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Identifying the Extent of Household Food Poverty Status in Tiro Afata and Dedo Districts of Jimma Zone, Oromia Regional National State, Ethiopia

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Abstract
This study predicts an empirical study aimed at investigating household food insecurity in the study area using household data. Data for the study was generated from a survey of the 150 randomly selected farm households in Dedo and Tiro Afata districts of Jimma administrative zone of Oromiya Regional State in Ethiopia from May up to October 2007 through critical observation, individual interviews and semi-structured questionnaires.

In the study of household socio-demographic structure, we incorporated twelve independent variables (namely age, education, family size, plots of land operated, livestock owned and number of oxen, total income and total expenditure, percept income, access to market and transportation) to distinguish whether these variables affect household food in security status or not only six of the twelve variables have significant relationship with household food security status. The binary logit model results make known that among twelve explanatory variables included in the model, six were found to be significant, and all exhibited the expected signs.. These significant variables, that affected food insecurity include: family size, number of plots operated, household income and expenditure, per capita income and distance to transport. The evidences suggest that the study area is highly food insecure and survival mechanisms are traditional. Along with food availability and entitlement, attitudinal variables also influence food insecurity.

To estimate the extent of food insecurity FGT index was used. Results of this study have shown that the incidence of inability to meet the minimum subsistence requirement food insecure without hunger, food insecure with moderate hunger, food insecure with severe hunger were found to be 16.7 percent, 28.7 percent and 26.4 percent , respectively. To substantiate its claim the thesis has tried to disclose a better substantial approach that food security production is directly related to the ability of land quality to support the population of the country. My final conclusion is that efforts should be made to improve different socioeconomic factors in general and demographic factors in particular to reduce rural poverty and enhance food security in study districts. The study findings suggest that Policy measures directed towards the provision of better family planning should be given adequate attention and priority by the Government in addition to improved access to education, new technology facility and agricultural extension services by rural households.

1. INTRODUCTION

Agriculture is the largest single source of livelihood and income (Ohlsson, 2000) of human enterprise that uses natural resources, land and water and other inputs (Pagiola & Holden, 2001). One of the major challenges facing humanity in this century is the need to increase food production to cope with the demand from an increasing population. Population growth is leading to increasing demands for food and hence claiming more and more land for food production. This process has thrown many developing countries into a poverty trap characterized by expansion of agriculture into marginal lands; land degradation and declining yields and loss of soil means that the expanding population in many parts of the world is pushing this resource to its frontier. Land degradation has been a problem ever since humans settled on the land and started to cultivate the soil and grazed domesticated animals. Periodically, land degradation has become so severe that it has contributed to the decline of civilizations. Land degradation, soil erosion, and nutrient depletion contribute significantly to low agricultural productivity and thus food insecurity and poverty in many areas of the developing world (Pagiola 1999; Shiferaw, Okello, and Reddy 2007; Nakonya et al. 2006). The integrated process of land degradation and increased poverty has been referred to as the "downward spiral of unsustainability" leading to the "poverty trap" of developing countries (Greenland et al., 1994). The existing reality is that this resource degradation not only threatens the present generation but also the future ones too.

Empirical studies by Novotny and Olem confirmed that the adverse effects of land degradation like loss of soil productivity, water quality degradation and less capacity to prevent natural disasters such as floods extremely affects production of food security (Novotny and Olem, 1994). Decreasing yields and vegetation cover and increasing erosion are the typical manifestations of mismanagement practices. As a result, the way land is instituted and distributed and ownership conflicts are resolved has a far-reaching consequence beyond the sphere of agricultural production (Deininger and Binswanger, 1999).

In sub Saharan Africa alone about 490 million hectares of agricultural land are affected by various forms of degradation. The rate of soil nutrient depletion in Sub-Saharan African countries is among the highest (Stoorvogel and Smaling, 1990), and soil erosion is a serious problem, especially in highland areas (Bagoora, 1988). For most major Farmers in Sub-Saharan Africa crop yields have been stagnant or declining since the early 1990's typically less than one-third of potential yields found in research stations (Sserunkuuma et al., 2001). Bumb and Baanante, (1996) reported that, in many countries of SSA region, soil nutrients are being removed at rates 3 to 4 times those of nutrient replenishment, while Lal (1995) estimates that soil erosion has reduced crop yields by about 6 percent. Up to now, most of the past policy interventions in the agricultural sector in sub-Saharan African countries have not yielded expected results and food insecurity is still a major problem (Lutz and Scherbov, 1999).

The dismal condition of the majority of the rural poor people in SSA countries shows that environmental degradation and food insecurity viciously challenge the farmers' ability and willingness to control degradation which in turn exacerbate land degradation, decline in agricultural productivity and food insecurity (WCED, 1987, 1993; Dasgupta, 1992; Barbier, 1999).

The Democratic Republic of Ethiopia is a land-locked nation located in the Horn of Africa with total land area of 1.104,300 km^2, of which 7,444 square km is covered by water and with over 79.2 million people (estimate of CSA, 2008). Population is growing at a rate of about 3% per year. Life expectancy on average has fallen to 43 years and infant mortality is 110 per 1,000 live births (CSA, 2007) and its per capita gross domestic product (GDP) income is estimated to be about $100-120 USD. By many accounts, Ethiopia is one of the poorest countries in Sub-Saharan Africa, which is broad, deep and structural and the proportion of the population below the poverty line is 44 per cent in 1999/2000 (MoFED, 2002).

Agriculture sector in Ethiopia is the dominant source of subsistence for the majority of the population. It accounts for more than 52% of GDP (World Bank, 2002), 90 percent of total exports, and provides employment for about 83.3 per cent of the total population (Abrar et al., 2004; FAO, 2004; CSA, 2007). It is dominantly undertaken by farm households that are characterized by use of only family labor, low productivity and low income for sustenance of their family livelihood. Rapidly growing population, environmental degradation and low agricultural production and productivity are the country's major problems .That is why, Ethiopia is among the poorest and most food insecure countries of the world where 44% of its population live below the national poverty line (World Bank, 2005) and 46% of its population get below the minimum levels of dietary energy consumption compared with other sub-Saharan and developing countries (World Bank, 2005).

Soil erosion by water and its associated effects are recognized to be severe threats to the national economy of Ethiopia (Hurni, 1993; Tamene, 2005). Since more than 85% of the country's population depends on agriculture for living, physical soil and nutrient losses lead to food insecurity. Hurni (1990, 1993) estimates that soil loss due to erosion in Ethiopia amounts to 1493 million tons per year, the same estimated soil loss of about 42 tons/ ha/y to have come from cultivated fields. This is far greater than the tolerable soil loss as well as the annual rate of soil formation in the country. According to an estimate by FAO (1986), some 50% of the highlands of Ethiopia are already significantly eroded and erosion causes a decline in land productivity at the rate of 2.2% per year.

Over 90 percent of the crop output is produced by the peasant sector, which is characterized by a low-level of technology and largely rainfed with a marketed surplus of less than 20% (ibid, 2004). Income from own-production accounts for about 73% of the total household income in rural areas (MOFED, 2002). Low agricultural production leads to low income and the lowest calorie intake of less than 1,845 Kcal per person per day (Aseffa, 2002). Most of the total national agricultural produce is generated by subsistence-oriented farmers, who are cultivating micro-holdings with impoverished soils on sloping and marginal lands. These smallholders constitute the poorest and largest segment of the population whose livelihoods directly depend on the exploitation of natural resources. They operate with obsolete agricultural technologies and with livestock playing the key role in the production process. The basic nature of the agricultural production is thus exploitative without sufficient use of ameliorative inputs which is undermining the sustainability of the life support systems.

Land degradation in the form of soil water erosion and declining soil quality is a serious challenge to agricultural productivity and economic growth (Mulugeta et al., 2005). In addition to this problem, tillage in Ethiopia is carried out with a breaking arid plough, the structure of which has remained unchanged for several thousands of years (Nyssen et al., 2000). Soil erosion due to high tillage frequency and other soil management problems has seriously affected over 25 percent of the Ethiopian highlands (Kruger et al., 1996).

Land degradation is one of the basic problems impacting the sustainability of agricultural productivity in Ethiopia (Gebremedhin and Swinton, 2003). Soil erosion is a phenomenon, which mainly occurs in the highlands of Ethiopia, which in turn constitute about 45% of the total area of the country. The high lands of Ethiopia support more than 80% of the population and account for over 95% of the regularly cultivated land and about 75% of the livestock population (Shiferaw and Holden, 1998; Miliyoon and Belay, 2004).

Various soil and water conservation measures henceforth have been developed to prevent land degradation and to improve the quality of the natural resource base in Ethiopia (Shiferaw and Holden, 2001).Nevertheless, still the problem of land degradation continues to be the most severe issue of improving the quality of natural resources. One of the major land-related problems in Ethiopia is insecurity of land tenure. Tenure insecurity, coupled with the subsistence nature of farming, has discouraged long-term investment and exacerbated the problem of land degradation (Alemu, 2005, Berhanu G. & Berhanu N, 2005, and Samuel, 2005, Alemayehu, et al., 2001).

According to Thomas, (1991) there are fundamental natural, political, and socio-economic factors responsible for the degradation of land resources, including soil degradation and these relate to the critical issue of food insecurity and poverty. The major causes for the slow growth rates of agriculture include various factors such as unfavorable climatic conditions, undeveloped infrastructures, inappropriate agricultural policies and predominantly traditional production systems (Mohamed, 1995). There is an increasing awareness that soil nutrient depletion from the agro ecosystem is a widespread problem and that it is an immediate crop production constraint in Ethiopia (Stoorvogel et al., 1993; Bojo and Cassels, 1995; Eyasu, 2002).

Although some economic studies on Ethiopia agriculture attempt to address issues of land sustainability (Folmer, 2000), inadequate attention has been paid to interaction between agricultural productivity and land degradation. Some studies on Ethiopia (Wiig et al., 2001), come close to this line of thinking by modeling the interactions between other macroeconomic variables such as exchange rates, tax rates and land nutrient balances. Nevertheless, these studies remain silent on how land degradation and perpetual food insecurity can be reduced.

The government of Ethiopia has embarked on an economic development strategy known as Agricultural Development-Led Industrialization (ADLI), which places greater emphasis on agricultural economic development focusing on conservation of natural resources and popular participation (MOFED, 2002).

So various Ethiopian government documents (MOFED, 2002) and (MOA, 2002)) repeated that agriculture is the driving force of economic development and the key sector for reducing poverty and ensuring food security and some progress has been made over the past few decades, Nevertheless, still the problem of land degradation and food insecurity continues to be the most crucial and overwhelming issue of concern in Ethiopia.

In the study areas one of the most serious environmental threats is land degradation which contributes to declining agricultural productivity, poverty and food insecurity. This research is, therefore, concerned with the study of the impacts of land degradation in the form of soil loss on food production in the area. The farm households in the study area face erratic rainfall, high evapo-transpiration, and experience crop failure due to water shortage. The continuous decline in the farm size is another dimension of the problem that aggravates pre-existing poverty and contributes to the decline in the economic capital of farm households. The major limitation of this area is the exposure of the land to heavy soil erosion due to extensive cultivation and chronically food insecure. Due to the limited research studies at farm household field plot level, the accuracies and scales of the available aggregate soil degradation statistics in the study area in particular and Ethiopia in general have been questioned (Eyasu, 2002 as sited Wagayehu, 2003).

This study was to estimate the amount of soil loss and understand the extent to which agricultural production is affected by soil losses and hence its influence on food security. Farmers' responses to land degradation in the form of soil loss are influenced by different socioeconomic, biophysical, demographic, and institutional factors. Therefore the study also aims at analyzing the behavior towards combating land degradation

The links between agricultural growth, food security and sustainable land management is very complex and a subject of much controversy. Therefore this study will help in the understanding of this relationship and the influence of various factors including demographic, economic, institutional, and policy on these relationships. This information is useful to plan appropriate technology, institutions and policies interventions that reduce or even solve the problems in the study areas and other similar areas.

This study is therefore useful to fill intervention gaps in the study of the inter-relationship between soil loss and food insecurity in study districts in particular and in Ethiopia in general by examining the impact of land degradation in the form of soil loss variables on food production using household-specific survey data.

Food is the basic necessities of life and access to it is human right as affirmed by article 25 of the Universal declaration foe Human Rights (1948-1998), that 'Every one has the right to a standard living adequate for the health and well- being of himself and his family, including food'. However, over 840 million people in the world and 175 million people in Africa suffer from shortage of food and absence of reliable access to food every year. The term food security employed here to express this issue, which is commonly defined as access by all people to adequate food at all times of the year for healthy and adequate life (World Bank, 1986). On the contrary food insecurity is an inadequate access to food.

The purpose of this study was to assess and examine the household food security situational status of farm households in selected districts of Tiro Afata and Dedo, Jjimma Zone in Ethiopia. Food security and insecurity are terms used to describe whether or not people have access to sufficient quality and quantity of food. They are affected by factors such as poverty, health, food production, political stability, infrastructure, access to markets, and natural hazards

From Genesis of Human being, Agriculture is the most important activity to acquire a fundamental element food for human existence in the world. Agriculture originally evolved from the need of communities to feed themselves in a given environment. This is essentially still the case in many rural areas where subsistence agriculture remains the core of the household economy. Agricultural productivity plays an increasingly important role in improving food supplies and food security. Food consumption is therefore the driving force as well as the outcome of rural farm household livelihood systems and social and economic development. One of the most important questions facing most of societies today is, how to produce enough food to feed the increasing human population on this planet (Kanwar, 2003), which is discussed as the main goal of development (Seers, 1982).

In the world food insecurity is largely a problem of the poor people and poor areas, which do not have enough resources that can ensure dependable access to required quantity and quality of food through production or exchange (Wisner, 1988).In the preceding epoch most hunger studies have traditionally explained food insecurity in terms of constraints on food production, and the misbalance between the growths in food production relative to population growth.For instance, Two hundred years ago, Thomas Malthus argued that population growth would inevitably outpace food production (Malthus, 1982). But according to the optimists' view the technological developments can boost food production enough to keep up with population growth for decades to come (Boserup, 1965). The common denominator for both pessimists and optimists' view is that they believe food shortage can be explained, and alleviated, in terms of food supply per capita based on food availability approach. With these two theories uneven against each other it is only natural to wonder whether they are mutually exclusive or if they show a different side of the same story. This is because they fail to fully incorporate the intermediate linkages both to and from the changing structure of land holding Lee (1986). Findings of many achievements concluded that there is positive relationship between population growths, increased density and intensity of agriculture but some in the contrary found that population growth has not led to agriculture growth (Kates et al 1993).

The food availability is assessed by comparing the amount of food available in an area to the minimum amount necessary to feed all of its populace in a nation. In the contrary, in the early 1980s a new perspective on food insecurity approach emerged suggesting that food production and supply in comparison to population is not only determining approach, but also should exist entitlement approach (Sen., 1981). Therefore, the availability approach, with its focus on the level of per capita food supply in the pessimists and optimists view largely ignored the important issues of the entitlement approach

2. MATERIALS AND METHODS

2.1. Study Area Description

The study is based on a survey conducted during May and October 2007 in Dedo and Tiro Afata the districts in Oromiya Rgional state Jimma Administrative Zone located in the southwestern part of Ethiopia. Dedo and Tiro Afata districts are located about 360 and 320 km, respectively, to the southeast of the capital, Addis Ababa (Finfinne). The districts were purposely selected because of the observed levels of land degradation and household food insecurity and of farmers' exposures to soil and water conservation measures that are likely to raise their awareness of the problems. The annually cultivated plots in the areas of in Tiro Afata district lies between 1340 and 2800 and Dedo district lies between 880 and 2400 meters above sea level sequentially. The mean annual rainfall ranges between 1200 and 2800 mm with a mean temperature of 20°C - 25°C. Accordingly, the annual average temperature in the high lands is 14°C - 20°C whereas it is 20°C - 25°C in the lowlands. In both districts, the most widely cultivated subsistence crops are especially maize, sorghum, teff, barley, horse bean, field pea and wheat. Some production of vegetable crops is observed in these areas. Hillside farming in these districts is especially intensive. Both districts suffer severe soil erosion problems due to the agro-climatic conditions on one hand, and the lack of soil protection on the other. Coupled with a short fallow period of one to two years, the degradation of the soil causes the decline of the fertility level, and consequently reduces crop yields.

2.1. Model Used for Identifying household food security status in the study area

To analyze the association between land degradation and food security status in rural households, a working model is being developed to study food insecurity which is synonymous to food poverty as being the real root cause for environmental and land degradation in the form of soil loss and vulnerability to food insecurity. Analyses of this objective involve by defining poverty. Poverty exists when persons fall short of reasonably defined minimum levels of wellbeing such as access to certain consumption or income levels, housing, health and education facilities and certain rights recognized according to standards of human needs and socio-economic conditions of the society. In more detail, poverty barrier to prosperity and is characterized by a lack of resources and opportunities, feelings of being disenfranchised from various support systems (i.e. food, clothes and shelter, educational, economic, cultural, and social), and diminished feelings of empowerment to obtain these resources and opportunities. An accepted poverty line is the second condition next to the derivation of real household per capita income of expenditures required to estimate poverty and welfare indicators.

Therefore the poverty line may be defined as the minimum level required by the poor to escape the situation. An accepted poverty line is the second condition next to the derivation of real household per capita income of expenditures required to estimate poverty and welfare indicators. A poverty line is ideally a level of income or expenditures required to satisfy a minimum level of consumption of goods and services that is though an individual should be able to purchase to be considered to be not in poverty. A poverty line is country specific and this level of income or expenditure varies from one country to another. Irrespective of countries however household disregard or individuals with per capita income falling below this line are considered poor. Households with per capita income above this line are considered non poor. Synonymously, a poverty line is an income level which separates poor from non-poor.

Ravallion (1993) defines an absolute poverty line as "one which is fixed in terms of living standards, and fixed over the entire domain of the poverty comparison," while a "relative poverty line, by contrast, varies over that domain, and is higher the higher average standard of living." Strictly speaking many of the studies using absolute definitions of poverty are based on per capita expenditure levels and use income levels only as a substitute on data availability grounds. The poverty literature has focused on two approaches to analyze the poverty growth links. The first approach uses a relative concept of poverty by which the poor are assumed to be a pre-specified proportion of the population – usually the lowest quintile of the population and analyzes how the income levels of this group evolve in time. Examples of this approach include Dollar and Kraay (2002) and Timmer (1997). The second approach uses an absolute definition of poverty where the poor are defined as those with income levels below a pre-specified threshold. This threshold may be common for all countries under analysis (for example PPP adjusted US$1 per person per day) or be country specific (for example when the threshold is based on the purchase cost of subsistence package which by definition is country specific). Examples of this approach are Ravallion (2000) and Bruno et al. (1998). Absolute poverty lines are anchored in some absolute standard of what households should be able to count on in order to meet their basic needs for monetary measures. These absolute poverty lines are often based on estimates of the cost of basic food needs, that is, the cost of a nutritional basket considered minimal for the health of a typical family, to which a provision is added for non food needs. The determination of food poverty generally proceeds by asking what amount of food expenditures is required to achieve some minimal required level of food-energy intake (or nutrient intake, such as proteins, vitamins, fats, minerals.

The food poverty line indicates the per capita cost of purchasing a specific basket of food items, the composition of which has been determined to be consistent with observed consumption patterns and which yields a certain nutritional minimum and the most popular method for estimating the non-food component of the basic needs poverty line is simply to go straight to an estimate of the basic needs poverty line by dividing the food poverty line by the share of food in total expenditures.

The FGT poverty index an (index proposed by Foster, Greer and Thorbecke) is employed to examine the extent and severity of rural poverty. The cost and income and consumption expenditure method proposed by Foster, Greer and Thorbeck (1984) are used in this study to determine whether the household is at food secure or food insecure status. The modified version of the Foster-Greer-Thorbeck class of poverty measures were used for the analyses of depth of food insecurity in the study samples.

The distribution sensitive poverty measure was proposed by Watts (1968) and takes the form: Following Atkinson (1987), one can characterize a general class of additive measures, encompassing W, the FGT class of measures, and some other measures as taking the following form: where $p(z, y_i)$ is the individual poverty measure, taking the value zero for the non-poor (yi>z) and some positive number for the poor, the value of which is a function of both the poverty line and the individual living standard, non-decreasing in the former and non-increasing in the latter so as to reflect inequality amongst the poor (Foster et al., 1984).

Consistency calculations are usually based on representative sample data of income or consumption expenditure approach and related to a poverty line. This in turn is established with reference to minimum consumption (in the case of absolute poverty). Defining minimum consumption is not easy, however: food is the usual numeraire, but required intake varies with age, gender, activity level, and environmental conditions. Additional problems arise in setting an international poverty line, like the current convention of using $US1 per day. Being a primary data based study data on different variables affecting the livelihood of rural households was collected from the respondents of rural farm households. Much of the literature on the development of poverty indices has focused on whether indices are decomposable across population subgroups. This has led to the identification of a subgroup of poverty indices known as the class of decomposable poverty indices. These indices have the property of being expressible as a weighted sum (more generally, as a separable function) of the same poverty indices assessed across population subgroups.

Most commonly they include the Foster, Greer, and Thorbecke (FGT) (1984) poverty indices, and the Watts (1968) index.

$$p^{\alpha}\left(Y_i Z\right) = \frac{1}{N}\sum_{i-1}^{q}\left[\frac{POVERTLINE - Income_i}{POVERTLINE}\right]^{\alpha}$$

Where, N= is the total sampled population; q=number of people below the poverty line; When α =0, p0 =Head-count Index (the number of poor), gives the head count ratio or the percentage of people below the poverty line; When α =1, P1= Poverty Gap gives the depth of poverty or the short fall from the poverty line; When α =2, P2 = Squared Poverty Gap ("poverty severity") index depth of poverty which gives greater weight for the more destitute subjects. The measures of poverty depth and poverty severity provide complementary information on the incidence of poverty. The Head Count Index measures how widespread poverty is, the Poverty Gap Index measures how poor the poor are, and the Squared Poverty Gap Index measures the severity of poverty by giving more weight to the poorest of the poor. With the increased awareness and availability of data, various measures of poverty have been developed overtime, among which the Foster, Greer and Thorbecke (1984), class of poverty index is the most commonly applied. Given a vector of suitable measure of well-being, Y, in increasing order, Y1, Y2, Y3,...,Yn, where n represents the number of households under consideration, the FGT poverty index (Pα) can be expressed as :We aggregate poor households into a National poverty statistic along the lines of the axiomatic approaches suggested by Sen (1976); Forster Greer and Thorbecke (FGT) (1984).

However, for ease of operationalisation and interpretation, the FGT measure has been used in capturing the number of the poor and the depth and severity of poverty.

Then the FGT measure is

$$p^{\alpha}\left(Y_i Z\right) = \frac{1}{N}\sum_{i-1}^{q}\left[\frac{Z - Y_i}{Z}\right]^{\alpha}$$

Where, N = is the total sampled population; q = the number of poor persons below the poverty line; Z =is the poverty line and Yi = income or expenditure of the i^{th} individual. α = is a parameter that measures the depth of poverty. As α varies, Pα also changes to give an indication of the depth of poverty. The parameter α represents the weight attached to a gain by the poorest. The commonly used values of α are 0, 1, and 2. When we set α equal to 0, then the equation is reduced to the headcount ratio which measures the incidence of poverty. When we set α equal to 1, we obtain P1 or the poverty deficit. P1 takes into account how far the poor, on average, are below the poverty line. Setting α equal to 2 gives the severity of poverty or p2 index. This poverty index gives greater emphasis to the poorest of the poor, as it is more sensitive to redistribution among the poor.

For each α ≥ 0, if α = 0, then p0 is simply the headcount ratio (also called incidence of poverty), while with α = 1, p1 is a re-normalization of the income-gap measure (also called poverty gap). Finally the sensitive measure p2 is obtained by setting α = 2 (called severity of poverty). For all α > 0, the measure is strictly decreasing in the living standard of the poor (the lower your standard of living, the poorer you are deemed to be). Furthermore, for α > 1 it also has the property that the increase in measured poverty due to a fall in one's standard of living will be deemed greater the poorer one is. The measure is then said to be "strictly convex" in incomes (and "weakly convex" for α = 1). The cost-and income and consumption expenditure approach method proposed by Foster, Greer and Thorbecke (1984) are used in this study to determine the food secure or food insecure status. It is one of the Foster-Greer-Thorbecke (FGT) classes of poverty measures that may be written as:

i) The headcount index (P0)

The headcount index answers the question how many poor are there? The headcount is the simplest and best known poverty measure. It identifies the share of a population whose income is less than the poverty line. The basic measure of poverty is the size of the poor population which fall underneath the poverty line and the same is reported as incidence of poverty by Poverty Headcount Index (HCI or P0) as a percentage of total population. The simple headcount index is the most used poverty measure, but it violates several important axioms. The HCI can mislead when it is used to compare sub domains as the size of the total population. Also depths of the poverty are dissimilar in different domains. The measure literally counts heads, allowing policymakers and researchers to track the most immediate dimension of the human scale of poverty.

The headcount is calculated by comparing the income Yi of each household to the poverty line Z. (The index i = 1…M, where M is the total number of households in the sample.) Concretely, an indicator variable is constructed for each household, taking the value 1 when income falls below the poverty line or 0 if income is greater:

I(Y, Z) = 1 if Yi ≤ Z

I(Y, Z) = 0 if Yi > Z

The headcount index is simply the sample average of the variable I (Y, Z), weighted by the number of people in each household Ni. It is measured by the formulae given below, FGT (1984). When q = 0, the resulting measure is the headcount index which provides an estimate of the proportion of the population living in poverty. The Head Count Index (HCI) is the proportion of the population whose economic well-being (y) is less than the poverty line (Z). If q people are deemed to be poor in a population of size n then HCI = q/n. For computing the head Count Index, estimates of individual economic wellbeing and the poverty line are required.

$$P^0 = \frac{1}{N}\sum_{i=1}^{q}\left[\frac{Z-Y_i}{Z}\right]^0$$

Where,
p0 =Head-count Index (the number of poor); N= is the total sampled population; q =the number of poor persons; Z= Poverty line; Yi= is income of the ith household and 0 = Power of the function.
When α = 0, then,

$$p^0 = \frac{q}{N} = HCI$$

The greatest virtues of the headcount index are that it is simple to construct and easy to understand. These are important qualities. However, the measure has at least three weaknesses. First, the headcount index does not take the intensity of poverty into account. Second, the head-count index does not indicate how poor the poor are, and, hence, does not change if people below the poverty line become poorer. Moreover, the easiest way to reduce the headcount index is to target benefits to people just below the poverty line because they are the ones who are cheapest to move across the line. By most normative standards, people just below the poverty line are the least deserving of the poor. Third, the poverty estimates should be calculated for individuals and not households, so in order to measure poverty at the individual level we must make a critical assumption that all members of a given household enjoy the same level of well-being. This assumption may not hold in all situations. For example, some elderly members, or female members of a household may be much poorer than other members of the same household. In reality, not all consumption is evenly shared across household members. The headcount measure is an important descriptive tool. As a sole guide to allocating resources, though, the headcount can significantly mislead. There are two large tensions. First, the headcount registers no change when a very poor person does not become less poor, nor does it change when a poor person becomes even poorer. Most observers, though, following Watts (1968) and Sen (1976), argue that changes in the income distribution below the poverty line are morally important. Although this notion is captured by the transfer axiom above, but the headcount fails the test.

ii) Poverty gap index (P1)

The Poverty gap index (P1) answers the question how poor the poor are? It is needed to use Poverty gap. The poverty gap is defined as the requirement of money (shortfall) by a poor to come out of the poverty or gap between the total consumption value of a poor and the value of the poverty line. The Poverty Gap Index (PGI or P1) is a standard measure of the depth of the poverty that averages the ratios of shortfalls to the value of poverty line over both poor and non-poor assuming zero shortfalls for non-poor and presents as a percentage. The measure of shortfall quantifies the poverty gap in terms of money required to escape the poverty.

It therefore provides more information than headcount to poverty alleviation policy makers and assistance to precise allocation of resources.

The poverty gap measure is conceptually defined as the extent to which incomes of the poor fall below the poverty line. It is the amount of money necessary to raise the incomes of all the poor up to the poverty line. The poverty gap is the mean shortfall of the total population from the poverty line (counting the non- poor as having zero shortfall), expressed as a percentage of the poverty line. This measure reflects the depth of poverty as well as its incidence. The poverty gap measures the extent to which incomes of the poor fall below the poverty line; it is the amount of money necessary to raise the incomes of all the poor up to the poverty line. Poverty gap index mean distance below line proportion taken over whole population counting zero shortfall.

The Poverty Gap Index is the average over all people of the gaps between poor people's standard of living and the poverty line expressed as a ratio to the poverty line. The poverty gap index (P1) measures the extent to which individuals fall below the poverty line (the poverty gaps) as a proportion of the poverty line. The sum of these poverty gaps gives the minimum cost of eliminating poverty if transfers were perfectly targeted. The measure does not reflect changes in inequality among the poor. When q = 1, the FGT index results in the poverty-gap index which provides a measure of the depth of poverty. It shows how far or near the poor are from the poverty line in terms of income or expenditure. It can be measured by the formula given below.

$$P^1 = \frac{1}{N}\sum_{i=1}^{q}\left[\frac{Z-Y_i}{Z}\right]^1$$

Where, P1 = Poverty Gap; N = is the total sampled population; q = the number of poor persons; Z = Poverty

line; Yi = is income of the i^{th} household and 1 = Power of the function.
However, with α = 1,

$P^1 =$ **HI=H {(Z-Y)/Z} = q/n {(Z-Y)/Z}**

Where,
Y = mean income (consumption) of the poor and I = (Z – Y)/Z is the average shortfall of income from the poverty line or the "income gap ratio." From the expression in equation _P1 = q/n {(Z - Y)/Z}, we obtain _nZP1= q (Z - Y) nZP1 provides an estimate of the total amount of resources needed to eliminate poverty. P1 takes into account the number of individuals who are poor and the depth of their poverty. A moderately popular measure of poverty is the poverty gap index, which adds up the extent to which individuals on average fall below the poverty line and expresses it as a percentage of the poverty line. More specifically it defines the poverty gap (P1) as the poverty line (Z) less actual income (Yi) for poor individuals. It therefore gives a lower bound to the budgetary outlays needed to eliminate poverty.

iii) The squared poverty gap ("poverty severity") index (P2)

The squared poverty gap answers the question How deprived the poor are? Presence of high inequality in possession of resources and access to basic consumption needs among people or social segments is attributed to an unjust society that leads to several social conflicts. To this view, the Squared Poverty Gap Index (SPGI or P2) is the measure for severity of poverty by means of the inequality among poor. The SPGI is the self weighted (squared) average of poverty gaps taken as proportions of the value of poverty line of both poor and non-poor assuming zero poverty gaps for the non-poor. The squared poverty gap index is simply a weighted sum of poverty gaps (as a proportion of the poverty line), where the weights are the proportionate poverty gaps themselves. The FGT measure is conceptually defined as related to the poverty gap, but in the calculation it weights more heavily the poverty gaps of the very poor than of the mildly poor. Unlike the head-count and poverty-gap indexes, the absolute value of the poverty severity index has no intuitive interpretation and is not easy to interpret. For poverty comparisons, however, the key point is that a ranking of dates, places or policies in terms of Squared Poverty Gap (P2) should reflect their ranking in terms of the severity of poverty. The squared poverty gap ("poverty severity") index (P2) averages the squares of the poverty gaps relative to the poverty line. The squared poverty gap index, which is sensitive to the extent of inequality among the poor, results when n=2. It indicates the severity of poverty among poor. It measures inequality amongst the poor. It is measured by the formula given below.

$$P^2 = \frac{1}{N}\sum_{i=1}^{q}\left[\frac{Z - Y_i}{Z}\right]^2$$

Where, P2 =Squared Poverty Gap ("poverty severity") index; N = is the total sampled population; Z= Poverty line; Yi = is income of the i^{th} household and 2 = Power of the function.
P2 can be thought of as a sum: an amount due to the poverty gap, and an amount due to inequality amongst the poor (Ravallion; 1992).

P2 = PG2 /H + (H-PG)2 /H.CV2 p

Where,
PG2 /H = contribution of the poverty gap
(H-PG)2/ H.CV2 p = contribution of inequality amongst the poor.
CV2p = the squared coefficient of variation of income among the poor.
α = 2, provides a measure of the severity of poverty. Put in other words, higher values of α would give more weight to the extreme poor than to those groups closer to the poverty line Z.

The decision whether or not to use anew technology could be considered under the general frame work of utility or profit maximization (Norris and Batie, 1987; Pryanishnikova and Katarina, 2003). Subsistence farmers use a technology only when the perceived utility or net benefit from using b a technology is significantly greater than would be the case without the technology. While utility is not directly observed the actors of economic agents are observed through the choice they make. Suppose that Yj and Yk represent a household's utility for two choices, which could be denoted by and Uk respectively. Following Greene, (2000) and Pryanishnikova and K atarina, (2003). The linear random utility model could be specified as:

Uj = ß'i Xi +εi and UK = ß'i Xi +εk -- (1)

Where, Uj and UK are the perceived utility of technology j and k, respectively, Xi is a vector of explanatory variables that influences the perceived desirability of the technology, βj and βk are parameters to be estimated and+εj and +εk are error terms ,assumed to be independently and identically distributed .In case of soil fertility and soil conservation technologies ,if a household decides to use option j on the ith plot, it follows that the perceived utility or benefit from option j is greater than the utility from other options (say k) depicted as:

Uij(ß'i Xi +εi)> UiK (ß'i Xi +εk), k≠j --(2)

The probability that a household was adopted option j among the set of soil fertility and soil Conservation practice could then be defined as:

P(Y=1/X)=P(Uij >Uik)

=P(ß'j Xi+ε i - ß'k Xi --εk >0/X)

= P(ß'j Xi - ß'k Xi +-ε i -εk >0/X)

= P(ß*j Xi+ε*> 0/X = F (ß*Xi)

Where, p is a probability function, Uji, U ik and Xi as defined above, ε* =+-εj--εk is a random disturbance term ß* = (ßj*- ß'k) is a vector of unknown parameters which can be interpreted as the net influence of the vector of independent variables influencing adoption and F(ß'i Xi) is the cumulative distribution function of the random disturbance term follows, several qualitative choice models such as a linear probability model ,a logit or probit models could be estimated (Greene,2000) qualitative choice models are useful to estimate the probability that an individual with a given set of attribute will make one choice rather than an alternative (Greene, 2000)of the three functional relationships often specified, the linear probability model is computationally simpler and easier to interpret parameter estimates than the other two models. However, if specification creates estimation problems involving the application of ordinary least squares (OLS) such as heteroscendasticity error terms ,predicted values may fall outside the (0,1) interval ,and non normal distribution of the error term .Although, transformation could provide homoscedastic disturbance terms and then apply weighted least square procedures, there is no guarantee that the predicted values will lie in the (0,1) probability range. These difficulties with the linear probability model compelled econometricians to look alternative model specification (Greene, 2000)

4.1 Specification of Econometric Models used in the Study

The main data for this study were based on a sample of 150 households. The data were collected from two districts of Tiro Afata and Dedo between May and October 2007. Each district was then divided into agro-ecological zones and samples of three different farm types/sizes: large, medium and small chosen from each ecological zone. The sampling procedure was purposely designed to target at least four households from each agro-ecological zone, comprising at least one household from each farm type. In most of econometric literature for estimating binary choice models the linear probability (LPM), logit and probit are the possible alternative models and have been widely used for a binary response variable (Gujarati, 2003). The single-parameter Rasch model, which was used to create the food security scale, assumes specifically that the log of the odds of a household affirming an item is proportional to the difference between the severity level of the food insecure household and the severity level of the ite m. Thus, the probability that a household at severity level h will affirm an item at severity level is:

$$P_{(h-i)} = \frac{e^{(h-i)}}{1 + e^{(h-i)}} \text{ -- (2)}$$

Where e is the base of the natural logarithms, h is household severity level and i is item severity level (Rasch, 1966).The set of food security questions included in the core survey module were combined into a single overall measure called the food security scale. This continuous linear scale value was used to measure the degree of severity of food insecurity experienced by a household. A household that had not experienced any of the conditions of food insecurity covered by the core module questions was assigned a scale value of 0, while a household that had experienced all of them was assigned scale value close to 10.The probability model, which expresses the dichotomous dependent variable (Yi) as a linear function of the explanatory variables (Xi), is called linear probability model (LPM). LPM has some econometric problems like nonnormality of the disturbances (Ui), heteroscedastic variances of the disturbances, non-fulfillment of 0<E (Yi/Xi) <1 and lower value of R2, as a measure of goodness of fit. Therefore, linear probability model is not appropriate to test the statistical significance of estimated coefficients (Liao, 1994; Gujarati, 1995).The logit and probit models will guarantee that the estimated probabilities will lie between logical limit 0 and 1 (Pindyck and Runbinfeld, 1981). Because of this and other facilities, the logit and the probit models are the most frequently used models when the dependent variable happens to be dichotomous (Liao, 1994; Maddala, 1989; Gujarati, 1995).Ignoring the minor differences between logit and probit models, Liao (1994), Gujarati (1995), Pindyck and Runbinfeld (1981) pointed-out that the probit and logit models are quite similar, so they usually generate predicted probabilities that are almost identical. Aldrich and Nelson (1984) indicated that in practice these models yield estimated choice probabilities that differ by less than 0.02. Liao (1994) reported that the logit model has the advantage that these predicted probabilities could be arrived at easily. Logistic regression is useful for situations where the dependent variable has a binary output, e.g. the presence or absence of a characteristic or outcome. The method is useful to predict the probability that a case will be classified into one as opposed to the other of the two categories of the dependent variable. Several transformations are made to adequately deal with the binary structure of the dependent variable. The odds that Y = 1, written odds(Y=1), is the ratio of the probability that Y = 1 to the probability that Y ≠ 1. The odds that Y = 1 is equal to P(Y=1) / [1− P(Y=1)]. Unlike P(Y=1), the odds has no fixed maximum value, but like the probability, it has a minimum value of 0 (Menard 2001).One further transformation of the odds produces a variable that varies, in principle, from negative infinity to positive infinity. The natural logarithm of the odds, ln {P(Y=1) / [1 –P(Y=1)]}, is called the logit of Y. The logit of Y, written logit(Y), becomes negative and increasingly large in absolute value as the odds decrease from 1 towards 0, and becomes increasingly large in the positive direction as the odds increase from 1 to infinity. If the natural logarithm of the odds that Y = 1 is used as the dependent variable, there is no longer the problem that the estimated probability may exceed the maximum or minimum possible values for the probability. It is important to understand that the probability, the odds, and the logit are three different ways to express exactly the same thing. Of the three measures, the probability is probably the most easily understood. Mathematically, however, the logit form of the probability best helps us to analyze dichotomous dependent variables (Menard 2001).

He also indicated that when there are many observations at the extremes of the distribution, then the logit model is preferred over the probit model. Therefore, this study applied binary logit model to identify the determinants between food secure and insecure groups. As Hosmer and Lemeshew (1989) pointed out, a logistic distribution (logit) has advantages over the other in the analysis of dichotomous outcomes variable in that it is an extremely flexible and easily usable model from mathematical point of view and results in a meaningful interpretation. Following Gujarati (1995); Aldrich and Nelson (1984); Hosmer and Lemeshow (1989) the functional form of logit model is specified as follows:

$$\Pi(\chi) = \frac{1}{1 + e^{(\beta_0 + \beta_1 \chi_1)}} \quad \text{---} (3)$$

We can write the above equation as follow

$$\Pi(\chi) = \frac{1}{1 + e^{-Z}} \quad \text{---} (4)$$

Where, Π(X) = is the probability of being food secure Zi =ßo+ß1X1 + ß2X2 + ... + ßnXn

ßo = is an intercept; ß1, ß2 ... ßn = are slopes of the equation; Xi = n explanatory variables, in this particular study, it represents 16 independent variables.The probability that a given household is food secure is expressed by (4).Similarly, the probability for being food insecure is:

$$1 - \Pi(\chi) = \frac{1}{1 + e^{Z}} \quad \text{---} (5)$$

Therefore, we can write two equations together as

$$\frac{\Pi(\chi)}{1 - \Pi(\chi)} = \frac{1 + e^{Z}}{(1 + e^{Z})^2} = e^{Z} \quad \text{---} (6)$$

Then,

$\frac{\Pi(\chi)}{1 - \Pi(\chi)}$ is simply the odds ratio in favor of food security

Finally, taking the natural log of equation (6) we obtain

$$L_i = \frac{\ln(\Pi(\chi)}{1 - \Pi(\chi)} = Z_i \quad \text{---} (7)$$

If the disturbance term (Ui) is introduced, the logit model becomes

Zi = ßo + ß1 X1 + ß2 X2 + ...+ ßnXn + Ui--- (8)

Li = is log of the odds ratio, which is not only linear in Xi but also linear in the parameters.

4.1.1. Vectors of relevant explanatory variables

Sometimes response categories are ordered but do not form an interval scale. There is a clear ranking among the categories, but the difference among adjacent categories cannot be treated as the same. Responses like these with ordered categories cannot be easily modeled with classical regression. Ordinary linear regression is inappropriate because of the non interval mature of the dependent variable-the spacing of the outcome choices cannot be assumed to be uniform. Ordinal logit and probit models have been widely used for analyzing such data (Liao, 1994). Some polychotomous dependent variables are inherently ordered. Although the outcome is discrete, the multinomial logit or probit models would fail to account for the ordinal nature of the dependent variable (Green, 2000). The ordered probit and logit models have come into fairly wide use as a frame-work for analyzing such responses (Zavoina and MacElvey, 1975).Hence, this study applied ordered logit model. Following Green (2000) and Liao (1994) the functional form of ordered logit model is specified as follows

$$Y^* = \sum_{k=1}^{k} \beta_k \chi_k + \varepsilon \quad \text{--(9)}$$

Y* = is unobserved and thus can be thought of as the underlying tendency of an observed phenomenon.ε = we assume it follows a certain symmetric distribution with zero mean such as normal or logistic distribution. What we do observe is

Y = 1 if y* ≤ μ1 (=0)
Y = 2 if μ1 < Y *≤ μ2
Y= 3 if μ2 < Y* ≤ μ3
Y = j if μj-1< Y * -- (10)

Where, y is observed in j number of ordered categories, μs are unknown threshold parameters separating the adjacent categories to be estimated with βs.The general form for the probability that the observed y falls into category j and the μs and the βs are to be estimated with an ordinal logit model is

$$\Pr ob(Y = j) = 1 - L(\mu_{j-1} - (\sum_{k=1}^{k} \beta_k \chi_k) \quad \text{--- (11)}$$

Where L(•) represents cumulative logistic distribution.Marginal effects on the probabilities of each food security status were calculated by

$$\Pr ob(Y = j = (f(\mu_{j-1} - (\sum_{k=1}^{k} \beta_k \chi_k) - f(\mu_j - (\sum_{k=1}^{k} \beta_k \chi_k) \quad \text{---------------------------------- (12)}$$

Where f (•) represents the probability density function

4. EMPIRICAL RESULTS AND DISCUSSIONS OF THE STUDY

The result and discussion section of this objective elucidates the way to differentiate between the food secure and food insecure household groups based on their per capita food consumption expenditure. The food secure/insecurity poverty line is defined as cut point Levels of consumption poverty. The food poverty line used in Ethiopia is based on a basket providing 2200 kilocalorie per adult equivalent per day. After adjustment for non-food components, the total poverty line (both food and non-food) was estimated at Birr 1,075.00 in 1995/96.

Therefore, household where per capita expenditure fall below Birr 1,075.00 in 1995/96 annually were designated food insecure while households with a mean per capita food expenditure equivalent or greater than Birr 1,075.00 Ethiopian birr annually were food secure. Thus, taking Birr 1,075.00 as a standard of income expenditure of sampled respondents 108 (72%) households food insecure were found to be unable to meet their minimum subsistence requirements and 42 (28 %) households were food secure that is they were found to meet their minimum subsistence requirements. These empirical assessment results can serve as an instrument to guide decisions as to which status should be given more emphasis to reduce the problem.

Table 21. Food security status of sample households

Food security status description	Category	sampled households	Percent
Greater than 1000 Et. Birr	Food secure	43	28.0
Less than 1000 Et. Birr	Food insecure	107	72.0
Total		150	100.0

Source: Own computation of survey data

Accordingly, the households greater than Birr 1,075.00 showed no or minimal evidence of food insecurity. But those less than Birr 1,075.00 food insecurity was manifested in household members' concerns about adequacy of the household food supply and in adjustments to household food management, including reduced quality of food and increased unusual coping patterns. More over the prediction successes and likelihood ratio index were better for three groups than four groups. Based on the methodology described above the following alternative results were found: the information to categorize households into food secure and insecure groups was obtained by comparing the total household expenditure per AE per annum to the minimum level of expenses required to ensure survival per AE per annum. Accordingly, Birr 1000 is computed as the sum of all these and considered as the minimum subsistence expense (threshold) beyond which the household was food secure or not. Appendix III.Questionnaire, Considering Birr 1000 as a benchmark, 108 sample households (72.0 %) were found to be unable to meet the minimum subsistence requirement and only 42 households (28%) were found to meet their minimum subsistence requirement. Based on the Core Food Security Module analysis, households were found to be grouped into four categories; food secure (28%), food insecure without hunger (16.7 %), food insecure with moderate hunger (28.7 %) and food insecure with severe hunger (26.7%) (Table 22). The majority of the respondents were food insecure without hunger followed by food insecure with moderate hunger. The results of this empirical assessment results can serve as an instrument to guide decision as to which status should be given more emphasis to reduce the problem.

Table 22. Difference among Food security status of sample households

Food security status	Category	Percent (%)
Greater than 1000 Et. birr	Food secure	28.0
750-1000 Et. birr	Food insecure without hunger	16.7
500-750 Et. birr	Food insecure with moderate hunger	28.7
Less than 500 Et. birr	Food insecure with severe hunger	26.7

Source: Own computation of survey data

Food secure (greater than 1,075 Et. birr): households' showed no or minimal evidence of food insecurity. Food insecure without hunger (750-1,075 Et. birr): food insecurity was manifested in household members' concerns about adequacy of the household food supply and in adjustments to household food management, including reduced quality of food and increased unusual coping patterns. Food insecure with moderate hunger (500-750 Et. birr): food intake for adults in the household had been reduced to an extent that adults had repeatedly experienced the physical sensation of hunger. Food insecure with severe hunger (Less than 500 Et. birr): at this level, all households with children had reduced the children's food intake to an extent that the children had experienced hunger. Basically the Core Food Security Module analysis provides four groups of food security status. Moreover, the prediction successes and likelihood ratio index were in all four groups. Therefore, descriptive and econometric analyses were done by four groups of food security status.

The industry standard for the aggregation of consumption poverty is the Foster, Greer, Thorbecke (FGT) Class of Measures which is represented as follows: Illustration of Aggregation in Consumption Poverty:

i) P0 = q/N = Head count index (HI), Where, q the number of poor persons and N the total of sampled population. P0 = 108/150 = 0.72 = 0.72X100 = 72%

ii) $P^1 =$ HI=H {(Z-Y)/Z} = q/N {(Z-Y)/Z}

Where, Y = mean income (consumption) of the poor and I = (Z – Y)/Z is the average shortfall of income from the poverty line or the "income gap ratio". Y = 724.06,I = (Z – Y)/Z = (1075– 724.06)/ 1075,I = 0.27594 is the average shortfall of income from the poverty line or the "income gap ratio." From the expression in equation _P1 = q/n {(Z - Y)/Z}, We obtain _nZP1= q(Z - Y)nZP1 provides an estimate of the total amount of resources needed to eliminate poverty. P1 = q/n {(Z - Y)/Z}, P1 = 72%X0.27594, P1 (poverty gap) = 0.247

iii) α = 2, provides a measure of the severity of poverty. When α is set to 2, the index squares the average consumption gap g, and then multiplies by the percentage of poor persons (Poverty Severity or the Squared Poverty Gap). Poverty severity is aggregation in consumption poverty is facilitated by the Poverty Basket and Cut-off Consistency (the same poverty dimension and line is used).

$P^2 = PG^2 /H + (H-PG)^2 /H.CV^2$ p

Where,

PG^2 /H = contribution of the poverty gap= $(0.208)^2$

PG^2 /H = $(0.208)^2$ /0.72=0.600 $(H-PG)^2$/H.CV2 p = contribution of inequality amongst the poor.

CV^2p = the squared coefficient of variation of income (consumption) among the poor.

(0.72--0.043) /0.72 x $(0.27594)^2$ = 0.0197, P^2 = 0.143

The estimates of rural poverty measures using the FGT indices are given in the following table.

Table 23. Rural Poverty Estimates of Households of the study areas

Poverty Measures	Poverty Estimates
Poverty Incidence (%)	72.00
Poverty Depth	0.247
Severity of Poverty	0.143

Source: Calculated from the Household Survey Data, 2008.

According to the results of the poverty measures, 72% of households are poor. The poverty depth is about 24.7 which means that 24.7% % of the poverty line is required to escape rural poverty. The severity of poverty is estimated at 14.3%, implying that there is 14.3% inequality among the poor. Put differently, a higher weight is placed on those households who are further away from the poverty line. This indicates how much a gap exists among the poor and what volume of resources is needed to bring these households closer to the poverty line or above it. **4.3.1 Consumption Expenditure**

In the study areas, the average food consumption expenditure per adult equivalent per year is Birr 388.70. While the average total expenditure per adult equivalent per year is Birr 724.06 (See table 24)

Table 24. Annual Mean Households' Consumption Expenditure in study districts, 2007

Ser. No	Household Consumption Expenditure	Mean
1	Real Annual Food Consumption Expenditure	3223.96
2	Real Annual Non-Food Consumption Expenditure	2781.27
3	Real Annual Total Consumption Expenditure	6004.93
4	Real Annual Food Consumption Expenditure Per Adult Equivalent	388.70
5	Real Annual Total Consumption Expenditure per Adult Equivalent	724.06

Source: Own computation of survey data

4.3.2 Poverty Lines for study areas

As discussed earlier in the methodology section the absolute poverty line determination is more realistic for developing countries like Ethiopia. In addition, a household's consumption expenditure is preferred to income as an indicator of a household's well-being in the study districts for reasons discussed in the methodology sector. The following procedures are followed to construct the absolute poverty line for study area districts. Since poverty lines are essentially tools to allow comparison of welfare across households and regions, constructing a diet for the poor which is identical for all households is suggested by Dercon and Krishnan (1996). For this study, the minimum food basket that gives 2,200 Kcal per adult the minimum calorie suggested by WHO required for an adult to perform daily duties, constructed for cereal-based farming rural areas of Ethiopia is adapted from Dercon and Mekonnen (1999).Then, the basket of food items is valued at local prices collected concurrently with the household survey at Dedo and Tiro Afeta so as to get the food poverty line for the study areas. Accordingly, the food poverty line for the study districts is found to be 32.39 Birr per adult per month, which is equivalent to Birr 388.68 per adult per year. The food poverty line for the study areas is less than the national food poverty line of Birr 647.8 per adult per year determined by MoFED (2002) based on a basket of food items in 1995/96 prices. It is a slight amount higher than the food poverty lines calculated by Getaneh (1999) valuing similar basket of food items per month in 1999 whose method consisted of corresponding local prices for the areas Dinki (Birr 386.52). This figure is, however, by far less than Yetmen (Birr 456) and Shumsha (Birr 502.2).

In addition, since the poor cannot be expected to live from food alone, incorporating values to the non-food consumption is suggested by Dercon and Krishanan (1996). This means some amount of money for essential non-food consumption needs to be added to obtain the total poverty line for the area. Ravallion and Bidani (1994) suggest estimating an Engel-curve demand function after correcting for household characteristics and with regional dummies to account for relative price differences so as to find the non-food share of those people whose food consumption is exactly sufficient for basic food requirements. More specifically, the following procedures are followed to estimate the non-food share of the total poverty line for the area:

A) Consumption information including the consumption from own production and stocks are expressed in monetary terms to get real consumption of households.

B) Consumption per household is rescaled to take into account the household size and composition. Calorie based equivalence scales developed by Dercon and Krishnan (1998) are used to calculate consumption per adult equivalent for each household in the study areas.

C) Food share for each household in the peninsula is calculated from the consumption expenditure data.

D) For deriving the expenditure share devoted to non-food items by households, an Engel-curve demand function with the logarism of total consumption per adult equivalent divided by the food poverty line as the consumption variable at the right hand side is regressed with the food share of households in the peninsula following Ravallion and Bidani (1994). To get a better model fit, demographic variables are included in the model.

E) The estimated minimum non-food expenditure is then added to the minimum cost of the food consumption basket to obtain the total poverty line for the peninsula. Hence the total poverty line for study area is derived from the formula (food share) (food poverty line). Accordingly, the total poverty line for study area is 724.06 Birr per adult per year.

Based on the poverty lines constructed above, the magnitude of rural poverty in study area is also determined in terms of incidence, depth and severity. To do this, the Foster-Greer and Thorbecke mathematical model of determining the three indices of poverty is put into practice. The results of the analysis indicate that on the basis of total poverty line 72% of the households in the study area are poor and 26.4% of the households constitute the poorest of the poor section of the study districts. Based on the poverty gap index, the average consumption shortfall that is needed to bring the entire population up to the total poverty line is 14.3%. On the basis of the food poverty line, the poverty head count index, depth and intensity of poverty in the study districts are 72.0%, 24.7%, and 14.7% respectively. As expected, the incidence, depth and severity of poverty of the area, calculated on the basis of total poverty line, is greater than the figures calculated on the basis of the food poverty line. This implies that people spend more of their income on food items than on non-food items (Table 25).

Table 25. Incidence, Depth and Severity of Rural Poverty in study area districts, 2007

Total Poverty			Food Poverty		
P0	P1	P2	P0	P1	P2
72.0%	24.7%	14.7%	72.0%	46.0%	14.73%

Source: Own computation of survey data

The indicated head count index for the study districts above is far above the national average, which were 48% in 1995/96 (MEDaC, 1999); 45% in 1995/96 (Dercon and Krishnan, 1998); 39% in 1994 (Decon, 2000) and 45% in 1999/00 (MoFED, 2002).

4.3.1. Food security status of household regarding land holding Per Capita

From any other productive resources land is definitely the most important resource in agriculture. The fertility status, location and other attributes of land in association with its size made it an essential resource in agriculture. In the study area, as witnessed by the survey result there was no significant difference in the mean cultivated land size between the food secure and food insecure households. The mean farm size of food secure and food insecure households was found to be 0.54 ha and 0.69 ha, respectively. The overall mean farm size was 0.583 ha. As indicated in the table below 42.1 % and 46.5 % of the total food insecure and food secure household groups had farm size in a range of 1.0 – 2.0 ha respectively.

Table 26 Distribution of sample households by farm size per household (in hectare)

Farm size/HH	Food insecure		Food secure		total	
	Number	Percent	Number	Percent	Number	Percent
Smaller (<1.0 ha)	35	32.7	10	23.3	45	30
Medium (1.0–2.0 ha)	45	42.1	20	46.5	65	43.3
Larger (>2.0 ha)	27	25.3	13	30.2	40	26.7
Total	107	100	43	100	150	100
Mean	0.541		0 .686		0.583	
SD	0.390		0.377		0.391	

Source: Own computation of survey data

Further, analyzing cultivated land size per capita showed the importance of land holding as a factor in identifying the two sample groups. Even if there was no significant difference in land holding per household, the survey result exhibited there was significant difference in the mean farm size per capita between the two sample groups at less than 1 percent probability level ($p<0.01$). As it is shown in Table 16, below, the overall mean farm size per capita is 0.26 ha; and that of food insecure and food secure households is 0.227 and 0.324 ha, respectively. In general, each individual in the study area has to live on average of 0.26 ha of farm size.

Table 27. Distribution of sample households Food security status by farm size per capita (in hectare)

Farm size/capita	Food insecure		Food secure		total	
	Number	Percent	Number	Percent	Number	Percent
Smaller (<1.0 ha)	35	32.7	10	23.3	45	30
Medium (1.0–2.0 ha)	45	42.1	20	46.5	65	43.3
Larger (>2.0 ha)	27	25.3	13	30.2	40	26.7
Total	107	100	43	100	150	100
Mean	0.227		0.324		0.255	
SD (Std. Deviation)	0.145		0.152		0.150	

Source: Own computation of survey data

4.3.2 Oxen Ownership

With regard to the contribution of labor, oxen ownership is an important variable. In the study area, as witnessed by the survey result a household owns 2 oxen. As it is shown in the table below, above 38 percent of sample households owns two oxen. According to the information of developments of study area some farmers who were obliged to own more than two oxen were afraid of the accidental emergence of cattle disease in the area.

Table 28. Distribution of sample households by oxen ownership

Number of oxen	Food insecure		Food secure		total	
	Number	Percent	Number	Percent	Number	Percent
2	28	34.6	29	42	57	38
4	28	34.6	29	42	57	38
>4	25	30.9	11	16	36	24
total	81	100	69	100	150	100
Mean	0.70		0.89		0.75	
SD	0.61		0.53		0.69	

Source: Own computation of survey data

4.3.3 Income and expenditure Food security status of household regarding

1. Household income

In the study area, as it is observed from the survey results the agricultural (cereal and livestock) production is the most significant source of household income. Household income in the study area not only depends on the agricultural potential and the relative price obtained by the farmers for agricultural products, but also on the time of sale and the type of off farm activities a household performs. The average household income per adult equivalent (AE) of the sample households was found to be Br. 604.65.Most of the sample farmers earned average annual income below or equal to 750 Br. /AE. All households in this income level are food insecure and their proportion from the total sample is amounted to 58.0 percent. It is only 11.3 percent of the sample households that earn an average household income over1075.00 Br. /AE. The group statistics also showed that there is significant difference in income of household/AE between the food secure and food insecure household groups at less that 1 percent ($p<0.01$).Where household income/AE in the food insecure group is 464.30 Birr, This amount is by far less than the mean income of the sample. However, the mean income of food secure households is 953.91 Birr per AE. The gap between the two groups is highly substantial. More than 99.1 percent of the food insecure sample households earn an annual average income less than Br. 750 per AE. Where as the corresponding proportion for the food secure households is only 23.3 percent. On the contrary, more than 76.7 percent of the food secure sample farmers earn an average annual income greater than 750 ETB per AE while only 0.9 percent of the food insecure earns the equivalent amount of 750 ETB.

Table 29. Distribution of sample households by amount of annual income per AE in Birr

Annual income per AE	Food insecure		Food secure		total	
	Number	Percent	Number	Percent	Number	Percent
<500	25	23.4	4	9.3	29	19.34
501-750	81	75.7	6	14.0	87	58.00
751- 1075	0	0	17	39.5	17	11.33
>1075	1	.9	16	37.2	17	11.33
Over all	107	100	43	100	150	100
Mean	464.30		953.91		604.65	
SD	283.78		728.23		506.05	
Minimum					90.00	
Maximum					1200	

Source: Own computation of survey data

*** Significant at less than 1% probability level

4.3.3.2. Food security status of household regarding consumption Expenditure

The farm households in the study area on average spent Br. 832.60 per adult equivalent (AE) including food and non-food items with a minimum and maximum of Br. 128.85 and 1117.15 per adult equivalent respectively. The group statistics showed that, in the total expenditure, there was significant difference in the mean expenditure at less than 5 percent ($p<0.05$) probability level between the food secure and insecure households.

Table 30 . Distribution of sample households by total expenditure per adult equivalent (Birr)

Expenditure per AE	Food insecure		Food secure		total	
	Number	Percent	Number	Percent	Number	Percent
<500	9	8.6	0	0	9	6.0
501-750	92	86	0	0	92	61.3
751- 1075	6	5.6	0	0	6	4.0
>1075	0	0	43	100	43	28.7
Over all	107	100	43	100	150	100
Mean	593.30		428.10		832.60	
SD	213.30		468.50		487.55	
t- value	8.4					
Minimum	128.85					
Maximum	1117.15					

Source: Own computation of survey data

Food security status at household level is best measured by direct survey of income, expenditure, and consumption and comparing it with the minimum subsistence requirements is used to identify the two food secure and food insecure groups. The reason for the use of this measure was that it produces a crude estimate of the minimum subsistence consumption requirements in the household.

To identify the correlates of rural poverty in the study districts, the binary logit model is fit in which the poverty situation of the households (1 if the household is "poor" and 0 if the household is "non poor") is regressed as dependent variable against the hypothesized independent variables. From the classification of Table result above, it were found that 42 and 108 households were found 28.00 % and 72.00% of the non-poor and the poor households respectively are correctly predicted by the model. From the total households, 96.6% of them are correctly predicted by the logistic model, which is good for a cross sectional data.

Table 31. A logit analysis result of factors determining food security status in Dedo and Tiro Afata study areas

Independent variables	B	S.E.	Wald	Sig.
Household age (age)	-4.377	10.253	0.182	0.569
Education level of (educ_1)	-0.507	0.283	3.207	0.073 *
Total family size (total_f)	-0.437	0.103	18.164	0.000***
Total land holdings (how_land)	-0.578	0.853	0.459	0.398
Total Plot operated (how_plot)	0.281	0.162	3.006	0.083 *
Livestock owned (do_ukee)	-1.996	4.027	0.246	0.869
Number of oxen (tno_oxen)	-0.494	0.759	0.424	0.298
Total income (total_in)	0.000	0.000	5.951	0.015**
Total expenditure (total exp)	-0.002	0.001	2.222	0.000***
Per capita income (per_cap)	0.027	0.010	7.415	0.000***
market distance (market)	0.009	0.011	0.738	0.835
Distance to Transport (transport)	-0.012	0.015	0.630	0.066 *
Constant	-13.163	21.631	0.370	0.569

Source: A binary logit analysis result.

Note: Asterisks denote coefficient significance at 1-percent level 0.01 (***); 5- percent level 0.05 (**); and 10-percent level 0.10 (*) levels.

The model result is significant at less than one percent probability level indicating the hypothesis that the coefficient except the intercept are equal to zero is rejected. Another measure of goodness of fit used in logistic regression analysis is prediction success, which indicates the number of sample observations correctly predicted by the model. The prediction success is based on the principle that if the estimated probability of the event is less than 0.5, the event will not occur and if it is greater than 0.5 the event will occur (Maddala, 1989). The applied model correctly predicted at 93.57 percent of the sample households. Thus, the model fits the data. Put differently, the explanatory variables included in the model can explain the response variable significantly better than the model with the intercept only (Liao, 1994).Therefore, it is possible to interpret the model results meaningfully. The binary logit model identified six significant variables out of sixteen hypothesized variables. These variables include family size (total_f, Education level of (educ_1), annual off-farm/non-farm income (off_inco) and annual total farm income (total_in), Total expenditure (total exp), and market distance (market). The interpretation and discussion of these significant variables are presented as follow:

The coefficient **of Education level** variable is significant at 10% and carries a negative sign suggesting that the higher the educational level of a head of household is, the more food secure the household and vice versa. This is expected because such households are assumed to have better food management techniques that will ensure equitable and all round supply of food. The results further show that the probability of being food secured increase at much higher levels of education.

The coefficient of **the Family size variable** is significant at 1% and carries a negative sign. This shows that household with large sizes had higher possibility of being food insecure than those with smaller size and vice versa in the study area. Household size has a negative significant coefficient implying that larger households are likely to be poorer than smaller households. The larger the number of less active children and adults (unemployed) is, the higher the load of the active members in meeting the cost of minimum household nutrition would be and, hence, the higher the level of food insecurity, and vice versa. . The possible explanation is that those households who depend on limited productive resources will face food insecurity by increasing family size.

The coefficient of **the farm Plot size operated** variable is significant and exhibits a positive relationship with the food security status of the household, showing that households with larger farm sizes are more food secure than those with smaller sizes and vice versa.

The market distance has been found to be positively related with food security and significant at less than 10 % probability level. It was expected that households nearer to market centers had better chances to be food secure than those who were away from market centers. But the result was not in agreement with the hypothesis that market distance does not have a significant effect on food security. The odds ratio, cetris paribus, in favor of food security increases by 1.1197 if market distance increases by one kilometer. This means they consumed what they had produced and became food secure. The probability of being food secure will increase by 2.2 % with one unit increase in market distance.

The Total off farm income - Crop production output and income earned from sales of livestock and livestock products is inadequate in the farming households of the study area and often look for income source other than agriculture to push themselves to the threshold of securing access to food security. So income earned from off-farm activity is an important variable, which determines household food insecurity in the study area. As a result, it is expected that households who managed to earn higher off farm income are less likely to be food insecure i.e, off-farm income is expected to have a negative impact on food insecurity. As expected, availability of this type of income was positively and significantly (1% probability level) associated with household food security status. The odds ratio is 1.0025 and therefore we may say that when off-farm/nonfarm income increases by one unit, the odds that the household is being food secure increase by a factor of 1.0025, when other variables are controlled. From its marginal effect of 0.0005, it is possible to conclude that the probability of being food secure increased by approximately 0.05 % with one unit additional off-farm/non-farm income.

The Total farm income variable was hypothesized to have positive influence on food security. In agreement with the hypothesis, its coefficient came out to be positive and significant at less than 1 % probability level. The probable explanation is that those farmers who have better access to different types of farm income are less likely to become food insecure than those households who have little access. The odds ratio in favor of food security increases by a factor of 1.0026 as the farm income increases by one unit. Total farm income has a marginal effect of 0.0005, which indicates the probability of being food secure will increase by approximately 0.05 percent with one unit additional farm income. The signs of these variables are in complete agreement with the hypothesis made and are quite relevant and indicative of the existing reality and better than the binary logit model outputs. Generally household wealth holding is considered as one of the measures of household self-assurance, which reduce the effects of unfavorable conditions on household food security. It is believed that some household wealth could be disposed of in terms of pressure. The higher the value of household wealth, the lower the probability of food insecurity.

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