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EFFECT OF SMALL SCALE IRRIGATION ON HOUSEHOLD FOOD SECURITY: THE CASE OF ADABA DISTRICT, WEST ARSI ZONE, OROMIYA REGIONAL STATE, ETHIOPIA

By

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JANUARY, 2021

ADDIS ABABA, ETHIOPIA

EFFECT OF SMALL SCALE IIRIGATION ON HOUSE HOLD FOOD SECURITY: THE CASE OF FURUNA KEBELE SMALL SCALE IRRIGATION SCHEMS IN ADABA DISTRICT, WEST ARSI ZONE, OROMIYA REGION, ETHIOPIA

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BY

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JANUARY, 2021
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DECLARATION

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ENDORESEMENT

As Thesis Research advisor, I hereby certify that I have read and evaluated this thesis prepared under my guidance, by **Gemechissa Abdiyo Mustefa**, entitled **Effect of Small Scale Irrigation on Household Food Security: The case of Adaba District, West Arsi Zone, and Oromiya Regional State, Ethiopia**. I recommend that it be submitted as fulfilling the Thesis requirement.

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DEDICATION

I dedicate this thesis manuscript to my father **ABDIYO MUSTEFA**, and my mother **WUBITU ANTONIO** for nursing me with affection and love and for their dedicated partnership in the success of my life.

LISTS OF ACRONYMS

ADLI	Agricultural Development Led Industrialization
AE	Adult Equivalent
CSA	Central Statistics Agency
CSI	Coping Strategy Index
DWAFED	Department of West Arsi Zone Finance and Economic Development
DPPA/C	Disaster Prevention and Preparedness Authority/ Commission
FAO	Food and Agricultural Organization
FDRE	Federal Democratic Republic
FGT	Foster, Greer and Thorbecke
HH(s)	Household(s)
IWMI	International Water Management Institute
LIMDEP	Limited Dependent Variable
OIDA	Oromiya Irrigation Development Authority
OESO	Oromiya Economic Study Office
RDA	Recommended Daily Allowance
STATA	Statistical Data Analysis
TLU	Tropical Livestock Unit
VIF	Variance Inflation Factor
WFP	World Food Program
WSDP	Water Sector Development Program

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ABSTRACT

Ethiopian agriculture is largely small scale subsistence oriented and crucially dependent on rainfall. Although irrigation is one means by which agricultural production can be increased, irrigated production is far from satisfactory in the country. The aim of this study is to analyze the effect of small scale irrigation on household food security. The study was conducted in Adaba Woreda. Data was collected on 144 household heads, 72 Irrigation users and 72 Non Irrigation user's households were interviewed.

A three stage random sampling technique was employed to select the sample respondents. Both descriptive and econometric data analysis techniques were applied. In the econometric analysis the effect of small scale irrigation on household food security is analyzed using the Heckman two-step procedures. The descriptive statistics revealed that 70 percent of the irrigation users and 20 percent of non-users are found to be food secured while 30 percent of the users and 80 percent of the non-users found to be food insecured.

In the first stage of the Heckman two-step procedure the variables that are found to determine participation in irrigation are: nearness to the water source, household size, household size square, size of cultivated land, livestock holding, farmers' perception of soil fertility status and access to credit service. In the second stage the following variables were found to significantly determine household food security: access to irrigation, household size, household size square, sex of the household head, size of cultivated land, access to extension service and nearness to the water source.

The study concluded that small scale irrigation is one of the viable solutions to secure household food needs in the study area.

Key words: small scale Irrigation, Food security, Households, Irrigation users, and non-irrigation users

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996; FAO,2002; FAO, 2003; WHO, 2011). At the household level, food security implies physical and economic access to foods that are adequate in terms of quantity, nutritional quality, safety and cultural acceptability to meet each person's needs. Household food security depends on adequate income and assets including land and other productive resources owned (FAO, 1997).

As the international development community makes frantic efforts to halve the number of hungry and undernourished people by 2015 as enshrined in the Millennium Development Goal (Gowing, 2003:2), food security has remained a formidable challenge in Sub-Saharan Africa. Sub-Saharan Africa (SSA) is the world's most vulnerable region and also extent and depth of poverty in Sub-Saharan Africa is a disgrace.

The extent and depth of poverty in Sub-Saharan Africa is a disgrace.An estimated 291 million, 46 percent of the population of the region, live in absolute poverty, struggling to survive on less than a dollar a day per person to meet food, shelter and other needs (World Bank, 2001). Likewise, in Ethiopia, poverty and food insecurity have become chronic problems. Ethiopia ranks as one of the poorest countries in the world. The World Bank's World Development Indicators (2000) better illustrate the grinding nature of Ethiopian poverty. The World Bank's Global Poverty Monitoring estimates that close to 76 percent of population in Ethiopia live on less than US$ 1.00 per day in 1995 (World Bank, 2001). In 2003, about 23 percent of Ethiopian population lives on less than US$ 1.00 per day (World Bank, 2006).

In Ethiopian, most of the population lives in rural areas where about 95% of the agricultural product is produced by smallholder farmers (MoARD, 2010). Agriculture is the backbone of the Ethiopian economy as it accounts for about 80% of the population directly or indirectly involved in it. This implies that it is the dominant sector for Gross Domestic Product (GDP)

contribution. For example, in 2011, agriculture contributed to national GDP (40%),

employment (80%), supply of raw materials (70%), government tax revenue (28%) and export earnings (85%). However, because of small and fragmented landholding, dependence on natural factors of production, environmental degradation, population growth, low access to new agricultural technologies, traditional methods of cultivation, and low institutional support services, it is largely based on subsistence farming (MoFED, 2012).

In order to enhance the development of agriculture, the economic performers designed a national strategic plan in 1991, Agricultural Development Led Industrialization (ADLI) that gives focus on irrigation, cooperative societies and agricultural technologies to answer the food demand and bring socioeconomic development in the country. Small scale irrigation development is one of the policies within this strategy. The success full history of Asian countries for instance China in the 1960s and 1970s in accommodating the growing population, achieving rapid economic growth and increasing employment through irrigated agriculture and eager the Ethiopian government to give more weight to the development of irrigation scheme (Bacha et al. 2011). Based on this, the federal and the regional governments associated with other international and local NGOs have significantly supported to rural farmers to participate and use irrigation farming. As a result, the irrigated farmland, irrigation production and the number of irrigation farmers in the country have notably increased, up to 80%, between 1990 and 2010 (CSA, 2012).

Irrigation is one means by which agricultural production can be increased to meet the growing food demand in Ethiopia. Increasing food demand can be met in one or a combination of three ways: increasing agricultural yield, increasing the area of arable land and increasing cropping intensity (number of crops per year). Expansion of the area under cultivation is a finite option, especially in view of the marginal and vulnerable characteristics of large parts of the country's land and also increasing population. Increasing yields in both rain-fed and irrigated agriculture and cropping intensity in irrigated areas through various methods and technologies are therefore the most viable options for achieving food security in Ethiopia (IWMI, 2005).

However, in Ethiopia irrigated production is far from satisfactory (Woldeab, 2003). While the country's irrigation potential is about 3.7 million hectares (WSDP, 2002), the total irrigated area is 190,000 hectares in 2004 that is only 4.3 percent of the potential (FAO, 2004)

In response to this situation, as well as based on previous development objectives, the country has developed a rural development policy and strategy and a comprehensive food security strategy. Both of the strategies target chronically food insecure segments of the population, especially in highly vulnerable areas (FDRE, 2002).

The government of Ethiopia, as stated in the sustainable development and poverty reduction program, has recognized the importance of water and increased its focus on water resource development and utilization to achieve food security (MoFED, 2002). The water policy of the country also stresses increased use of small scale irrigation through diversion of rivers and building of small dams to fill multiple gaps in social and economic development endeavors of the country (MoWR, 1999).

The development of small-scale irrigation is one of the major intervention areas to boost agricultural production in the rural parts of the country. Small scale irrigation schemes enable greater agricultural production than is achieved with rain fed agriculture, help poor farmers overcome rainfall and water constraint by providing a sustainable supply of water for cultivation and livestock, strengthen the base for sustainable agriculture, provide increased food security to poor communities through irrigated agriculture, contribute to the improvement of poor nutrition level, provides a source of household income. Moreover, small scale irrigation schemes are simple enough to be managed at community level (FAO, 2003). On the other hand, less attention was given for the small scale irrigation schemes that may assist most smallholder farmers in the country through generating sustained farm income and employment opportunity particularly for women. As a result, this study can serve as a say for upcoming intervention programs, studies and policy making.

1.2. Statement of the Problem

Agriculture is mainstay of Ethiopian economy in terms of income, employment and generation of export revenue. Its contribution to GDP, although showing a slight decline over the years has remained very high. The critical role of agriculture in the Ethiopian economy is well known. However, development policies and strategies pursued by pervious regimes had not given agriculture the emphasis that it deserves. During the time of the Derg,

preoccupation with the socialization of agriculture had geared every effort towards state farms that accounted for about 2 percent of agricultural output. Agricultural extension service, credit services, allocation of foreign exchange, distribution of fertilizer and improved seeds had been deliberately lopsided to state farms while all available studies indicated that productivity of state farms had been consistently lower than productivity of private smallholder farmers that accounted for well over 95 percent of agricultural production.

The country's economy is dominated by small holder and rain fed agriculture. Small scale irrigation development has been slow, in spite of long history of irrigation in this country that probably pre-dates the Axum Empire of more than 2000 years ago (Kloos,1991).

Ethiopia cannot assure food security for its population with rain fed agriculture without a substantive contribution of irrigation. The government of Ethiopia had prepared and undertaken a water sector development program implemented for 15 years between 2002 and 2016. This program provides a prominent part to the development of irrigation in the country for food production (MoWR, 2001).

In the National Regional State of Oromia, where this study focuses, food insecurity is a crosscutting issue that is becoming worse. Drought in this region is attributed predominantly to land degradation, high deforestation rate, change in the pattern, occurrence and distribution of rainfall, high population pressure, which increase the demand for more cultivable land and fuel wood, in turn leading to the destruction of forest and other resources. These have strong cause and effect interplay, and reinforce one another, consequently forming vicious circle in which population pressure intensifies land degradation and deforestation, which in turn disturb the amount and distribution of rain fall; this on its part causes a serious short fall in production resulting in shortage of food in the region (OIDA, 2006).

According to a study conducted by Oromia Economic Study Office (OESO) (2000) there is 1.7 million hectares of land suitable for surface irrigation in the region that can benefit about 6.8 million household heads. The amount of water potential to be utilized for the purpose of irrigation in Oromia is estimated to be 58 billion cubic meter of mean annual run off generated in the region and 2.1 billion cubic meter of underground water.

The specific study area, Adaba Woreda is also one of the Woreda in Oromia Region, West Arsi zone of Ethiopia with a high irrigation potential area. Hence, the government of Oromia Region gives emphasis on irrigation in this Woreda like the other parts of the region in order

to improve the livelihood of the society. As a result, because of the availability of many river water in most selected Kebeles of the Woreda, the government of Oromia and the administrative of the Woreda gave special attention on irrigation in these Kebeles to increase agricultural production of the rural households. In the Woreda more than 2800 ha is under irrigation with a total beneficiary of 5,600 households. Out of this 265 ha is being developed by Furuna irrigation schemes. The major horticultural crops produced in the irrigation schemes are Onion, Potato, Carrot, Cabbage, Black paper and Tomatoes. However, productivity and sustainability of these schemes are low, characterized by lack of access to modern technology and low productivity.

Irrigation is assumed to improve agricultural production and food security. However, it is not well known to what extent the households using irrigation are better off than those who depend on rainfall in the study area. Therefore, this study is intended to examine the effect of Furuna irrigation scheme on household food security and identify determinants of rural household participation in small scale Irrigation.

1.3Objectives of the Study

General objective

- The general objective of this research paper is to assess the effect of Furuna small scale irrigation scheme on household food security of the farmers.

Specific Objective

- To assess the effect of Furuna small scale irrigation schemes on household food security
- To identify determinants of rural household participation in small scale irrigation

1.4 Significance of the Study

The national development plan of the country is based on the second Growth and Transformation Plan (GTP II) aiming at equitably benefiting people at all levels and bringing about structural transformation of the agricultural sector and the overall economy. It is expected to result in a significant shift in agricultural productivity, thereby enhancing the

contribution of the sector to the economy and stabilizing the macroeconomy. Central to achieving the agricultural development policy objective is the promotion of irrigated agriculture (MoFED, 2002).

Ensuring an adequate and reliable supply of irrigation water increases yields of most crops. Along with higher yields irrigation increases incomes and reduces hunger and poverty. Where irrigation is widely available under nourishment and poverty are less prevalent. Even landless laborers and small holder farmers who lack the resource to employ irrigation themselves often benefit through higher wages, lower food prices and a more varied diet (FAO, 2003).

To this end, identifying, analyzing and understanding the effect of small scale irrigation on household food security would contribute to the sustainable improvement of household food security, and executing the government strategy of poverty reduction.

1.5. Scope and Limitation of the Study

The study focuses on the effect of small-scale irrigation on household food security. This study is limited to only one district because of the limited time and resource. The district where the study was conducted is Adaba. It is found in the West Arsi zone of Oromia Region. This district is selected because of its accessibility and relatively better irrigation practice.

1.6 Organization of the paper

This research paper is organized in five chapters. Chapter one consists of background in which facts about agricultural production, food security and small scale irrigation in the country, statement of the problem, objectives of the study and scope and scope and limitation of the study significance of the study are described in detail. Chapter two deals review of literature that are related to the research topic and its objective. The third Chapter deals with design and methodology of the study. Chapter four deals result and discussions of the study. The final fifth chapter compromises summery of conclusion and recommendations. All necessary annexes and bibliographies are annexed at the end of the research report.

CHAPTER TWO

LITERATURE REVIEW

2.1. Definition of Terminologies

2.1.1. Definition of a household

Callens and Seiffert (2003) defined a household as a unit of people living together headed by a household head. This is often a man or a woman, in case there is no man. Increasingly, grandparents are taking up this role, as well as adolescents, in those households where both parents have deceased. Apart from the head of the household, there may be a spouse, children and permanent dependents like elderly parents or temporary dependents like a divorced daughter or son.

Ellis (1993) defines a farm household as an individual or a group of people living together under one hearth deriving food from a common resource, obtained mainly from farming activities.

2.1.2. Definition of food security

Food security is defined by different agencies and organizations differently without much change in the basic concept.UN (1990) defines household food security as "The ability of household members to assure themselves sustained access to sufficient quantity and quality of food to live active healthy life." Food security can be described as status in which production, markets and social systems work in such a way that food consumption needs of a country and its people are always met.

FAO (1992) defines food security not only in terms of access to, and availability of food, but also in terms of resource distribution to produce food and purchasing power to buy food, where it is produced. USAID (1992) defines food security as: "when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life." Here food security includes at a minimum the availability of nutritionally adequate and safe food, and assured ability to acquire acceptable foods in

socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies).

One of the most influential definitions of food security is that of the World Bank (1986). The Bank defines it as "access by all people at all times to enough food for an active and healthy life." This definition encompasses many issues. It deals with production in relation to food availability; it addresses distribution in that the produce should be accessed by all; it covers consumption in the sense that individual food needs are met in order for that individual to be active and healthy. The availability and accessibility of food to meet individual food needs should also be sustainable. This implies that early warning systems of food insecurity should monitor indicators related to food production, distribution, and consumption. Among the various definitions of household food security, this study adopted the definition given by the World Bank.

Often, the term household food security and 'food security' are intermingled. Food security is defined in its basic form as access by all people at all times to the food needed for a healthy life. The focus in 'household' food security is on the household as the most basic social unit in a society. The distinction between food security and household food security is important because activities directed towards improving household food security may be quite different from those aimed at improving national level food security. The latter often being more related to macro-level production, marketing, distribution and acquisition of food by the population as a whole (FAO, 2003).

The focus in household food security is on how members of a household produce or acquire food throughout the year, how they store, process and preserve their food to overcome seasonal shortages or improve the quality and safety of their food supply. Household food security is also concerned with food distribution within the household and priorities related to food production, acquisition, utilization and consumption (ibid).

The generation of household food security is dependent on the physical availability of food at the market or community level, the ability of household to access the available food, the ability of individuals-particularly those especially susceptible to food deficits such as women, infants and children-to eat the food, and finally the body's ability to process the nutrients consumed (Bouis and Hunt, 1999). The assessment of food security extends to consider the

health of those eating the food-the objective is a healthy and active life. Here nutritional consideration begins to come to the fore (Benson, 2004).

Nutrition security is defined as the appropriate quantity and combination of inputs such as food, nutrition, health service and caretaker's time needed to ensure an active and healthy life at all times for all people (Haddada et al., 1994). The quality of food to which an individual or household has access must be considered. To enjoy a productive, healthy and active life, all people require sufficient and balanced level of carbohydrate, protein, fat, vitamin and minerals in their diets. Households or individuals facing deficiencies or other imbalances in diet because they lack access to the necessary food for balanced diets are not food secure (Benson, 2004).

2.2. Core Concepts in Household Food Security

The many definitions and conceptual models all agree that the key defining characteristic of household food security is secure access at all times to sufficient food.

2.2.1. Sufficiency: What is "Enough?"

The concept of "enough food" is presented in different ways in the literature: as a minimal level of food consumption, as the food adequate to meet nutritional needs. In more descriptive formulations, it refers to enough (food) for life, health and growth of the young and for productive effort, enough food for an active, healthy life and enough food to supply the energy needed for all family members to live healthy active and productive lives. From these definitions, four aspects of the question can be distinguished (Maxwell and Frankenberger, 1992).

First the unit of analysis in these definitions is the individual, not the household. Where the household refers to an aggregation of individuals whose food needs must be satisfied. Secondly, although the definitions mostly refer to "food'' the main concern is with calories not with protein, micro-nutrients, food quality and safety. This is mainly because analysts operate on the principle that other needs are usually satisfied when calorie intake is satisfactory. Because it is difficult to estimate precise calorie needs for different groups in the population, it is concluded that all estimates of nutritional requirements have to be treated as value judgments. Finally, although the difficulty of measurement, an important aspect of assessing whether people have access to "enough" food is to ask how far they fall below the

threshold. In the earlier literature on malnutrition and in the current literature on poverty, the size of the gap is an important theme (ibid).

2.2.2. Access and entitlement

Access to food is necessary but not a sufficient condition for a healthy life. A number of other factors such as health, sanitation and household and public capacity to care for vulnerable members of society also come in to play (Von Broun et al., 1992).

Food access is ensured when households and all individuals within them have adequate resources to obtain appropriate food for a nutritional diet. Access depends up on income available to the household, on the distribution of income within the household and on the price of food. Accordingly, household food access is defined as the ability to acquire sufficient quality and quantity of food to meet all household members' nutritional requirements for productive lives. Food access depends on the ability of households to obtain food from their own production, stocks, purchases, and gathering or through food transfers from relatives, members of the community, the government, or donors (FAO, 2003).

A household's access to food also depends on the resources available to individual household members and the steps they must take to obtain those resources, particularly exchange of other goods and services (Bilinsky and Swindale, 2005).

Access to different resources and the pattern of social support have greater impact on the procurement strategies of food supplies. The basic resources like cash, labor, land, markets and public services determine the possibility of increasing entitlement to food. These are the key factors for either promoting food security or increasing vulnerability to food insecurity (Debebe, 1995). Sen (1981) also argued that mere presence of food in the economy or in the market does not entitle a household or a person to consume it. According to the same study people usually starved mainly because of lack of the ability to access food rather than because of its availability. In a sense, income or purchasing power is the most limiting factor for food security.

In many ways the antithesis of food security is famine. The key elements that determine successful food security, food availability, access and use are the outcome of multiple processes of food supply, marketing and demand operating at both national and household level. By contrast, the major symptoms of famine-resource base depletion, social and economic dislocation (community break up, market and institutional failure), and human

mortality-derive from the failure of many of the processes and events (Webb and Braun, 1994).

2.2.3. Security

The third main concept is that of "security", that is, secure access to enough food. This builds on the idea of vulnerability to entitlement failure, focusing more clearly on risk. It is necessary to identify the risks to food entitlements. These can originate from many sources and include variability in crop production and food supply, market and price variability, risks in employment and wages and risks in health and morbidity. Conflict is also an increasingly common source of risk to food entitlements (Maxwell and Frankenberger, 1992).

According to Sen (1981) risks to food entitlement could originate from a number of sources such as: weather variability, food production and supply variability, variability in price and market, health hazard and morbidity causing risks, employment and wage variability. In general, it could be environmental, natural, political, social, cultural and economic risks.

2.2.4. Time

Finally, we come to “time", that is, secure access to enough food at all times. The topic is not much discussed in the literature. However, following the lead of the World Bank (1986) it has become conventional to draw distinction between chronic and transitory food insecurity. Chronic food insecurity means that a household runs a continually high risk of inability to meet the food needs of household members. In contrast, transitory food insecurity occurs when a household faces temporary decline in the security of its entitlement and the risk of failure to meet food needs is of short duration. Transitory food insecurity focuses on intra and inter-annual variations in household food access. This category can be further divided in to cyclical and temporary food insecurity. Temporary food insecurity occurs for a limited time because of unforeseen and unpredictable circumstances. Cyclical or seasonal food insecurity occurs when there is a regular pattern in the periodicity of inadequate access to food. This may be due to logistical difficulties or prohibitive costs in storing food or borrowing (Maxwell and Frankenberger, 1992).

Food security in general is a concept, which integrates a number of important issues the magnitude of which ranges from micro to macroeconomics. Its attainment involves overall

considerations in terms of policy and program development in all aspects of the food system. Hence, the success in production and distribution plays an important role in influencing the food security status of an individual or a society at large (Debebe, 1995).

2.3. Indicators of Household Food Security

Along with the development of the concept of food security, a number of indicators have been identified to make monitoring of food situation possible. Their utilization varies between the characteristics of the investigations, procedures and level of aggregation. In most cases, the purpose and depth of investigations highly influence the use of indicators, in some early warning systems, for example, three sets of indicators are often used to identify possible collapses in food security. These include food supply indicators (rainfall, area planted, yield forecasts and estimates of production); social stress indicators (market prices, availability of produce in the market, labor patterns, wages and migration) and individual stress indicators (which indicate nutritional status, diseases and mortality). These indicators are important to make decisions on the possible interventions and timely response (Debebe, 1995).

Chung et al. (1997) identified and proposed two types of indicators at individual and household level. First, generic indicators are those that can be collected in a number of different settings and are derived from a well-defined conceptual framework of food security. Second, location specific indicators are those indicators typically carried only within a particular study area because of unique agro climatic, cultural, or socioeconomic factors. Location-specific indicators can be identified only from a detailed understanding of local condition by using qualitative data collection methods, while the generic indicators are drawn from the food security literature and tested using statistical methods.

The different types of indicators, however, are classified into two main categories; 'process' and ' outcome' indicators. The former provides an estimate of food supply and food access situation and the latter serves as proxies for food consumption (Frankenberger, 1992).

2.3.1. Process indicators

Process indicators are divided in to two: indicators that reflect food supply and indicators that reflect food access.

Indicators that reflect food supply: One critical dimension of household food security is the availability of food in the area for the households to obtain. Regional food shortages have a strong influence on household food availability. A number of factors play a role in limiting food availability and the options households have for food access. These are indicators that provide information on the likelihood of a shock or disaster event that will adversely affect household food security. They include such things as inputs and measures of agricultural production, food balance sheet information, and access to natural resources, institutional development, market infrastructure and exposure to regional conflicts or its consequences. These types of indicators are not mutually exclusive of food access indicators, and considerable overlap and interaction between the two categories may exist (Frankenberger, 1992).

Indicators that reflect food access: unlike supply indicators, food access indicators are relatively quite effective to monitor food security situation at a household level. Their use varies between regions, seasons and social strata reflecting various strategies in the process of managing the diversified source of food that shift to sideline activities, diversification of enterprises and disposal of productive and nonproductive assets (Debebe,1995).

2.3.2. Outcome indicators

Outcome indicators are used to measure the status of food security at a given point in time. Household food security outcome indicators can be grouped into direct and indirect indicators. Direct indicators of food consumption include those indicators which are closest to actual food consumption rather than to marketing channel information or medical status. Indirect indicators are generally used when direct indicators are either unavailable or too costly in terms of time and money to collect. Some of the direct indicators include: household budget and consumption surveys, household perception of food security and food frequency assessment. The indirect indicators include storage estimates, subsistence potential ration and nutritional status assessment (Frankerberger,1992)

2. 4. Measuring Household Food Security

At the household level, food security is measured by actual dietary intake of all household members using household income and expenditure surveys (Saad,1999). Using a survey data the minimal standard of living is proxy by the level of consumption expenditure that will enable the household or individual to attain the basic needs. This usually refers the ability of the household to purchase a basket of goods containing the minimum quantity of calories and non-food commodities. Households who are not able to achieve this critical level of consumption expenditure or income can be described as poor (Nsemukila, 2001).

Bickel et al. (1998) suggests that household food security can be measured by food poverty indicators and by anthropometric data. A food poverty indicator shows the number of individuals living in a household whose access to food is sufficient to provide a dietary intake adequate for growth, activity and good health. The anthropometric measure refers to nutritional status at individual level. Thus, individual food security implies an intake of food and food absorption of nutrients sufficient to meet an individual's needs for activity, health, growth and development. The individual's age, gender, body size, health status and level of physical activity determine the level of need. Hoddinott (2002) discusses four ways of measuring household food security: individual intakes (either directly measured or 24-hour recall), household caloric acquisition, dietary diversity and indices of household coping strategies.

According to Hoddinot (2002) individual food intake is a measure of the amount of calorie or nutrients consumed by an individual in a given time period, usually 24 hours. To collect the data an enumerator resides in the household throughout the entire day, measuring the amount of food served to each person and the amount of food prepared but not consumed ("plate waste") is also measured. In addition, the enumerator notes the type and quantity of food eaten as snacks between meals as well as food consumed outside the household. The second method is recall. The enumerator interviews each household member regarding the food they consumed in the previous 24-hour period. This covers the type of food consumed, the amount consumed, food eaten as snack and meals outsides the household.

According to the same study the individual food intake method has two principal advantages: implemented correctly, it produces the most accurate measures of individual caloric intake

(and other nutrients) and therefore the most accurate measure of food security status of an individual. Second, because the data are collected on an individual basis, it is possible to determine whether food security status differs with in the household. Set against these significant advantages are a large number of disadvantages. These are measures of intakes need to be made repeatedly ideally for seven non-consecutive days. It requires highly skilled enumerators who can observe and measure quantities quickly and accurately. The recall method requires enumerators to interview carefully every household member until they have established the exact make up.

The second way of measuring household food security proposed by Hoddinot (2002) is household calorie acquisition. This is the number of calories, or nutrients, available for consumption by household members over a defined period of time. Here the principal person responsible for preparing meals is asked how much food, she prepared over a period of time. After accounting for processing, this is turned into a measure of the calories available for consumption by the household. A set of questions regarding food prepared for meals over a specified period of time, usually either 7 or 14 days is asked to the person in the household most knowledgeable about this activity. Hoddinott (2002) states the advantages and disadvantages of the method as follows: the advantage is that, this measure produces a crude estimate of the number of calorie available for consumption in the household. Therefore, the level of skill required by enumerators is less than that needed to obtain information on individual intake. The disadvantage of the method is that, the method generates a large quantity of numerical data that needs to be carefully checked both in the field and during data entry.

The third way of measuring household food security in the same study is dietary diversity. This is the sum of the number of different foods consumed by an individual over a specified time period. It may be a simple arithmetic sum, the sum of the number of different food groups consumed. To collect data, one or more persons with in the household are asked about different items that they have consumed in a specified period. These questions can be asked to different household members where it is suspected that they may be differences in food consumption among household members. The advantage of this method is that, it is easy to train enumerators to ask these questions and individuals generally found them easy questions to answer. The disadvantage of this measure is that the simple form of this measure doesn't

record quantities. If it is not possible to ask about frequency of consumption of particular quantities, it is not possible to estimate the extent to which diets are inadequate in terms of caloric availability.

Indices of household coping strategies is the fourth way of measuring household food security in Hoddinott (2002). This is an index based on how households adapt to the presence or threat of food shortages. To generate the data, the most knowledgeable woman in the household regarding food preparation and distribution within the household is asked a series of questions. According to the study there are three attractive features of this measure. First, it is easy to implement, typically taking less than three minutes per household. Second, it directly captures notions of adequacy and vulnerability. Third, the questions asked are easy to understand both by respondents and by analysts.

Some disadvantages of this measure are also identified by the same study: as it is a subjective measure, different people have different ideas as to what is meant by "eating smaller portions" comparison across households or localities is problematic. Second, its simplicity makes it relatively straightforward to misreport a household's circumstances. For example, households might perceive that they are more likely to receive assistance when they report greater use of these coping strategies.

Maxwell et al. (2002) states that coping strategy is people's response to conditions under which they do not have enough to eat. The more people have to cope, the less food secure they are. There are two basic types of coping strategies. One includes the immediate and short term alternation of consumption pattern. The other includes the alternation of income earning or food production. Coping strategy index (CSI) is defined as a numeric measure of household food security status. In order to construct the index, it is important to know how severe each strategy is and to do this, information is collected from community level focus group discussion. To give a quantitative value to the relative frequency, the midpoint of the range of days for each category will be taken.

The study by Maxwell et al. (2002) also discussed that the CSI clearly declines with calorie intake, as households become more food secure. Change in the index provides a rapid indication of whether food security is improving or deteriorating. Maxwell et al. (2002) concluded that, the CSI is a good proxy for food intake (calorie adequacy), as well as food

share (the proportion of income that households devote to food purchased), food frequency, income status and presence or absence of a malnourished child in the household.

According to a study by Greer and Thorbecke (1986) household food security can be measured by the food poverty line. This is the minimum amount of food an individual must consume to stay healthy. It can be measured in terms of the nutritional characteristics of the foods (eg calorie), the quantity of the food stuffs themselves or the monetary value of the foods. In this method, the minimum food expenditure refers to the expenditure necessary for a person with the accepted and typical regional food consumption pattern to consume a nutritionally adequate diet. Focusing on food poverty allows use of the nutrient recommended daily allowances (RDAs)1 as the basis for setting the food poverty line.

2.5 Food Security Situation in Ethiopia

Ethiopian history is punctuated by famine. Although most of the occurrences fall within the past 200 years, food related crises can be traced as far back as 250 BC. Several incidences of famines were reported since then. The most recent tragic famines were experienced in 1984/85 (Webb and Braun, 1994).

Currently nearly about 8.5 million people are food insecure in Ethiopia. Therefore, there is a pressing and urgent needs to assist farmers to be able achieve food security through rapid increase in food productivity and production on an economically and environmentally sustainable basis (Gezahegn et al., 2004).

Because of the primary dependence on crop production in Ethiopia, harvest failure leads to household food deficits which in the absence of off farm income opportunities and/or timely food aid assistance, leads to asset depletion and increasing level of destitution at the household level. The effect is mirrored at the national level, resulting in overall declining food availability and increased reliance on food aid import to prevent wide spread mortality. Over the last fifteen years this situation has resulted in Ethiopia importing average of 700,000 metric ton food aid per annum to meet food needs among others, demonstrating the scale of the problem in Ethiopia (MoFED, 2002).

To achieve food security and reduce poverty, the logical and paramount goal of the government of Ethiopia is to pursue objectives of sustainable development. Sustainable

[1] This recommended daily allowance for Ethiopia is 2200Kcal per adult equivalent per day (MoFED, 2002).

development entails the harmonization of population growth with utilization and exploitation of the natural resource. This requires redirection and reorientation of research and development as well as institutional change. The basic requirement in this harmonization process is to address change posed by negative synergy arising from rapid population growth, environmental degradation and low agricultural production, leading to food insecurity (Gezahegn et al., 2004).

Thus, there is an urgent need to harness soil and climate resources in an agro ecological balance sense for sustained and increased crop production in the country. Effective technologies are needed to sustain dry land agriculture. The primary socioeconomic concern which should be taken into account is that rain fed agriculture particularly in the dry land is very complex and a high – risk enterprise. Thus, a system approach and risk management is key issue (ibid).

2.6. Definition and History of Irrigation Development

2.6.1Definition

Irrigation is much discussed but seldom clearly defined. It may mean frequent and regular application of water, to others as little as one annual watering. A wide definition such as the following is, therefore, more useful. Irrigation is the practice of applying water to the soil to supplement the natural rainfall and provide moisture for plant growth (Uphoff, 1986).

2.6.2 History of irrigation development

Irrigation is a very old practice in the world. It is an old human activity and been practiced in some parts of the world for several thousand years. Rice has been grown under irrigation in India and Far East for nearly 5000 years. The Nile valley in Egypt and the plain of Tigris and Euphrates in Iraq were under irrigation for 4000 years (Peter, 1997).

Irrigation has formed the foundation of civilization in numerous regions for millennia. Egyptians have depended on the Nile's flooding of the delta for years, this may well be the longest period of continuous irrigation on a large scale. Mesopotamia, the land between the Tigris and Euphrates, was the bread basket for the Sumerian Empire. This civilization managed a highly developed, centrally controlled irrigation system. In that same time frame, irrigation apparently developed in present day China and in Indus basin (Schilfgaarde,1994).

Irrigation has long played a key role in feeding expanding populations and is undoubtedly destined to play a still greater role in the future. It not only raises the yields of specific crops, but also prolongs the effective crop- growing period in area with dry seasons, thus permittingmultiple cropping(two or three and sometimes four crops peryear) where only a single crop could be grown. Moreover, with the security provided by irrigation, additional inputs needed to intensify production such as pest control, fertilizer, improved varieties and better tillage become economically feasible. Irrigation reduces the risk of these expensive inputs being wasted by crop failure resulting from lack of water (FAO, 1997).

According to FAO (1997), 30-40 percent of world food production comes from an estimated 260 million ha of irrigated land or one–sixth of the world's farmlands. Irrigated farms produce higher yield for most crops. FAO (2001) also reports that the role of irrigation in addressing food insecurity problem and in achieving agricultural growth at global level is well established. Cleary irrigation can and should play an important role in raising and stabilizing food production especially in the less developed parts of Africa South of the Sahara.

2.6.3 Irrigation Development in Ethiopia

Irrigated agriculture is not an entirely new phenomenon in Ethiopia. As some literatures indicated, Small-scale traditional irrigation has been practiced for decades throughout the highlands where small farmers could be diverted seasonally for limited dry season cropping (FAO, 1997). According MoWR 1999) modern irrigation has documented in the1960s where the government designed large irrigation projects in the Awash Valley to produce food crops for domestic consumption and industrial crops for exports and it was strongly believed that rain fed agriculture should be supplemented by irrigation in order to achieve national food self-sufficiency and ensure household food security. The total irrigation potential in Ethiopia is 3,798,782 hectares but currently irrigation schemes have covered only 368,160 hectares, 10% of the potential (MoFED, 2012).

The development of modern irrigation has relatively recent history in Ethiopia, where as traditional irrigation has been in existence for long periods. Private concessionaires who operated farms for commercial cotton, sugar cane and horticultural crops started the first formal large and medium irrigation schemes in the Awash Valley (MoA, 1993). Irrigation contributes to agricultural productivity through solving the rainfall shortage, motivates farmers to use more of modern inputs

and harvest throughout the year and creates employment to members of the households especially to wife and children (FAO, 2011).

According to WSDP, 2002 irrigation in Ethiopia can be classified in to three:

1. Small-scale irrigation which are often community based and traditional methods covering less than 200hectares.
2. Medium scale irrigation which is community based or publicly sponsored, covering 200 to 3000 hectares.
3. Large scale irrigation covering more than 3000 hectares, which is typically commercially or publicly sponsored.

The large-scale irrigation scheme is inefficient although it increases food security (Torell and Ward 2010). Small scale irrigation is affordable and efficient in terms of cost, operation and maintenance (Awulachew et al. 2007). It is constructed with small financial amounts by the local communities. The technology used to control and divert water for the schemes is simple and traditional. Its management system involves local leadership, water users' association or irrigation cooperative (Hagos et al. 2009). The schemes are also distributed widely at village level. Hence, this study mainly concentrated on the small-scale irrigation system in the region.

2.6.4 Overview and definitions of Small Scale Irrigation

Small-scale irrigations are type of irrigations that defined as schemes that are controlled and managed by the users. Small-scale schemes developed, operated and maintained by individuals, families, communities, or local rules and landowners, independently of government W. Bart (1996). In the same way, Small-scale irrigation is a type of irrigation defined as irrigation, on small plots, in which farmers have the controlling influence and must be involved in the design process and decisions about boundaries (Tafese, 2007).

Small-scale irrigation is widespread and has a vital role to play in Ethiopia. The success of small scale systems is due to the fact that they are self-managed and dedicated to the felt needs of local communities. Indeed, small-scale schemes are defined as schemes that are controlled and managed by users themselves (Taffa, 2002).

According to Taffa (2002) the main advantages of small-scale irrigation schemes are:

- Much lower investment costs, and in a majority of cases these costs are borne by the community
- Do not involve dams or storage reservoirs, hence no population displacement is involved
- Less demanding in terms of management, operation and maintenance
- No land tenure or resettlement implications
- No serious adverse environmental impact
- Allow a wider diffusion of irrigation benefits and permit farmers to learn irrigation techniques at their own pace and in their own way.

2.6.5. Status and potential of small scale irrigation in Ethiopia

The estimates of the irrigation potential of Ethiopia vary from one source to the other, due to lack of standard or agreed criteria for estimating irrigation potential in the country (IWMI, 2005). According to MoWR (1999) the irrigation potential of the country is one of the most underutilized opportunities. The country has an irrigable land of about 3.7 million hectare whereas the total irrigated area is 190,000 hectare. The size of area cultivated under small scale irrigation system is about 70,000 hectare (WSDP, 2002). In addition to the government, several organizations are involved in the planning, designing and construction of small scale irrigation schemes (IWMI, 2005).

2.7 Small-scale Irrigation and Food Security

Studies in Agriculture and food security show that it can hardly be disputed that the majority of the world's poor still live in rural areas and depend crucially on agriculture for their livelihoods (IFAD, 2001:2). It seems reasonable then that raising the profitability of agriculture will be helpful to the poor, and this involves taking steps either to increase agricultural productivity per acre or encouraging a switch to higher valued crops (FAO, 2002:45). Increased agricultural productivity raises profits and hence incomes for those who own land. This may help reduce poverty if the poor also own some land and participate in the productivity increase (FAO, 2002:45). With the ever increasing food insecurity in Sub-Saharan Africa, irrigation has been brought forward as a strategy of ensuring food security. Rukuni is cited as acknowledging that irrigation development represents the most important

interface between water and land resources (Nhundu and Mushunje, 2008:3). With only 4% of the 871 million hectares of land in Africa being under irrigation, small-holder irrigation has been hailed as the panacea for food insecurity in dry regions, especially in light of climatic change.

This study reviewed the economic contribution of small scale irrigation on rural household food security. Irrigation investment in India enabled farmers to increase diversification of crops, and use of more chemical inputs like pesticides, fertilizers or improved seed varieties (Bhattarai et al., 2007) and switched from low-value subsistence production to high-value market-oriented production in China (Huang et al., 2006). Farmers in rural areas suffered from persistent poverty and food insecurity due to climatic changes and dependent on variable rainfall. This leads to low agricultural productivity. As a result, the low productivity areas characterized by persistent rural poverty and increasing population pressure have often resulted in a vicious circle of poverty and environmental degradation (Von Braun, 2008). As many of the low productivity areas did not use water resources, irrigation development is recognized as a backbone of agricultural productivity, enhancing food security, earning higher incomes and increasing crop diversification (Smith, 2004). In many developing countries, small scale irrigation schemes were considering as a means to increase production, reduce the risk of unpredictable rainfall and provide food security and employment to poor farmers (Burrow,1987).Small-scale irrigation is a policy priority in Ethiopia for rural poverty alleviation, food security and growth.

It enables households to generate more income, increase their resilience, and in some cases transform their livelihoods (MOFED, 2006). Small-scale irrigation in Ethiopia had a significant role in diversification of production to new types of marketable crops like fruits, cash crops and vegetables (Eshetu, 2010).

2.8. Environmental impact of small scale irrigation schemes

Irrigation development may have both positive and negative impacts on the environment (FAO, 1997). To a large extent environmental and health issues associated with irrigation and water development in Ethiopia are not to be linked to the limited knowledge of the issue, lack of capacity and resource to invest and mitigate the constraints and limited knowledge of

indigenous practices used to protect human health or the environment (Manoncourt and Murray, 1996). Negative environmental impacts of irrigation development occur off-site as well as on site. The effects take place upstream of the land to be developed, where a river is to be dammed for the purpose of supplying irrigation. Another set of problem is generated downstream from the irrigated area by the disposal of excess water that may contain harmful concentration of salts, organic waste, pathogenic organisms, agrochemical residues, and causing siltation, water logging and erosion. Sometimes full utilization of the water creates water shortage to downstream affecting the ecosystem negatively (Wagnew, 2004).

A study by Lire et al. (2004) states that small scale irrigation dam creation in Tigray is associated with important health side effects. There are concerns that these new sources of water may have increased the prevalence of water borne diseases such as malaria and schistosomiasis. According to the same study, malaria and schistosomiasis have historically been present in Tigray, but only seasonally during the rainy months. The presence of micro dams has increased the prevalence of these ailments during the other seasons, as standing water provides a favorable environment for disease transmission (MUC, 1994).

To be sustainable, irrigation must avoid the negative impacts (FAO, 1997). Carefully designed irrigation dams could significantly improve agricultural production and food security (Lire et al., 2004). Construction of small scale irrigation schemes with proper management results in improved livelihood with positive impacts on microclimatic and environmental conditions (Mintesinot et al., 2002).

2. 9 Empirical Evidence of Irrigation for Household Food Security

Different studies were conducted to identify determinant of irrigation participation and food security in different countries including Ethiopia. For example, a study conducted by Dillon (2011) found that household head education level, gender of the head, age of household head, landholding, livestock units, access to credit from financial institutions, farmland size, distance to the roads, distance to markets, distance to rivers, household sizes, access to market information, type of peasant associations and training are important factors influenced to participate in irrigation farming.

Chamber (1994) based on some empirical studies confirms that reliable and adequate irrigation increases employment. Landless laborers as well as small and marginal farmers have more work on more days of the year. A study conducted in 10 Indian villages in different agro-climatic regions shows that increasing irrigation by 40 percent was equally effective in reducing poverty as providing a pair of bullocks, increasing educational level and increasing wage rates (Singh et al., 1993). Kumar (2003) also stated that irrigation has contributed significantly in boosting India's food production and creating grain surpluses used as drought buffer.

As per the study by G/Egziabher (2008), farm production in irrigation and rainfall-based areas of Tigray has big difference in their productivity. He found that the farm production produced based on irrigation was high due to post harvest storage facilities, and doubling or tripling effects of irrigation while the rain-fed areas produced subsistence crops and encountered a chronic food deficit. A study conducted by Hagos et al. (2009) also indicated that irrigation in Ethiopia increased yields per hectare, income, consumption and food security.

A study by Hussain et al. (2004) confirms that, access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. This in turn opens up new employment opportunities, both on farm and off-farm, and can improve incomes, livelihood, and the quality of life in rural areas. Hussain et al. (2004) identified five key dimensions of how access to good irrigation water contributes to socioeconomic uplift of rural communities. These are production, income and consumption, employment, food security, and other social impacts contributing to overall improved welfare.

According to a study carried out on five irrigation schemes in Zimbabwe, the schemes were found to act as sources of food security for the participants and the surrounding community through increased productivity, stable production and incomes. The farmers participating in the irrigation schemes never run out of food unlike their counterparts that depend on rain-fed agriculture (Mudima, 1998).

Ngigi (2002) disclosed that for the two decades in Kenya agricultural production has not been able to keep pace with the increasing population. To address this, challenge the biggest potential for increasing agricultural production lies in the development of irrigation. According to the same study, irrigation can assist in agricultural diversification, enhance food self-sufficiency, increase rural incomes, generate foreign exchange and provide employment opportunity when and where water is a constraint. The major contributions of irrigation to the National economy are food security, employment creation, and foreign exchange.

Muduma (2001, cited in Lijalem, 2011) found that smaller irrigation has brought many successes to farmers. Some of the success are here below;

- Crop yield and farmers' incomes under small holder irrigation can increase many folds with Irrigation
- Crops unknown to communal farmers started to be grown under Irrigation
  Smallholder Irrigators are able to grow high – value crops both for local and export market, thus effectively participating in the main stream economy.
- Farmers in successful Irrigation schemes have acquired physical assets (Improved Housing, farm implements, furniture, and electrical appliances) and their standard of living has improved sustainability.
- Irrigation schemes provided an alternative source of employment to the rural people thereby discouraging rural to urban migration.

Small-scale irrigation in Ethiopia had a significant role in diversification of production to new types of marketable crops like fruits, cash crops and vegetables (Eshetu, 2010). Similar study by Shiferaw.et.al (2004) found that the analysis of household food security determinants in Southern Ethiopia that adoption of improved technology; having larger farm size and having better land quality were found an important role in ensuring household food security in the study area.

In Ethiopia a study conducted by Woldeab (2003) identified that in Tigray irrigated agriculture has benefited some households by providing an opportunity to increase agricultural production through double cropping and by taking advantage of modern technologies and high yielding crops that called for intensive farming.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Description of the Study Area

3.1.1. Location, Population topography and Climate

Adaba district is one of the Woreda in the Oromiya Region of Ethiopia; itshares the name of its administrative center, Adaba. Part of the West Arsi Zone, Adaba is bordered on the Southwest by Nensebo, on the west by Dodola, on the Northwest by the Shebelle River which separates it from the Gedeb Asassa, and on the east and south by Bale Zoneand it is 420 Km from the capital city Addis Ababa.

Maps of Adaba Woreda, previously it was located under Bale zone but now it is located West Arsi zone, Oromiya region, Ethiopia.

The total population of Adaba district is 138,717, of whom 68,775 were men and 69,942 were women; 12,099 or 8.72% of its population were urban dwellers The majority of the inhabitants were Muslim, with 84.39% of the population reporting they observed this belief, while 14.46% of the population said they practiced Ethiopian Orthodox Christianity (CSA, 2007).

As far as the land distribution is concerned, the land in this Woreda shows that 16.9% is arable or cultivable, 23.3% pasture, 52.2% forest, and the remaining 7.6% is considered swampy, mountainous or otherwise unusable as per the report of the District Office of Agriculture and Rural Development. The district has a mean land holding of 0.37 hectares per household with minimum and maximum mean holding of 0.18 hectares and 1.57 hectares per household. Agriculture, with rain fed crop cultivation of 96.3 percent and 3.7 percent livestock rearing, is the main source of household income and employment. Moreover; 95 percent of the household's use mixed farming system and 1.5 percent of the households based their livelihood only on livestock rearing.

The largest proportion of Adaba district (about 95 percent of its surface areas) belongs to Woinadega2 agro-climate and the remaining small proportion of land (about 5 percent of its surface area) is classified as Dega3 agro-climate .

3.2. Description of the irrigation schemes

The study was in Furuna Kebele of Adaba Woreda. This Kebele has relatively high water potential, farmers in the areas have long history of traditional practices, this Kebele has better irrigation activities that give opportunity to government in developing modern small-scale irrigation schemes and the Kebele accessible in terms of roads, market etc. Therefore because of the above reasons, the researcher chooses the Woreda as well as the Kebele to study the impact of small-scale irrigation on rural household food security.

The Furuna small-scale irrigation scheme is established by diverting water from the Erer Mede Telila River in Furuna Kebele of the Adaba district. The river has an estimated discharge of 350 lit/sec. The irrigation scheme was developed in 1993 with total investment cost of 503,421 Birr (Ethiopian currency) funded by LWF/Lutheran World Federation/. The

[2]Woinadega refers to a weather condition which is moderate (temperature)
[3]Dega refers to highland

capacity of the irrigation scheme is an area of 150 hectares with gravity flow of water. With this capacity, the irrigation scheme is benefiting 265 households in the Kebele.

3.3. Sources and Methods of data collection

The study area has a total of 4278(713HH) individuals living in Furuna Kebele. Considering time and cost constraints a questionnaire survey found to be applicable method. Both primary and secondary data were used for this study. The primary data were collected by interviewing sampled farmers with the help of structured questionnaire. The questionnaire incorporated information on demographic information of household heads, like age, sex, educational level, and household size in adult equivalent, cultivated land, farm experience, and access to extension service, access to credit, irrigation access, livestock holding, market access, household income and expenditure of the household heads.

For the purpose of primary data collection, three enumerators were recruited from the study area, who know the culture and languages of the locality. A two-days training on interviewing techniques and recording response was organized and given to the enumerators. Before the conduct of actual task, the structured questionnaire was pre-tested with few households randomly selected from a PA nearer to Adaba town.

Secondary information that could supplement the primary data were collected from published and unpublished documents obtained from, Bale zone Irrigation Development Authority, Adaba Woreda Agricultural and Rural Development office, Adaba Woreda administration, Ministry of Finance and Economic Development, Oromiya Irrigation Development Authority.

3.4. Sample Size and Sampling Technique

In this study, three stage sampling technique was used. Firstly, Adaba Woreda is purposely selected mainly because of the area has relatively better small-scale irrigation activities that gives opportunity to develop modern small-scale irrigation schemes. Secondly, the sampling frame obtained from the Furuna Kebele was stratified into two groups of irrigation participants and non-participants.

For this study, participants are those households in Furuna Kebele, who used irrigation (River diversion or well). While the non-participants are those households, in the same Kebele, with no irrigation access from the scheme. Finally, 144 farm households consisting of 72 irrigation users and 72 non –users were selected from the identified list using simple random sampling

technique taking into account). Due to time and financial constraints are among the factors that forced the researcher to limit the number households to 50% of the normal sample size which is 264 and assumed additional 9% for the house hold who are non-respondent.

3.5 Data Analysis Techniques

To achieve the objectives, both descriptive statistics and Hackman's two stage estimation were used to analyze the collected data.

3.5.1. Descriptive statistics

The descriptive analyses tools used are mean, percentage mean, mean difference and standard deviation. The descriptive statistics was run to observe the distribution of the independent variables. The socio-economic and institutional characteristics of the respondents such as age, sex, level of education, farm experience, household size in adult equivalent, cultivated land holding, soil fertility, livestock holding, access to extension service, access to credit, distance to market, distance to farmer training center, and uses of household heads are analyzed.

T- statistics and chi-square (χ 2) tests were used to identify whether the variables are statistically significant or not. The t-test is used to test the significance of the mean value of continuous variables of the two groups of users and non-users and chi-square (χ 2) is used to test the significance of the mean value of the potential discrete (dummy) explanatory variables.

3.5.2 Econometric analysis

Heckman two-step procedure: Evaluating the impact of an institution or a program on an outcome variable using regression analysis can lead to biased estimate if the underlying process which governs "selection in to the institution or a program is not incorporated in the empirical framework. The reason for this is that, the effect of the program may be over (under) estimated if program participants are more (less) able due to certain unobservable characteristics, to derive these benefits compared to eligible non-participants (Zaman, 2001).

To evaluate the benefit from a program, a model commonly employed is the following

$$Y = \beta X + \alpha D + u \quad \ldots\ldots (1)$$

Where Y is the outcome/impact, X is a vector of personal exogenous characteristics and D is a dummy variable (D=1, if the individual participates in the program and 0 otherwise). From

this model, the effect of the program is measured by the estimate of α. However, the dummy variable "D" cannot be treated as exogenous if the likelihood of an individual to participate or not to participate in the program is based on an unobserved selection process (Maddala,1983).

One solution to this problem in econometrics is the application of Heckman two-step procedures. The Heckman model is a response to sample selection bias. It is the appropriate tool to test and control sample selection biases (Wooldrige,2002). It involves two equations.

The first stage models a 'participation equation', attempts to capture the factors governing membership in a program. This equation is used to construct a selectivity term known as the 'Mills ratio' which is added to the second stage 'outcome' equation. If the coefficient of the 'selectivity' term is significant then the hypothesis that the participation equation is governed by an unobserved selection process is confirmed. Moreover, with the inclusion of extra term, the coefficient in the second stage 'selectivity corrected' equation is unbiased (Zaman, 2001).Therefore, to evaluate the impact of small scale irrigation on household food security, the Heckman two-step procedure is employed.

Let Z be a group of K variables which represent the characteristics of a household i which influences the probability of participation in irrigation agriculture measured by a latent variable Di and γk are the coefficients which reflect the effect of these variables on the probability of being an irrigation farmer, and is X is a group of variables which represent the characteristics of household i which determine household's food security (Ci) and βs are the coefficients which reflect the effect of these variables on household food security. Thus, the Heckman two-step procedure takes the following form:

$D^*I = \sum Zi\gamma k + ui$ (k=1up to k) …… (2)

$Ci=\sum \beta s+Xis+\varepsilon i$(s=1 up to s) Observed only if Di >0 ……. (3)

Where the disturbances ui and εi follow a bivariate normal distribution with a zero mean, variance бu and бε respectively, and covariance бεu. Therefore, we define a dichotomous variable Di which takes a value 1when a household is an irrigator and 0 otherwise. The estimator is based on the conditional expectation of the observed variable, household food security (Ci):

$$E(Ci/Di>0) = x\beta + \sigma\varepsilon u + \sigma\varepsilon\lambda(-\gamma k) \quad \ldots\ldots (4)$$

Where λ is the inverse Mills ratio defined as $[\lambda(-\gamma z) = \phi(-\gamma z)]/[1-\varphi(-\gamma z)]$; β and γ are he vectors of parameters which measure the effect of variables X and Z, ϕ and φ are the functions of density and distribution of a normal, respectively. The expression of conditional expectation shows that Ci equals β x only when the errors ui and εi are none correlated, i.e., σεu=0; otherwise, the expectation of Ci is affected by the variable of equation 2. Thus, from expression 4 we find that:

$$Ci/Di>0 = E(Ci/D^*>0) + Vi = x\beta + \sigma\varepsilon u\sigma\varepsilon\lambda(-\gamma z) + Vi \quad \ldots\ldots (5)$$

Where Vi is the distributed error term, $N\ [0, \sigma\varepsilon(1-\sigma\varepsilon u(\lambda(\lambda-\gamma z)))]$

3.6. Variables of the Model

Different variables are expected to affect rural households‟ decision participation in small-scale irrigation schemes and level of income from small scale irrigation in the study area. The variables hypothesized to influence participation decision in small-scale irrigation and food security status are explained in this section.

Dependent Variables

For the Hackman second step analysis household expenditure in adult equivalent is a continuous variable measured in ETB. The dependent variable of the first stage of this study is participation in the small-scale irrigation scheme with dummy values of 1 for households having access to irrigation and 0 for those having no access to the irrigation scheme in the study area. Moreover; the outcome variable for this study is food consumption expenditure per adult equivalent. The dependent variable was assumed to be influenced by its independent variables. Each variable is defined with their hypothesis based on economic theory and results of previous empirical studies.

Independent variables

The independent variables that are hypothesize to influence the households‟ decision to participate in small scale irrigation and food security status are combined effects of various factors such as: demographic, socio-economic and institutional factors. Based on review of literatures on factors influencing participation in small scale irrigation and level of

farm income the following potential explanatory variables are considered in this study and examined for their effect in farmers‟ participation decision of small-scale irrigation and food security status. These are presented as follows:

Irrigation (ACCIRRIG):it is hypothesized that access to irrigation increases production, and consumption of a household. Abebaw (2003) indicated that irrigation reduces the risk of food insecurity. Therefore, it is assumed that access to irrigation and household food security have a positive relationship. The variable is entered the model as a dummy variable (takes a value of 1 if the household has access to irrigation and 0 otherwise).

Distance from Market Center (DISMARKE):this variable is a continuous variable measured in kilometer. It is hypothesized that the farther the market center is the lesser the income from the sale of farm produce. Especially for perishable commodities if the market place is located far away from the farm, the commodity may perish before reaching the market and to avoid such incidences the farmer sells his output for cheaper price thus reducing the income and bringing negative impact on household food security.

Socio-Demographic Factors

Age of the household head (AGEHEAD):a study conducted by Abebaw (2003) indicated that age has significant effect on household food security. That is, the older the household head, the more experience he has in farming and weather forecasting. As a result, the chance for such household to be food secure is high. Therefore, it is hypothesized that age of household head has positive impact on household food security. This variable is a continuous variable measured in number of years.

Dependency Ratio (DEPRATIO): this is a continuous variable and defined as the number of household members whose age are less than 15 plus household members whose age are greater than 64, divided by the total family members. This ratio tells us the proportion of household members who are dependent on the active members of the family. It is hypothesized that the more the dependency ratio in a household the less food secure the household would be. It is expected that this variable negatively affects household food security.

Household Size: (HHSIZEAE):this variable refers to the size of household members converted in to adult equivalent. The existence of a large household size negatively influences

household food security (Mulugeta, 2002). Therefore, it is expected that household size and food security are negatively related. It is a continuous variable measured in the number of adult equivalent.

Sex of Household Head (SEXHEAD):it is hypothesized that male-headed households are in a better position to pull labor force than the female headed ones. Christina et al., (2001) states that women farmers may need a long adjustment period to diversify their ye food secure than female headed households. This variable is entered the model as dummy variable (takes a value of 1 if the household head is male and 0 otherwise) and expected to have a positive relationship do not with household food security.

Level of Education of the Household Head (EDUCATAGORY): this variable entered the model in five categories: illiterate, read and write, grade1-4, grade 5-8 and grade >8. It is hypothesized that household heads that are literate have a better knowledge of how to make a living. Abebaw (2003) indicated that literate household heads contribute to household food security positively. This variable is a categorical variable and expected to have a positive relationship with household food security.

Size of Cultivated Land (CUTLAND):Mulugeta (2002) and Ayalew (2003) identified that size of cultivated land has positive impact on household food security. This variable represents the total cultivated land size (both irrigated and rain fed) of a household measured in hectare. It is hypothesized that farmers who have larger cultivated land are more likely to be food secure than those with smaller area. A positive relationship is expected between household food security and cultivated land size.

Livestock Holding (LIVESTOC):increased livestock holding leads to improved food security status Belayneh (2005). This variable is expected to have a positive relationship with household food security and entered the model as a continuous variable measured in Tropical Livestock Unit.

Farmers' Perception of Soil Fertility Status (SOILFERT):if the farm land is fertile the household can produce more and if the land is infertile less will be produced affecting the household food security (Yilma, 2005). Thus, it is expected that households with fertile land are more food secure than households with infertile land indicating a positive relationship with household food security. This variable is entered the model as a dummy variable (it takes a value 1 if the household has fertile land and 0 otherwise).

Nearness of the Household to the Water Source (NEARNESS): nearness of the households to the water source is expected to determine both the household's participation in irrigation scheme and improving household food security status. This variable is a continuous variable measured in kilometer.

Institutional Factors

Access to Extension Service (SUPPEX):it is expected that extension service widens the household's knowledge with regard to the use of improved variety and agricultural technologies and has positive impact on household food security. This variable entered the model as a dummy variable (takes a value of 1 if the household has access to extension service and 0 otherwise).

Access to Credit Service (CREDIT):it is hypothesized that accesses to credit and food security have positive relationship. The variable is entered the model as a dummy variable (it takes a value 1 if the household has access to credit service and 0 otherwise).

Definition of independent variables are presented on Table 1

VARIABLES	DEFINITIONS
ACCIRRIG	Access to irrigation of the household/It is a dummy variable that takes a value of 1 if the household has access to irrigation, 0 otherwise
HEADAGE	Age of household head measured in years/It is a continuous variable/
HEADAGE2	Age of the household head square/ It is a continuous variable/
HHSIZEAE	Age of the household head square/ It is a continuous variable/
HHSIZEAE2	Household size in adult equivalent square/ It is a continuous variable/
EDUCATAGORYE	Education of the household head in category/illiterate, read and write, grade 1-4, grade 5-8 and grade >8/
SEXHEAD	Sex of the household head/ This is a dummy variable which takes a value of 1 if the household head is male and 0 otherwise
CUTLAND	Cultivated land size (both irrigated and rain fed) in hectare/ It is a continuous variable/
LIVESTOC	Total livestock holding measured in Tropical Livestock Unit/ It is a continuous variable/

DISMARKE	Distance from the market place in kilometer/It is a continuous variable/
SOILFERT	Farmers' perception of soil fertility status / it is a dummy variable (takes a value 1 if the household has fertile land and 0 otherwise).
NEARNESS	Nearness of households to water source in kilometer/It is a continuous variable/
SUPPEX	Access to extension service of the household/ It is a dummy variable, takes a value of 1 if the household gets access to extension service and 0 otherwise
CREDIT	Access to credit/ It is a dummy variable, takes a value of 1 if the household takes credit and 0 otherwise

3.7. Measuring Household Food Security

Using the available data, food security measurement can be estimated through several feasible methods. In this study the food energy intake method by Greer and Thorbecke (1986) was employed for ease of computation. What the food energy intake method is aiming to do is find a monetary value of the poverty line at which "basic needs" are met. Food energy intake will naturally vary at a given expenditure level.

Recognizing this fact, the method typically calculates an expected value of intake. To obtain the estimated cost of acquiring the calorie recommended daily allowance (RDA) that is, 2200 kcal per adult equivalent per day, this method regresses food energy intake (calorie) against total food expenditure per adult equivalent per annum. Accordingly, birr 990 was found to be the minimum food expenditure per adult equivalent per annum required to meet basic needs (calorie recommended daily allowance). In this study food expenditure data was collected on a monthly basis, however, in order to calculate the food expenditure, the data was scaled up to yearly basis.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1. Descriptive Statistical Results of the Model Variables

4. 1.1. Household Size

According to the study, the total size of household members in the 144(72 Irrigation user and 72 non irrigation user) sample householdswere678 people. The average household size of the total sample households in adult equivalent was 4.7 persons, with 1 and 9.3 being the minimum and the maximum household sizes respectively. When we compare the average family household sizes between irrigation users and non-users, the study revealed that households with access to that use irrigation have smaller family household size than households with no access to that do not use irrigation. Average family size household size for users is 4.3 persons and 5.1 persons for non-users. The mean comparison of family size household size between the two groups showed that there was a statistically significant difference in the mean family household size at less than 1 percent probability level between users and non-users.

4. 1.2. Dependency Ratio

The survey result showed that the average dependency ratio for the sample households is 0.4 implying that every 100 people within the economically active population groups supported not only themselves but also additional 40 economically dependent persons with all basic necessities. The mean dependency ratio for irrigation users is 0.4 the corresponding figure for non-users is, 0.5 which is significantly higher. The t-test revealed that the mean difference between the two groups is statistically significant.

4. 1.3. Age of the Household Head

The average age of the sample household heads is 48 years where the minimum is 22 and the maximum is 90. The average household age of irrigation users is 46 and the corresponding figure for non-users 49. From the statistical analysis performed, it is found out that the mean age difference between users and non-users is not statistically significance.

4. 1.4. Sex of the Household Head

According to the survey result, 12.5 percent of the sample households are headed by females and the rest 87.5 percent are headed by male. When we see the comparison by access to

irrigation, out of the 72 irrigation user households 7 are headed by female and the corresponding figure for non-users is 9 out of 72 non irrigation users. The chi square test showed that there is no relationship between sex of the household head and access to irrigation.

4. 1.5. Level of Education of the Household Head

In the study area, 49.3 percent of the sample household heads are found to be illiterate, where as 13.2 percent of the sample household heads have attained education level greater than grade 8. The comparison by access to irrigation reveals that 41 users and 30 non users are found to be illiterate. 12 user household heads have attained grade greater than 8 the corresponding number for non-user household heads is 7. The chi square test shows that there is relationship between access to irrigation and level of education.

4. 1.6. Size of Cultivated Land

The land holding of the sample household varies from 0.1 ha to 7.2 ha. the average land holding being 1.5 ha. The mean land holding for users is 1.5 ha the corresponding figure for non-users is 1.4 ha. The t-test revealed that mean difference between the two groups is not statistically significant.

4. 1.7. Livestock Holding

The study showed that out of the 144 sample households 98 own livestock. The mean livestock holding in Tropical Livestock Unit (TLU) for the sample households is 6.7, where the minimum is 0.7 and the maximum is 15.9. Irrigation user households have a better livestock holding than nonuser households. According to the study, out of the 98 households with livestock holding 71 are users and the rest 27 are non-users. The mean livestock holding for user households is 7.3 TLU and 5.0 TLU for non-users. The mean comparison for the two groups showed that the difference between the groups with regard to livestock holding is statistically significant at 1percent probability level.

4.1.8. Total Production

The major crops grown in the study area are barely, wheat, pea, beans and horticultural crops such as onion, tomato and potato. The mean annual production of the sample households is 7,972.2 kg, though the range varies between 80 kg and 183,400.0 kg. The average annual production for irrigation user households is 13,689.1 kg while the annual average for non-users is 2,255.4 kg. The mean comparison between the two groups in relation to annual crop

production showed that the difference between the two groups is statistically significant at 1 percent probability level.

4. 1.9. Total Consumption Expenditure

The average consumption expenditure per adult equivalent per annum for sample households is found to be Birr 1,368. The average spending for irrigation users is Birr 1,780.3 and for the non-user households it is Birr 955.6. The mean difference between the two groups was found to be statistically significant at 1 percent probability level.

4. 2.10. Distance from Market Center

The mean distance to the market place in kilometer for the sample households is found to be 6.7 km with a minimum of 3 km and a maximum of 13 km. The average for households with access to irrigation is 7.3 km while the non-user households have a better access to the market place which is 6.1 km. The mean difference between the two groups with regard to distance from the market place is statistically significant at 1 percent probability level.

4. 1.11. Access to extension service

The study result showed that 56 percent of the sample households get extension service. When we compare irrigation user and non-user households' majority of the user households get support from extension agents when compared to non-users. According to the survey 67 users and 45 non users get extension service. Extension service here refers to advice, training, demonstration and distribution of input. The chi square test indicated that there is significant relationship between access to irrigation and access to extension service.

4. 1.12. Access to credit service

The main source of credit in the study area is micro finance institute. From the sample households 41 percent get credit while 59 do not take credit due to various reasons. The comparison by access to irrigation disclosed that 21 users and 38 non users take credit. From users 50 percent of the sample respondents and from the non-user 31 percent households said that they don't want credit and the rest complained about high interest rate. The chi square test result revealed that the relationship between access to credit and access to irrigation is statistically significant.

4. 1.13. Farmers perception of soil fertility status

In the study area soil infertility is not a major problem. Majority of the respondents said that they do not have soil fertility problem, 83 percent of them stated that they consider their land

fertile. The comparison between user and non-user households showed that 68 users and 52 non users have fertile land (according to their opinion). The chi square test revealed that there is a statistically significant relationship between soil fertility status and access to irrigation at 1 percent probability level.

4.1.14. Nearness of the households to water source

The average distance between the villages and the water source in kilometer for the sample households is found to be 13 km with a minimum of 2 km and a maximum distance of 25 km. The average distance for irrigation user villages is 12.5 kilometer, the corresponding figure for non-users is 13.5 km. The t-test for the two groups with regard to nearness to the water source is not statistically significant.

The summary of the descriptive statistics for both continuous and discrete variables are displayed in Table 2 and Table 3 respectively.

TABLE 2

Summary of descriptive statistics for continues variables

Variable	User		Non user			t-value
	Mean	Std.	Mean	Std	MD	
HEADAGE	46.8	14.4	49.5	12.5	2.7	1.4
HHSIZEAE	4.3	1.7	5.1	1.8	0.7	3.0***
DEPRATIO	0.4	0.1	0.5	0.1	0	3.1***
CUTLAND	1.5	1.5	1.4	0.7	0.1	0.9
LIVESTOC	7.3	3.4	5	2.6	2.2	3.6***
TOTPRODUC	13,689.10	21,706.80	2,255.40	3,487.00	11,433.70	5.2***
TOTEXPEN	1,780.30	946.4	955.6	434.5	824.7	7.9***
DISMARKE	7.3	2.2	6.1	1.9	1.2	4.0***
NEARNESS	12.5	7.5	13.5	11.5	1	0.4

Source: Computed own survey (2020)

*** indicates significance level at 1 percent.

** indicates significance level at 5 percent.

* indicates significance level at 10 percent.

TABLE 3

Summary of descriptive statistics results of the dummy variables

Variable	User	Non user	Total	P Value
EDUCATAGORY				0.007***
Illiterate	41	30	71	

Read and write	**1**	**13**	**14**	
Grade 1-4	**3**	**7**	**10**	
Grade 5-8	**15**	**15**	**30**	
Grade >8	**12**	**7**	**19**	
SEXHEAD				**0.6**
Female	**7**	**9**	**16**	
Male	**65**	**63**	**128**	
SUPPEX				**0.002*** **
Access to extension	**67**	**45**	**112**	
No access to extension	**5**	**27**	**32**	
CREDIT				**0.01*** **
Access to credit	**21**	**38**	**59**	
No access to credit	**51**	**34**	**85**	
SOILFERT				**0.001*** **
Fertile	**68**	**52**	**120**	
Infertile	**4**	**20**	**24**	

Source: Computed own survey (2020)

4. 1.15. Means of transportation of agricultural produce to the market

Households in the study area use different ways of transporting their produce to the market place. Among the users, 45 percent of the households transport their produce on horseback and 23 percent of the households use both vehicle and horseback for transporting agricultural produce, carrying on human back and using donkey are also means of transportations for few of the households. The common means of transportation for non-users is loading on horse and donkey backs. The survey showed that 33.5 percent of the non-users transport their produce on horseback and 15.5 percent of them load on donkeys. This may be due to two reasons: the non-user villages are located near the Adaba town so they may not need to pay for transport, the second reason may be non-users may not afford the transportation cost to use vehicle.

4.1.16. Food shortage months of the households

The survey result disclosed that irrigation users are better than non-users with regard to securing the household with sufficient food. The survey showed that almost all the non-users face food shortage during some months of the year. Specially, September is the most serious food shortage month for non-users, 49.5 percent of the non-users face the problem in

September. August, October and July are also identified to be months of insufficient food with 36.5 percent, 31.5 percent and 12 percent of households respectively facing the problem. This may be because non users are producing once a year and if they run out of food before the next harvesting season they may not have other alternative food source. In the case of users, they can produce more than once a year to supplement the rain fed agriculture. Some of the users also face food shortage problem that is, 17.5 percent of them reported food shortage in October, 7 percent in August and 7.5 percent of them in September.

4. 1.17. Coping strategies of households

Households in the study area have various coping mechanisms during crop failure. The survey showed that user households have a better coping strategy than the non-users. None of the users search for off farm employment as a coping strategy. On the other hand, 6.5 percent of non-users join off farm employment during bad times as a coping mechanism. Sales of small animals are the major coping strategy in the study area, 44.5 percent of the users and 48 percent of the non-users sell animals to pass bad years. Taking credit is also the other way of coping mechanism, 15.5 percent of non-users and 8 percent of users employ this strategy. Cattle selling is also a coping strategy in the study area, 12.5 percent of the non-users and 5.5 percent of users apply this strategy.

4. 1.18. Food security status of households by access to irrigation

The study grouped households into food secure and insecure based on their access to irrigation. Accordingly, 80 percent of the non-users and 30 percent of users are found to be food insecure respectively and 20 percent of non-users and 70 percent of the users are food secure. Generally, out of the 144 sample households 45 percent of them are food secure and 55 percent of them are food insecure. This classification is made on the basis of the calculation done to measure household food security (Section 3.7). However, access to irrigation is only one of the many other variables that influence the food security status of households. For this reason, the result of the multivariate analyses is presented in the following section.

4.2. Econometric Analysis

In the descriptive analysis part of this thesis the important explanatory variables, which are expected to have effect on households' decision to small-scale irrigation participation were presented. In this section, the selected explanatory variables were used to analyze the determinants of small-scale irrigation participation and outcome using Heckman model.

4. 2.1. Detecting multi-collinearity and outliers

One of the assumptions of the multiple regression models is that there is no exact linear relationship between any of the independent variables in the model. If such a linear relationship does exist, we say that the independent variables are perfectly collinear, or that perfect collinearity exists. Perfect collinearity is easy to discover because it will be impossible to calculate the estimates of the parameters. In practice the more difficult problem is having a high degree of multi-collinearity. The variance inflation factor (VIF), the condition index (CI) and contingency coefficient are the most important tests to detect multi-collinearity (Pindyck and Rubinfeld, 1991).

The study used the variance inflation factor to check for multi-collinearity among continuous variables and contingency coefficient was used to check multi-collinearity among discrete variables. According to the test result, multi-collinearity was not a serious problem both among the continuous and discreet variables. (see appendix II). The study also checked for outliers. An outlier is an observation that lies at an abnormal distance from other values in a random sample from a population. Since there are many ways to identify outliers, this study used a scatter plot diagram to identify outliers. Accordingly, 7 observations were found to be outliers, not representative of the sample, and removed from the model analysis.

4. 2.2. Model results

The econometric analysis for the Heckman two-step procedure was performed using LIMDEP version 7. Data were collected on 144 observations, however, the model was analyzed using only 137 observations because 7 observations were found to be outliers. The Heckman two-step procedure was employed in order to control the selectivity bias and endogenity problem and obtain consistent and unbiased estimates. The Heckman model in the first stage predicts

the probability of participating in the irrigation scheme of each household, in the second stage it analyses the determinants of household food security.

The output for the Probit /participation/ equation shows that seven variables determine the probability of using irrigation. These are Nearness to the water source (NEARNESS), household size in adult equivalent (HHSIZEAE), size of cultivated land in hectare (CUTLAND), farmer's perception of soil fertility status (SOILFERT), household size square (HHSIZE2), access to credit service (CREDIT) and livestock ownership (LIVESTOC).

Nearness to the water source: nearness of the household to the water source has a positive sign as expected and significant at 1 percent probability level. The positive relationship tells us that the nearer the household to the water source, the higher the probability of participating in the irrigation scheme. The marginal effect also indicates that, when the household is closer to the water source by one kilometer, the probability of participating in the irrigation scheme increases by 16 percent. From the result we can see that those households who are situated in nearby places to the water source know that they can easily access the irrigation scheme with minimum cost so they quickly decide to participate in the irrigation schemes.

Household size: the second variable which negatively affects participation in irrigation is household size. This variable is significant at 5 percent probability level. The reason for the negative relationship between family size and participation in irrigation might be that large family size is associated with poor households and the poor households have little bargaining power in negotiating for instance the placement of irrigation schemes. The better off farmers might have influenced the irrigation layout process. The marginal effect indicates that when the household size increases by one adult equivalent the probability of participating in irrigation decreases by 30 percent.

Household size square: the result of the regression estimate shows that household size square has a significant and U-shaped relationship with participate in irrigation. The variable is significant at 5 percent probability level. The significant relationship might be due to two reasons: first larger family size contributes family labor which is required to participate in irrigation. Second larger family size is sometimes related with rich household heads (household heads with more than one wife and many children) who could contribute big sum of money to influence the layout process. The marginal effect result tells us that as household size increases the probability of participation in irrigation increases by 27 percent.

Size of cultivated land: this variable showed a negative relationship with participation in irrigation. It is significant at 1 percent probability level. The possible justification for the negative relationship could be households with larger farm size may not be interested to participate in irrigation suspecting land redistribution. The other reason for the negative relationship could be those households with larger farm size may be able to produce more and secure the family's food need so they may ignore the importance of irrigation for food security. The marginal effect indicates that a one-hectare increase in cultivated land size reduces the probability of participating in irrigation by 24 percent.

Livestock holding: this variable is statistically significant at 1 percent probability level. The positive relationship indicates that households with larger livestock holding may have money to spend on any possible cost to participate in irrigation. The marginal effect indicates that as the households' livestock holding increases by one TLU the probability of participating in irrigation increases by 14 percent.

Farmers' perception of soil fertility status: this variable is significant at 1 percent probability level. It has a positive relationship with participate in irrigation. The regression analysis shows that soil fertility status has an influence on participation in irrigation. Households with fertile land could successfully produce much, in addition to this opportunity, when the households are given access to use irrigation, the output may increase by a significant amount both for household consumption and for sale. This situation encourages them to participate in irrigation. The marginal effect also confirms that better fertility status increases the household's chance of participation in irrigation by 33 percent.

Access to credit service:

this variable negatively influences irrigation participation of households. It is significant at 5 percent probability level. The negative relationship indicates that households might invest the credit they get on other activities other than irrigation. More credit may imply more deviation from participation in irrigation such as: rearing of livestock or spending on consumption. The marginal effect shows that for households with access to credit the probability of being an irrigation beneficiary decreases by 24 percent. In the study area, the descriptive statistics reveals that 15.5 percent of non-users and 8 percent of users use credit as a coping strategy during bad years.

TABLE 4Estimation result of the Binary Probit model and its Marginal Effect

Variable	Coefficient	Marginal effect
CONSTANT	**2.634**	**1.050**
	(0.203)	**(0.203)**
AGEHEAD	**-0.861**	**-0.343**
	(0.248)	**(0.248)**
HHSIZEAE	**-0.764**	**-0.304**
	(0.021)**	**(0.021)**
SEXHEAD	0.414	0.165
	(0.438)	**(**0.438)
EDUCATAGORY	**-0.293**	**-0.117**
	(0.764)	**(0.764**)
DISMARKE	**-0.324**	**-0.129**
	(0.673)	**(0.673**)
CUTLAND	**-0.604**	**-0.241**
	(0.004)***	(0.004)
LIVESTOC	**0.362**	**0.144**
	(0.000)***	(0.000)
SOILFERT	**0.838**	**0.334**
	(0.019)***	(0.019)
SUPPEX	**-0.427**	**-0.170**
	(0.169)	**(0.169**)
CREDIT	**-0.615**	**-0.245**
	(0.024)**	(0.024)
NEARNESS	**0.403**	**0.160**
	(0.008)***	(0.008)
AGEHEAD2	**0.722**	**0.288**
	(0.302)	**(0.302**)
HHSIZEAE2	**0.687**	**0.274**
	(0.034)**	(0.034)

Dependent variable	**Participation decision**
Weighting variable	**one**
Number of Observations	137
Logliklihood function	**-69.13501**
Restricted log likelihood	-133.6504
Chi squared	**129.0309**
Degree of freedom	13
Significance level	**0.0000**

Source: Model output (2020)

*** indicates significance level at 1 percent.
** indicates significance level at 5 percent.
* indicates significance level at 10 percent
Values in parenthesis are p values

In the selection /outcome/ equation of the model, eight variables are found to be a significant determinant of household food security. These are: access to irrigation (ACCIRRIG), household size (HHSIZEAE), sex of the household head (SEXHEAD) access to extension service (SUPPEX), size of cultivated land (CUTLAND), household size square (HHSIZEAE2) nearness of the household to the water body (NEARNESS) and the inverse Mills ratio (LAMBDA).

According to the model output, the Lambda (inverse Mills ratio) term is significant at 5 percent probability level indicating the presence of selectivity bias. The negative sign suggests that the error terms in the participation and outcome equations are negatively correlated. This shows that those unobserved factors that make the household participate in irrigation are likely to be negatively associated with household food security also.

Access to irrigation: although the lambda term confirms that there are some unobservable factors that contributed to improved household food security status, access to irrigation is also positively related to household food security. It is significant at 1 percent probability level. The result shows that in the study area irrigation enable households to grow crops more than once a year to insure increased and stable production, income and consumption thereby improving food security status of the household. The coefficient of the variable confirms that

the food consumption expenditure for irrigation user households is greater that the food consumption expenditure of non-user households by Birr 576 indicating a better food security status of irrigation users.

Household size: household size is negatively related with household food security. The variable is significant at 1 percent probability level. The negative and significant coefficient of household size reveals that larger household size leads to food insecurity. This means, as household size increases there are many dependents in the household to share a plate of food. The coefficient of the variable indicates that as the household size increases by one adult equivalent the food consumption expenditure of the household decreases by Birr 391.9. In other words as the household size increases by one adult equivalent, to keep the household food secure the income should increase by Birr 391.9 This result is consistent with the finding of Mulugeta (2002) and Yilma (2005).

Household size square: the study hypothesized that the relationship between household food security and household size may not be linear throughout. It was assumed that at some point the relationship may become nonlinear. As hypothesized the regression coefficient is found out to be positive and the nonlinear relationship (U-shaped) is found out to be significant at 1 percent probability level. We might assume that there are two extreme cases where the household size becomes large, the first extreme is very poor household heads tend to have larger household size since poor people have the incentive for high fertility to increase the number of potential income earners in the household and to provide for old age security (Smith, 1997).

On the other extreme rich farmers tend to marry more than one wife and increase the number of children. If the household size is increased because of the latter case, there would be a direct relationship between household food security and household size because they can afford to produce or purchase enough food and keep the household food secure. Moreover, larger household size might benefit from economies of scale such as bulk purchase, cooking fuel and labor availability during peak labor demand in agriculture. However, the U-shape relationship obtained in this study might need further investigation.

Sex of the household head: this variable shows negative relationship with household food security. It is significant at 1 percent probability level. The coefficient of the variable shows that when the head of the household is male, food consumption expenditure of the household

decreases by Birr 331.1. The possible justification for this inverse relationship could be, though male headed households are in a better position to pull resource to increase production, they might spent more money on nonfood expenses rather than spending on food items to meet the household's food needs. According to the model output, female headed households are wiser on financial resource allocation to keep their family food secure despite the smaller amount of resource and less experience they have to produce when compared to male headed households. This finding is contrary to the finding of Belayneh (2005) where he identified that male headed households are able to keep their family food secure than female headed households.

Size of cultivated land:the regression result shows that this variable has the expected positive sign and it is significant at 10 percent probability level. As the cultivated land size increases, the household becomes able to increase and diversify the quantity and type of crop produced on the cultivated land, this may in turn imply increased consumption insuring household food security. The coefficient of the variable shows that as the household gets one more hectare of land food consumption expenditure of the household increases by Birr 85 and this may lead to improved household food security status. This result is consistent with the finding of Mulugeta (2002) Ayalew (2003), Abebaw (2003), and Yilma (2005).

Access to extension service:this variable is statistically significant at 10 percent probability level and has the expected positive sign. The positive relationship may indicate that in the study area, those households who get technical advice, training or those who participated on field demonstrations are well aware of the advantage of agricultural technologies and willing to adopt new technologies and produce more, thereby improving the household food security status. The coefficient of the variable indicates that households with access to extension service increase their food consumption expenditure by Birr 117 than those households that do not have access to extension service.

Nearness to water source: as hypothesized this variable is found to be a significant determinant of household food security. It is positively related to household food security and significant at 1 percent probability level. This positive and significant relationship tells us that as households become closer to the irrigation scheme, food security status improves significantly. The possible justification could be households who are closer to the irrigation scheme do not incur much cost to access their farm so they can follow up the farm activity

closely and frequently and may get a better yield. The coefficient of the variable also confirms that when a household is closer to the scheme by one kilometer, the food consumption expenditure increases by Birr 9.6.

TABLE 5Estimation result of the Selection Equation and its Marginal Effect

Variable	Coefficient	Marginal
CONSTANT	1553.936	1553.936
	(0.000)***	(0.000)
ACCIRRIG	576.882	576.882
	(0.000)***	(0.000)
AGEHEAD	14.918	14.918
	(0.348)	(0.348)
HHSIZEAE	-391.676	-391.676
	(0.000)***	(0.000)
SEXHEAD	- 331.133	-331.133
	(0.001)***	(0.001)
EDUCATAGORY	1.736	1.736
	(0.930)	(0.930)
DISMARKE	13.567	13.567
	(0.378)	(0.378)
CUTLAND	85.751	85.751
	(0.058)*	(0.058)
LIVESTOC	-5.063	-5.063
	(0.717)	(0.717)
SOILFERT	-47.613	-47.613
	(0.534)	(0.534)
SUPPEX	117.729	117.729
	(0.069)*	(0.069)
CREDIT	-44.539	-44.539
	(0.429)	(0.429)
NEARNESS	9.602	9.602
	(0.009)***	(0.009)
AGEHEAD2	-0.112	-0.112
	(0.441)	(0.441)
HHSIZEAE2	25.607	25.607
	(0.001)***	(0.001)
LAMBDA	-243.448	
	(0.041)**	
Dependent variable	Total food (Total Food expenditure per adult eq per annum)	
Number of Observations		137

Selection rule is: **User=1**	
Log-L = **1395.691**	**-**
Restricted (b=0) Log -L = **1489.707**	**-**
R-squared =	**0.588**
Correlation of disturbance in regression and selection criteria (Rho) **0.669**	**-**
Prob value =	**0.000**

Source: Model output (2020)

*** indicates significance level at 1 percent.

** indicates significance level at 5 percent.

* indicates significance level at 10 percent

Values in parenthesis are p values

CHAPTER FIVE

SUMMARYCONCLUSION AND RECOMMENDATION

5.1. Summary

The aim of this study is intended to examine the effect of Furuna irrigation scheme on household food security and identify determinants of rural household participation in small scale Irrigation. Irrigation on household food security and identify determinants of access to small scale Irrigation. Out of the 144 sample households 72 of them are irrigation users and the rest 72 are non-users. From the 72 users ,70 percent of them are food secured and the rest 30 percent are food insecured. Out of the 72 non users 80 percent are found to be food insecured and the rest 20 percent food secured. Generally, out of the 144 sample households 45 percent are food secured and the rest 55 percent are food in secured. This descriptive statistic clearly indicates that those households who have access to irrigation are by far better than in securing their food need.

The descriptive analysis also compares the mean of the two groups by using different determinants of household food security. The result revealed that irrigation user households are in a better position when compared to those that are non-users. For example, users have small household size, higher level of education of the household head, large size of livestock holding, better consumption expenditure and all these contributed significantly to a better food security status.

A t- test was also performed to statistically compare the mean difference between the two groups with regard to these variables and a statistically significant result is obtained.

The chi square test also reveals that variables like access to extension service, access to credit and farmer's perception of soil fertility status have significant relationship with access to irrigation.

The descriptive statistics reveals that households with access to irrigation face food shortage in only few months of the year while non users suffer from critical food shortage in August September and October. The survey revealed that households in the study area have various coping strategies during months of food shortage. Sales of small animals, sales of cattle, off farm employment and credit are some of the strategies.

In the study area the common means of transportation of agricultural produce to the market for non-users is loading on horseback and for users' vehicles and loading on horseback. This may be due to two reasons: the non-user villages are located near to the Adaba town so they may not need to pay for transport, the second reason may be non-users may not afford the transportation cost to use vehicle.

Multivariate analysis is performed using the Heckman two- step procedure. The Heckman two -step procedure is implemented in order to capture the selectivity bias and get the effect of small scale irrigation on household food security.

In the first stage of the Heckman two-step procedure the following variables determined participation in irrigation: nearness to the water source, household size, household size square, size of cultivated land, livestock holding, farmer's perception of soil fertility status and access to credit. In the second stage of the Heckman two-step procedure, access to irrigation, household size, sex of the household head, support from extension agents, size of cultivated land, household size square and nearness to the water source are found to determine household food security.

5.2. Conclusions

- The variables that significantly determine participation in irrigation are: household size, size of cultivated land, livestock holding, farmers' perception of soil fertility status, access to credit, nearness to the water source and household size square.
- Livestock holding, farmers' perception of soil fertility status, nearness to the water source and household size square are variables that positively affect participation in Irrigation
- Household size, size of cultivated land, and access to credit are variables that negatively affect participation in Irrigation.
- The negative relationship between access to credit and access to irrigation participation may be because households in the study area be explained by the fact that (1) the HHs in study area use credit as a coping strategy during bad years. (2) in Ethiopia, the institutional credits usually give priority to rain-fed agriculture, and (3) the demand for credit among farmers with access to irrigation may be lower for they can satisfy cash needs through sales from their irrigated crops.

- The positive relationship in livestock holding indicates that livestock holding contributes to participation in irrigation through sales of livestock and income generation for any possible spending in the participation.
- Households that have fertile land are willing to participate in irrigation because they are encouraged to produce more with the given opportunity.
- Households that are situated near the water source are willing to participate in Irrigation.
- In the study area the use of small-scale irrigation contributes significantly to improve household food security. In addition to access to irrigation, access to irrigation, household size, sex of the household head, size of cultivated land, and access to extension service significantly influence the food security status of a farm household.
- Access to irrigation, size of cultivated land, access to extension service and nearness to the water source are variables that positively determine household food security.
- Household size and sex of the household head are variables that negatively determine household food security.
- Access to irrigation is found to be a significant determinant of household food security
- The relationship between a household food security status and household size is non-linear (see the signs for the variables household size and the square of household size). As the size of a household increases the per capita food expenditure decreases, but up to a point, after which the per capita food expenditure starts to increase as the household size increases.
- The negative relationship tells us that households headed by male are food insecure than households headed by female. Therefore, to keep male headed household's food secure they should be given training on financial resource management.
- Size of cultivated land and household food security are positively related indicating larger farm size improves household food security. Households with large farm size are found to be food secure, however, there may not be a possibility of expanding cultivated land size anymore because of increasing family size and degradation of the existing farm land. Therefore, household must be trained as to how to increase production per unit area (productivity).

- Access to extension service is also positively related to household food security. Extension workers could play a key role in transferring knowledge to the rural people easily there by improving production and consumption. Capacity building of the existing ones and training more extension workers might help address the issue.

5.3. Recommendations

The following possible policy recommendations have emerged from the analysis of this research study and are presented as below:

- Access to irrigation is found to be a significant determinant of household food security Therefore, Small-scale irrigation is a policy priority in Ethiopia for rural poverty alleviation, food security and growth.
- Expanding the capacity of small-scale irrigation agriculture and creating additional access through integrated water investment is important to increase agricultural product and hence leads to increase household's food security
- Introduction of family planning is one way in order to limit the number of children in a household to get a healthy and productive family member that are both physically and financially strong to make decision and to avoid the negative effect on the HH food security.
- Households in the study area should be introduced the advantage of new technologies such as the use of small scale irrigation to produce more than once a year and increase yield. Since Size of cultivated land alone may not help a household to keep its family food secure.
- Households should be given training on financial resource management (allocation) so that they can properly invest the credit rather than consume it.
- Provision of training on modern livestock management system households could generate more income and improve their financial status.
- Provision of training for households about soil conservation practices help maintain the soil fertility.
- Female headed households should be empowered and given equal access to resource since they have a better capacity of allocating the financial resource to meet the household's food needs.

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ANNEXES

Table 6. Kilocalories per gram of different food types

Food Group	Mean kcal per gram
Cereals	
Teff Wheat	3.41
Pulses	
Beans Chick pea Cowpea(Guaya)	3.45
Salt/Sugar	
Salt Sugar	1.78
Oils and fats	
Oil Butter	8.12
Vegetables	
Onion Tomato Potato Cabbage Black Pepper Carrot Beet root	0.37
Coffee/Tea	
Coffee Tea	1.19
Spices	2.97

Source: Ethiopian Health and Nutrition Research Institute

Table 7. Conversion Factor for Adult- Equivalent (AE)

Years of age	Men	Women
Less than 10	0.60	0.60
10-13	0.90	0.80
14-16	1.00	0.75
17-50	1.00	0.75
Above 50	1.00	0.75

Source: Source: Storck, et al. (1991) s

Table 8 Conversion factor for Tropical Livestock Unit (TLU)

Livestock Type	TLU
Ox	1.00
Cow	1.00
Heifer	0.75
Bull	1.00
Calf	0.25
Sheep	0.13
Goat	0.13
Donkey	0.70
Horse	0.75
Poultry	0.013

Source: Abdinasir, Ibrahim (1991)

Table 9 Variance Inflation Factors (VIF) of Continuous variables

Variable	VIF
AGEHEAD	1.045
HHSIZEAE	1.218
DISMARKE	1.415
CUTLAND	1.430
LIVESTOC	1.765
TOTINCOM	3.412
NEARNESS	1.16

Source: Model output

Table 10 Contingency Coefficients for Discrete Explanatory Variables

Variable	ACCIRRIG	SEXHEAD	SOILFER	ACCESS TO CREDIT	SUPPEX	EDUCATAGORY
ACCIRRIG	1.00					
SEXHEAD	0.04	1.00				
SOILFER	0.30	0.04	1.00			
CREDIT	0.16	0.00	0.13	1.00		
SUPPEX	0.22	0.01	0.16	0.06	1.00	
EDUCATAGORY	0.26	0.21	0.11	0.09	0.25	1.00

Source: Model Out put

Research questionnaires

Questionnaire for Household Interview

The impact of small-scale irrigation on rural household food security in Furuna Kebele of Adaba Woreda

1. Identification Information

1.1 Name of the irrigation Scheme _____

1.2. Kebele _____

1.3. Irrigation typology (put √ mark)

1. Modern _____2. Traditional _____

2. Household Socio-economic Characteristics (Household information)

01	02	03	04	05	06	07	08	09
No	Name of the House Hold head and family members	Age (years)	Sex	Marital Status	Relation to the household	Religion	Level of Educ.	Occupation Other than farming

Variable codes

Sex: 1 Male 2 Female

Marital Status: 1=Single 2=Married 3= Divorced 4= Widow 5 = Others

Relationship to house hold head: 1=Head 2=Husband 3=Wife 4= Daughter 5= Son 6= grand Father 7= Grandmother 8= Others

Religion: 1= Orthodox 2= Protestant 3= Muslim 4 = Others

Level of education: 1= Literate (read & write) 2= Grade 1-4 3= Grade 5-7 4 = Above Grade 8 5= Illiterate

Occupation: 1=Farmer 2=Trader 3=Housewife 4=Construction 5=Weaving 6=Carpentry and 7= Others

3. Infrastructure/access to road and irrigation

3.1 Distance from the main asphalt road (in km) _____

3.2 Distance from the market place (in km) _____

3.3. How do you transport agricultural produce to the market place?

1. On back --------- 3. Horse cart ----------
2. Vehicle---------- 4. Other specify---------

3.4. Access to irrigation (Put √ mark)

1.User---------- 2. Non user----------

3.5 Reason for not using irrigation

1. No access
2. There is enough rain and moisture
3. No information about irrigation

4. Contribution towards household food security

4.1 Do you think that irrigation has a positive impact on household food security? (Put √ mark)

1. Yes---------- 2. No----------

4.2 If your answer is yes, what are the positive impacts of irrigation that you have seen? (Put √ mark)

1.Diversification of crops grown _____
2.Increased agricultural production _____
3. Increased household income _____
4.Other specify _____

4.3. What is the contribution of diversification to your family (Put √ mark)?

1.Maintained high income level _____
2.Decreased fluctuation in level of food production _____
3.Increased production per unit area _____

4.4. How many times do you produce within a year?

1. Before adoption of irrigation technology _____
2. After adoption of irrigation technology _____

4.5. What change (s) did you see as a result of double or triple cropping?

_____

4.6. The household income Source before the implementation of Irrigation (put √ mark)

1. Sales of vegetables _____ 2. Wage _____
3. Rent of own land _____ 4. Sales of cereals _____
5. Others, Specify _____

4.7. During which month (s) are food shortages severing? Choose according to their severity level? (give rank i.e for the most severe month put 1 then 2 etc.)

October ____ November ___ December ____ January ___ February ___ March ___April ___ May ___ June ____ July ___ August ___ September ____

4.8. How do your households used to cope during crop failures? (put √ mark)

1) Sale of livestock _____ 3) Sale of Animals _____

2) Reduce the number of meals _____ 4) Wage employment _____

5) Other specify _____

4.9. Household expenditure during 2005

4.9.1. Consumption expenditure

Food type	**Consumed from purchased**	
	Amount (kg)	**Value (birr)**
Cereals		
Fruits and vegetables		
Animal source (Butter cheese etc)		
Other		
Salt		
Oil		
Sugar		

4.9.2. Non Food Expenditure

Item	**Expense**
Clothing (dress and foot wear)	
House rent	
Water expense	
Transport and communication	
Entertainment (visit of relatives)	
Education	
Health care	
Religious& cultural expense	
Animal health expense	
Gas and Other fuel	
Beverages and cigarette	

Government tax	
Social expenses	

5. Livestock production

5.1 Do you rear livestock? (Put √ mark)

1. Yes----- 2. No--------

5.2. What domestic animals do you rear?

:

Type of animal	Number
Ox	
Cow	
Calf	
Heifer	
Sheep (young)	
Sheep (adult)	
Goat (young)	
Goat (adult)	
Donkey (adult)	
Donkey (young)	
Mule	
Horse	
Chicken (poultry)	
Bull	

5.3 If you don't have enough oxen what do you use for your farm operation? (put √ mark)

1. Use Mekenajo _____
2. Exchange with labor _____
3. Hire oxen _____
4. Others (specify) _____

6. Land Ownership

6.1. Do you possess your own land? (Put √ mark)

1. Yes _____ 2. No _____

6.2. If yes, its total area in hectare _____

6.2.1. Area of grazing land _____
6.2.2 Area of fallow land _____
6.2.3. Area covered by trees _____
6.2.4. Total area of cropland _____

Area under irrigation _____
Area under rain- fed _____

6.3 How do you perceive the condition of your land? (Put √ mark)

1. Fertile _____
2. Moderately fertile _____
3. Less fertile _____
4. Infertile _____

6.4 If you don't have your own land, what is the source of land for your farm operation (explain)

_____

6.5. How did you get your irrigation land? (put √ mark)

1. Inherited from family _____ 3. Purchase _____
2. Gift from relatives/on kinship basis _____ 4. Government redistribution _____
5. Others, specify: _____

6.6. Do you lease-out irrigable land (for sharecropping)? (put √ mark)

1. Yes _____ 2. No _____

6.7. If yes, Area leased out (out of the total plot) _____ (in hectare)

6.8. If yes, reasons for leasing-out your irrigation land? (Put √ mark)
_____

6.9. Sharecropping arrangement /output share (land owner to partner)? (put √ mark)

A. Equal _____
B. One-third for the land owner and two-third for the shareholder (Siso/local name)
_____
C. One-fourth to the land owner and three-fourth for the shareholder
_____
D. Other type of arrangement, specify
_____

7. Marketing Issue

7.1. Do you produce for market using irrigation? (Put √ mark)

1. Yes _____ 2. No _____

7.2. If you don't produce for market, which of the following is important reasons for you? (Put √ mark)

A. No enough water is received for surplus production _____
B. No enough land for surplus production _____
C. No enough market demand _____
D. Others specify, _____

7.3. What are the problems in marketing your produce? (Put √ mark)

A. Transportation problem _____ D. Low bargaining power _____ B. Too far from market place _____ E. others (specify) _____
C. Low price of agricultural produce _____

7.4. Where do you sell your farm products? (Put √ mark)

A. On farm (local assembler _____ C. Through service cooperatives _____ B. Taking to the local market _____ D. Other specify _____

7.5. Do you get reasonable price for your produce in 2005? (Put √ mark)
1. Yes _____ 2. No _____

7.6. If no, what are the reasons? (Put √ mark)

1. No demand for the produce _____ 2. More supply of the produce _____
3. Others (specify) _____

8. Extension issues

8.1. Do you receive support from DAs? (Put √ mark)
1. Yes _____ 2. No _____

8.2. If yes, what are the supports given? (Put √ mark)
1. Advice _____ 4. Conflict resolution _____
2. Training _____ 5. controlling water distribution _____
3. Demonstration _____ 6. Other specify _____

9. Access to credit Issues

9.1. Have you ever used Access to credit for your agricultural activities? (Put √ mark)
1. Yes _____ 2. No _____

9.2. If yes, what are the sources? (Put √ mark)

1. Cooperatives _____ 4. Neighbors and relatives _____
2. Local lenders _____ 5. Micro finance institutes _____
3. The irrigation office _____ 6. Other specify _____

9.3. If no, why? (Put √ mark)

1. No collateral _____ 3. No Access to credit supply _____
2. No need _____ 4. High cost of Access to credit _____
5. Other, specify _____

10. Irrigation practices

10.1. When did you start using irrigation?

_____

10.2. Have you ever faced a problem of crop failure when using irrigation?

1. Yes _____ 2. No _____

10.3. If Yes, why? (put √ mark)

1. Water shortage _____ 3. Weed problem _____
2. Crop disease _____ 4. Water logging _____
5. Other, specify _____