House wife, house maid, student, head of the household, dependent)

4. Days of morbidity...................................

7. What was the prognosis after getting treatment (put X mark)

1. Good ☐
2. Fair ☐
3. No improvement ☐

8. If not, what actions have you taken..

9.Howmuch money you expend from your pocket to get treatment from malaria illness ?

-------------------------.

10. If the affected members have a job, what are his/her wage levels in birr ....

11. Lost school days due to malaria illness................................

12. How did you compensate the lost working days due to malaria (put X mark)

1. Hired off laborers ☐
2. Covered by sick leave only ☐
3. Covered by other family members, friends, relatives ☐
4.Not covered ☐

14 Members of household lost working days to take care of the sick household members

....

15. What would be the income of the care provider/ month................

Part Three:

ii) Schistosomiasis Morbidity record sheet

1. Would you specify the number of your family affected by malaria.......................
2. Name... Sex......... (M/F) Age.........

Religion...

3. Major/ role /Duties in the household (underline)

(House wife, house maid, student, unemployed, children <5, head of the household)

4. Days of morbidity...................................

Part Three:

ii) Schistosomiasis Morbidity record sheet

1. Would you specify the number of your family affected by malaria........................
2. Name.. Sex.........(M/F)Age.........

   Religion...
3. Major/ role /Duties in the household (underline)

   (House wife, house maid, student, unemployed, children <5, head of the household)

4. Days of morbidity...................................

5. Have you taken the sick person to the health institutions (Put X mark)

   Yes [ ] No [ ]

6. If yes, how s/he was managed (put X mark)

   Clinically [ ] Definitive diagnosis [ ]

7. What was the prognosis after getting treatment (Put X mark)

   1. Good [ ]
   2. Fair [ ]
   3. No improvement [ ]

8. If no, what actions have you taken...

9. How much money you expend from your pocket to get treatment from malaria illness?

   -------------------------.

10. If the affected members have a job, what is his/her wage level/ month in birr...........

DECLARATION

I declare that this is my original wok has not been presented for a degree in any university and all the sources of materials used for the thesis are duly acknowledged

Name: YITAGES MENGISTU

Signature: ________

Date: 16/05-07

Place: Addis Ababa University, Addis Ababa

This thesis has been submitted with my approval as a thesis supervisor

Name supervisor: for / DR. J. Manohar RAO

Signature: ________

Date: May 16/2007.