



IMPACT OF SMALL SCALE IRRIGATION ON HOUSEHOLD FOOD SECURITY IN
MEHAL SAYINT WORDA, SOUTH WOLLO ZONE, AMHARA REGIONAL STATE,
ETHIOPIA

BY

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Declaration

This thesis is my original work and has not been presented for MA/MSc degree in any other university and that all the source and materials used for the thesis have been properly acknowledged.

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APPROVAL

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Acronym

ADLI	Agriculture Developments Lead by Industrialization
AfDB	Africa Development Bank
ATE	Average Treatment Effect
ATT	Average Treatment Treated
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
FCS	Food Consumption Score
FGD	Focus Group Discussion
HHDS	Household Food Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale
MOFED	Ministry of Finance and Economic Development
MWOA	Mehal Sayint Worda Food Office of Agriculture
SD	Standard Division
SPSS	Statically Package for Social Science
USAID	United States of America International Development
WFP	World Food Program
WSDP	Water Sustainable Development Program

Abstract

Agriculture is the main contributor of Ethiopian economic growth and holds the majority work forces. But the agriculture practices is dependent with rainfall and small scale subsistence production system. Because of this backward agricultural production practice, the country hits by frequent drought and many people have been being food insecure. Farming irrigation is one key solution to minimize those kinds of vulnerability and improve food security. The research objective is to analyze the impact of small scale irrigation on household food security in Mehal Sayint Woreda, south Wollo zone, Amhara region established on 204 (105 irrigation non-user and 99 irrigation users) sample. Both primary and secondary data used for the study .Descriptive statistics analyze and propensity score matching used to determinants impacts of small-scale irrigation on household food security and household food consumption. In the study descriptive analyze and econometric analyse found irrigation have positive impacts to ensure food securities. The studies found from irrigation user households 80.8 % ensure food security. The average treatment effect of the propensity matching results dig out, 51.1% irrigation user households ensure more food security than irrigation non-user household. From irrigation non-user only 28.6 % ensures food security. In the same ways the study finding indicates the main challenge of irrigation in the study area is the cost of technology. The study concluded that irrigation is one key valuable potential solution to ensure food security in the study area. Therefore, it is recommended that government and all other participant should give focus on irrigation to minimize large number of the study area food insecure households

Key words:-food security, impacts, irrigation, Mehal Sayint Woreda

Chapter One

1. Introduction

1.1 Background

Today, all four corners of the globe states and personals are worrying and discussing about food insecurity. Because of this reason vital issue, different scholars and global origination has tried to give different definition at the different time. Food security has remarkable definition by different organizations, scholars and researchers. From the multifarious definitions, one of the accustomed and well-known definition is “*Food security is a situation that exists “all people at all times have physical, and economic access to sufficient food to meet their dietary needs for a productive and healthy life” (USAID 1992:2)*. This definition is too vast and consolidates main pillar’s food access, availability, stability and utilization.

Food security and irrigation are the key postulate of all growths and development policies and strategies for all developing economies in the globe. For most of these economies, particularly that leading resource provision is land to produce agricultural product to the most executable option out of poverty. Agriculture is the backbone of Ethiopian economy; it contributed 85 of export earnings, 80% of employment and 45% of a country’s gross domestic product (MoFED 2007).

According to (MoFED 2012) climatic and agro ecology agriculture practice influence of production decreasing soil fertility, small and fragment land tenure, soil erosion, limited access to modern farming inputs and equipment, fast population growth, old-fashioned system of agricultural practice, and low organizational support was listed as a key causes that retain smallholder production at subsistence level in the country. Like other developing countries in Ethiopia, the economic sector of agriculture is mostly dependent on rainfall. Therefore, as African Development Bank Report (AfDB 2003). , Ethiopia's economy was among the most vulnerable and heavily dependent on the agricultural sector in sub-Saharan Africa, which has suffered by frequent droughts and extreme fluctuations of output. This natural problem affects the rural household food security. In addition to natural problem the rural household food security has been affected by high dependence of the population on low-input, low-output (and

shock-prone) cultivation for their living Devereux et al (2003). By this and other reason many Ethiopians have been being food insecure. In Ethiopia agriculture sector covers the lion share of the economy, but the country has been a food deficit country for several ten years. According to FAO (2001), to cover this deficits Ethiopia's cereal food aid shared 14 percent of total cereal production

Irrigation is too ancient agricultural practice, which had been comprehensively used by a number of early on civilizations such as the ancient Egyptians and Ethiopians (Chazovachii, et al 2012). In Ethiopia Irrigation agriculture practice is not totally fresh occurrence, its takes place many thousands year. According to (FAO 1994), Small-scale irrigation has been experienced for a long time all the scheme through the plateaus' someplace small numbers of farmers could be turned seasonally for limited arid time cultivating agriculture products.

On the way to tackle the chronic agricultural farming problem, Ethiopian government designed Agricultural Development Led Industrialization (ADLI) Strategy in 1991 that had been focused to the spreading out of small-scale irrigation, establishing of cooperative societies, access rural credit service and access to agricultural technologies. This was important to give answer the food demand and bring about the socioeconomic growth and development in the country. Irrigation agricultural production can be increased to meet the growing food demand in Ethiopia (Awulachew et al. 2005). But Ethiopia's irrigated production didn't match the water, rural work force, land potential as well as the countries food insecurity situation. The country has not used its irrigation potential and land. But at the same time, the country receives food aid. The country's irrigation potential is about 3.7 million hectares land (WSDP 2002).

According to minister of agriculture report 2,139,775 hectares land was cultivated area in (2019). But because of low input, poor farming practice, pesticide, lack of government focuses, less institutional support and by others problem the irrigation production is very low. It was claimed that Ethiopia cannot assure food security for its population with rain fed agriculture alone without a substantive contribution of irrigation.

According to the Mehal Sayint Worda (2018/2019) report the study area has been being irrigated 2112.8 hectares. This research paper was conducted to analyze the impact of small-scale

irrigation on household food security based on Mehal Sayint Worda, South Wollo district in Amhara regional state of Ethiopia.

1.2. Statement of the Problem

In Ethiopia, the food insecurity problem is worse by low agricultural production and crop damage mainly caused by erratic weather (poor and irregular rainfall) among others. The main water source of the country agriculture production is rainfall. Due to this rainfall dependency the agriculture sector has been hitting by climatic erraticism, which frequently outcomes in partial or full yield damages. According to MOFED (2010) to minimize this savior problem, the Ethiopian government has been implementing policies and strategies to through complete or supplementary irrigation agriculture practice. Irrigation agriculture uses to mainly reduce the agriculture production problem that happen caused by erratic rainfall as well as heighten productivity each small of land, and increase the amount of over-all production significantly.

According to Lipton et al. (2004 cited in Haile (2008) state that irrigation cultivation can diminish extreme poverty and ensure food security through raised production and household income, stabilize the food market and decrease of food prices. This condition helps very poor households to meet the essential needs by improving their overall economic welfare, protect them from crop loss due to insufficient rainwater supplies and encourage their use of production heighten farm inputs which in the long run enables them left out from poverty trap. According to Desta Dawit and Almaze Balta research conducted (2015) on impacts irrigation to food security found irrigation had positive impact to reduction rainfall dependency and food security in Ethiopia. Irrigation user households are food secure compare with irrigation non-user households (Muez Haileleul 2014). This explanation contains irrigation agriculture has large impact to improve rural household food security in particular, quality of life in general. According to (FAO 2017) report 30 % the Ethiopian population of is food insecure. In addition to that according to that USAID reports by (2018) from the total Ethiopian children 38 % of child are stunted.

Mehal Sayint Worda has ten main rives and numerous springs, that can be used for irrigation purpose. In the study area farmers have been practicing traditional irrigation practice including

traditional river diversion, spring development, and nowadays, farmers have been practicing some modern irrigation machines especially using water pumps and plastic tap (MWOA, 2018).

In the study area from the total population more than 44 % peoples are chronic food insecure but have ten rivers in the study area. Irrigation has been being implicit to get better agricultural production and food security. Even, despite the listed different above study found fact that, it is not well identified to what amount households that are using irrigation more food secure than those who depend on rainfall agriculture in the study area. Many of the earlier studies investigated about the impact of irrigation on household food security. However, it has not received direct attention in the study area. The research gap is the impact of small-scale irrigation on household food security that has not yet well studied in the study area (Mehal Sayint Worda). So the knowledge on the topic of the impacts and contributions of irrigation to household food security is lacking in the study area.

Further significantly, in Mehal Sayint Worda, where this study is conducted, an in-depth comparative examination studies were inadequate on factors that challenge rural households who were participation in small-scale irrigation and the impact of small-scale irrigation on household food security. Therefore, This study was motivated to choose the study area, and to reveal the weightiness of the problem and to fill the gaps by analyzing of rural household's whether irrigation access in the study area has producing positive impact alter on rural household the impact food security or not.

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of this study is to analyze the impact of small-scale irrigation on household food security in Mehal Sayint Worda

1.3.2. Specific Objective

- To assess irrigation practices in the study area
- To estimate rural household food security in the study area
- To analyze the impact of irrigation on food security of rural households in the study area
- To examine the challenge of irrigation practice in Mehal Sayint Worda

1.4. Research Questions

1. Is production variety of irrigation user household different from irrigation non-user household?
2. Is food production/availability the same irrigation user households compared to non-irrigation use households?
3. What are the challenges to use irrigation in the study area?
4. What is the contribution of small-scale irrigation to food security in the study area?

1.5. Significance of Study

The study has examined the impact of small-scale irrigation on household food security in Mahl Sayint Worda. The result of these studies is important to policymakers and development planners, who are concerned in relation to irrigation development for household food security. In addition to that, the research findings can be used as an input for future researchers to additional knowledge generation linked to small-scale irrigation development and household food security concepts. As well as the locating of the study could be contribute to the reinforcement and existing information about to the issue and supports to conduct additional interventions in the study area. It is important to study area household for gaining supplementary technology supply and extension service from worda agricultural sector and all concerned bodies.

1.6. Scope and Limitations of the Study

This study scope is one administration woreda and three kebeles. The data of the study was used base on a cross- sectional survey and quasi -experimental. The objective of this research is to assess the impact of small-scale irrigation on household food security. The researcher met a figure of difficulties on the time of data collection. The core difficulties were inaccessibility of respondents because they were busy in diverse communal responsibilities and agricultural works. The other limitation was financial and time limitation.

1.7. Organization of the Paper

This study has five chapters. The first chapter contains the introduction part of background of the study, statement of the problem, objectives of the study, significance of the study and scope and delimitation of study. Chapter two review of related literature, chapter three the research methodology, chapter four data analyze and interpretation, and the fifth chapter contain also conclusions and recommendations.

Chapter Two

2. Review of Related Literature

This chapter has presented on different related literature review association with irrigation and food security contained definitions, measuring and Concepts of food security, and small-scale irrigation. In addition to that, it seeks to discourse the main theoretical views on food security and small-scale irrigation giving particular standpoints on the impact of small-scale irrigation to household food security. Different studies conducted on the related with research title that the contribution of small-scale irrigation systems in enhancing rural agricultural production, ensure food security and alleviating poverty were widely recognized. Synthesis of few appropriate and related empirical studies undertaken on irrigation and food security also highlighted to know the right gap of study in this chapter. Eventually, the conceptual framework for this study drawn from the theoretical perspectives, and also was included at the last section.

2.1 Theoretical Review

2.1.1 Concept of Food Security

Food security is a hard theme to measure since it deals too extensive terms agricultural sub system way with the production, consumption and distribution of all essential human food. On the other hand food insecurity lends itself more readily to measurement and analyze. It should be emphasized which food security, famine and hunger are not to be complex. As (Marion Napoli 2011), food security refers to the availability of food, whereas, famine and hunger are not the result of the non-availability of food, inappropriate consumption and insecurity through certain period, that mine the outcomes of food insecurity. In addition to the above description Marion Napoli putted Food security is a barometric concept as reflected by the numbers tries to set define it in policy usage and research.

The concept of food security invented some 50 years ago, in the early (1970s), at a time of global food crises. Even two decades ago, there were more than 200 definitions for food security in published writings, (Maxwell and Smith 1992), showing the contextual dependent features of the definition. The food security definition was the well accustomed, that defines food security as “*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 2010:8). In addition to this, other familiar and globally known food security definition, (World Bank 1986) putted food security had do with access by all human beings at entire times to adequate diet for an active and well life. This definition has contained remarkably issues. It deals with production in connection to food availability; it describes distribution in that the produce should be accessed by all; it shields consumption in the view that personal food needs are met in order for that individual to be healthy and active. The availability and accessibility of food to meet individual food needs have also to be sustainable. This indicates which food insecurity should monitor index related to food production, consumption and distribution. As (Hartwig et al. 2011 , Babatunde et al. 2008), the concept of food security is built on four inter connected pillars: Food availability refers to physical existence of adequate amounts of diet at a family level, whether from own production or markets. Food access refers to households have enough resources to obtain suitable food for a nutritional diet. Food utilization is understood as people have appropriate information of nutritional diet and upkeep follows and have access to sufficient water and hygiene. Food stability refers to the need to evaluate food in both short and long term in different level. The pillar of food availability focus on creates food availability by production in the country or import from aboard, or get aids from charity. The access pillars center get foods from market, in home take from somebody, on the other hand food utilizing concern food nourishing and hygiene. The Stability of food on the above description contains get foods all over times. All the above food security pillar description has Mach with (Nyange 2001). Nyang explained that household food security is the ability of the household to secure food, either from own production or through purchase of acceptable food for meeting nutritional needs of his members. Connection to this according to the World Bank (2003) when considering ensured food security at a family level, we must understand about food supply and distribution, effective access to food by the household level and effective consumption by the individuals. All the above description contained production, agricultural that gets from plant. Plants growth does require water, soil, air and sunshine. So that to produce food items, the farmer may use rainfall agriculture practice or irrigation agriculture practices to get water for plant. Therefore, water is essential to plant-growth and crop-production (Widtose, 2001).

At a different level like world, regional, national, household, and individual level of food security problems have been studied by different scholars. Food security at a national level does essential point out among regions, communing households and individual. Associated to this Because of a different reason determine food security in Ethiopia is one of the country's largest, deepest and vast challenges. According to Ethiopian national planning commission (2016) report 23.5 % Ethiopians are under poverty line .That mean all the above number people are food insecure. During the (2015/16) nearly one in five Ethiopians required food support drought demonstrates a too high level of food insecurity and a large portion of the population are vulnerable to becoming food-insecure (Cochrane, et 2017). Both the Ethiopian plan commission report and Cochrane agreed that Ethiopian food security problem is both extensive and intensive.

2.1.2. Dimensions of Food Security

According to Peng and Elliot M Berry (2019) cited FAO (2008) food security definition includes four main dimensions of food security. The primary dimension is Accessibility. The food can reach to the consumer (transportation infrastructure) and the finally have enough money to buy adequate food goods. To such physical and economic accessibility is added socio-cultural access and morals to ensure that the food is culturally acceptable and that social protection nets exist to help the less fortunate. The second is Utilization. The individual must be able to eat adequate amounts in both quantity and quality to live a healthy and full life to realize his or her potential. Food and water must be safe and clean, and thus adequate water and sanitation are also involved at this level. A person must also be physically healthy to be able to digest and utilize the food consumed. The third is Availability of food produced locally and imported from abroad. The fourth domain of Stability, deals with the ability of the nation/community/(household) person to withstand shocks to the food chain system whether caused by natural disasters (climate, other)or those that are man-made (wars, economic crises). Thus, it may be seen that food security exists at a number of levels. Availability to National, Accessibility to Household, Utilization to Individual, Stability to may be considered as a time dimension that affects all the levels. All fours of these dimensions must be intact for full food security.

Peng and Elliot M Berry more recent developments emphasize the importance of sustainability, which may be considered as the long-term time (fifth) dimension to food security. Sustainability

involves indicators at a supra-national/regional level of ecology, biodiversity and climate change, as well as socio-cultural and economic factors (Berry et al. 2015).

2.1.3 Determinants of Household Food Security

There are too numerous research studies has been conducted particularly in Ethiopia. According to (Regassa 2011 and Bedeke 2012) farmland size, land fertility, irrigation access, household workforce, non-farm revenue, distance from market, education level, health status, volume of rainfall and spreading, adoption of new agriculture technology, crop pasties and diseases, institutional support, dependency ratio, amount and quality of livestock ownerships, and household size were identified as leading determinants factors to ensure household food security.

2.1.4 Small-scale Irrigation

Agriculture work is a risky business to it involves inconsistent factors such as erratic weather condition, natural disaster and market failure. Because of global warming and rising of world population number more than any time. Irrigation is the most vital important development investments issue that can have both direct and indirect impacts on reduction poverty and food security. To minimize particularly erratic weather, irrigation is key solution to supply water by artificial way. Irrigation brings a range of benefits to individuals and households that economists sometimes distinguish between primary and spillover effects (Shah 1993). According to Shah Benefits to people in irrigated areas are increased and more stable flows of income from farming made possible by increased intensity of cropping, improved yields and new farm enterprise / technology mixes, Appreciation of the value of land with access to water for irrigation. Globally irrigation has been using as a means of improving crop and forage production by heighten the production and productivity of available land as well as expanding aggregated agricultural production particularly to secure food in arid and semi-arid regions of the globe. Availability and access to irrigation had been considered key for crop production, asset creation; eradicate rural poverty, stabilizing food price, increase consumption and expansion of development frontiers. Irrigation is the supply of water to farming crops by artificial systems designed to allow farming in semi-arid and arid regions to minimize the effects of rainfall shortage semi-arid and arid regions. Even though in specific area the total seasonal i, and variable from year to year, irrigation is important for both areas (Woldeab 2003). Irrigation is import to cultivate lands

without natural means. Artificially cultivated agriculture is called irrigation is too essential to improve the rural household food security. The second issue that was described tackle droughts, irrigation is important minimizes the drought negative impact. According to (Carter 2006) explanation, Small scale irrigation is irrigational often conduct on small piece of lands, that mostly farmers have the main controlling influence and exercising or applying a level of technology which the irrigation operational activity can be effectively operate and maintain by farmers. As a country of Ethiopia small-scale irrigation is the main irrigation system exercised by farmers. The small-scale irrigation in the country is cultivated by household farmers. Most parts of Ethiopia there are five types of small scale irrigation methods applicable by the farmers traditionally. Spate methods (which use occasional flood flows), spring system (that use flows from spring), storage system (that store water behind dam), Diversion system (diverting natural river flow) and lift system (that extracts water from rivers, irrigation canals, reservoirs and wells. (Berhanu and Pendel 2003) In different parts of Ethiopia there are huge water potentials that might be used for small, medium and wide range irrigation. A different studying show, that have been conducted on the field of irrigation, the country has 12 main river basins and many tributaries and its annual water total flow volume is over 122 billion cubic meters(Kedane 2015). In addition, according to (Awulachew 2010), Ethiopia groundwater potential has been being estimated to be more than 2.6 billion cubic meters). According to Ethiopia rural development policy (MOFED 2006) puts that Small-scale irrigation is a policy priority for rural poverty eradication, food security, employment opportunity and country growth and development. It assists families to make additional revenues, increase households coup ups and resilience, youth job opportunity and certain cases change their livelihoods. According to (Eshetu 2010), Small-scale irrigation in Ethiopia had a significant impact to extension of production to different kinds of marketable crops similar to fruits, cash crops and vegetables. Small-scale irrigation is also important to diversify food and feeds to improve the household nutrition status.

2.1.5 Irrigation System

Irrigation system is the method of getting irrigation water from the sources. Muez Haileleul Aregawi (2014) cites Dupriez and De Leener (2002) the irrigation systems depends on water resources, water rules, rainwater, topography, plants cultivated and growing seasons there. Surface water irrigation system and sub-surface irrigation or overhead water systems have been implementing for cultivation agricultural products by irrigation.

From the two-irrigation system Surface irrigation are the oldest methods, which convey water from the surface to the fields in by traditional or modern canals. It is way of distribution of water in into farm over the soil surfaced by the gravity flow of water. Basins irrigation, Borders irrigation, Flood irrigation and Furrows irrigation are applying systems to irrigation (Widrose 2001). The irrigation able to elect the irrigation systems, depending on the type of soil, the slope of the land, the position of the water stream, agro ecological zone, the water available and types of crop. On the other side, overhead irrigation system of irrigation, farming is takes placed spray water into the ups and allows falling on the ground surface like rainfall. According to (Dupriez and De Leener 2002), Sprinkler irrigation design imitates from rainfall.

2.2 Empirical Review

2.2.1 Irrigation and Food Security

A good deal of research has conducted on impacts of irrigation to food security on household level, country level and regional level. The research conducted by (Desta Dawit, Almaz Balta 2015) on Impact of Small Scale Irrigation in Household Food Security in Ethiopia concluded that irrigation had positive impacts to reduction in rainfall risk, increased water reliability, enabled households to diversify production to new types of marketable Crops like fruits, cash crops and vegetables, Increased yield of crops and marketing, reduced unemployment, Reduced inequality and poverty, high economic Growth and improve food security. This indicates irrigation has been impacting to nutritional and food security to rural household. In addition to that (Thinah Moyo1 & Charles L. Machethe1 2016) conducted on irrigation impacts to food security availability had concluded irrigation farming significantly contributes to household food availability and dietary diversity. Different research has ensured irrigation has positive impacts to food security demission that mean accessibility, availability utilization and stability. According to (Muez 2014) research held that the food security analyze indicates most nonirritating households are poor compare with farmer who is using irrigation. The food insecurity occurrence in non-irrigating households was greater than in irrigating households (Muez 2014).This is the big evidence to present that the contribution of small-scale irrigation on household food security. In addition to this, the research has been conducted on the impacts of irrigation to food security describes, it had both directly and in-directly impact on enhancing

rural households food security through different dimensions. such as diversification of agricultural product, increased agricultural production yields, household income, increase permanent assets farm employment opportunity and participation in community decisions (Dereje Mengistie and Desale Kidane 2016). Many scholars and organization which conducted research on impacts of irrigation to food security had agreed by small-scale irrigation have significant impact to secure foods at all fours food security dimension. To support this explanation the research has been conducted on irrigation scheme in Ghana food security situation has improved after house hold small scale irrigation because agricultural related activities became all year round with dry season gardening providing the necessary ingredients (vegetables) to complement staple foods produced during the rainy season (Ernest Bagson and Conrad-J.WulekaKuuder 2013)

2.2.2 Contribution of Irrigation to Food Security

Different scholars has studded particularly on the impact of irrigation to household food security to rise in crop yield, employment opportunity, income, alleviation of rural poverty diversification and generating farm and off-farm activities. According to (FAO 1995), family revenue and consumption are considerably higher in irrigation participant than irrigation non-participant is, and a 50 percent point gap is usual results. This explanation indicates how much impact irrigation contributes for household food security. According to (Lipton et al.2004),there are four interconnected ways irrigation can ensure food security and improve diversification. That are, by Growing production and revenue, contributes to decline of food prices (that supports too low income families gain the basic necessities and connected with increases in household entire economic wellbeing), keeping against threats of crop damage in case of unpredictable, high or inadequate rainfall, encouraging more use of yield improving agriculture inputs and foundation of further job opportunities, which composed assists societies to move out from the food insecurity in particular and poverty in general. The usage of irrigation to agriculture is so far important to improve production and minimize crop failed. Irrigation has allowed for least developing country and food insecure households to get large yields of production and growing more of their food, be less dependent upon import, and buy particularly in view of the incident of crop fail in the country. Connecting to this, (Derbew 2009) cited (Desta 2004) agriculture development in general, and irrigation in particular would be an obvious to vital key for solving food problem caused by crop failed. Production, income, employment, food security, and other

social impact, which small scale irrigation schemes can contribute to uplift socioeconomic and rural poverty (Huang et al. 2006). Improving agricultural productivity, employment generation, linkage among different sectors of the rural economy, and increasing opportunities for rural livelihood diversification are elements how irrigated agriculture could reduce poverty (Huang et al. 2006) Husain et al. 2006). On the other hand world food and agriculture organization (FAO 2014) described the potential pathways through which irrigation can effect food security, nutrition, and health outcomes including 1) a production pathway, 2) an income pathway, 3) a water supply pathway, and 4) a women's empowerment pathway.

Ensuring household food security needs wide policy instruments tools such as strategies for increase different production, sustainable supply (from domestic production and imported), price stabilization, employment, land distribution and ownership, macroeconomic growth, distribution of the gains from economic growth, population growth and income stabilization. On the side of agriculture more support essential for extension work, credit access, using irrigation encouragement of greater use of inputs and technology such as fertilizer, modern farming practice that is supported by science, improved seeds and agriculture machinery. Because of agriculture's central role in source of employment opportunity and income in rural areas, policies aimed at increasing agricultural production and productivity are necessary for driving household food security and nutrition in 3rd world country. The least developing countries are not only focusing to domestic consumption but also needs work for global market. Because most food insecure happened in those country but in the country agriculture has the lion share from the total economy. According to (FAO, 1997) the importunity of irrigation not only emphasize the absolute level of income, but also the control of income and the source, as these can significantly influence household food security.

According to (Awulacew 2007), some Farmers in Ethiopia has not able to produce adequate amounts of food because of unpredictable, erratic, unseasonal rainfall, backward farming practice, not used agriculture inputs and technology accordingly. To solve the rainfall connection problem to small scale irrigation has been given attention as an instrument to secure foods and reduce poverty by Ethiopian government. Modern technology innovation (e.g. irrigation) is adopted the main driving force for agricultural product growth and poverty alleviation (Norton et al. 2010). Accourding to (Desta Dawit, Almaz 2015) cited (Baltac Swamikannu and Berger

2009) were constructed an irrigation-poverty dynamics connection model to explore how irrigation can reduce poverty. Baltac Swamikannu and Berger conceptual framework indicates that all investment in irrigation could reduce farmers from rainfall high dependency. On the same time irrigation heighten cultivated farmland by human made system to feed water for plants (farmers would encourage to produce two or three times in a year and use more of modern agricultural technology and different inputs), increase income and generates employment opportunities. Different Studies has been conducted on linkage of food security and irrigation show that small scale irrigation in developing countries has been contributing to increase production, reduce the dependence effects of unpredictable rainfall, increase food supply and provide jobs to the poor (Chazovachii 2012), (Torell and Ward 2010). Irrigation in semi -arid tropical countries is an important investment to rural development that could have direct and indirect impacts on food security and poverty (Bhattarai et al. 2007). All The above explanation have concluded small -scale irrigation has been creating on/non-farm employment opportunities; increase food production, increase income, increase food supply increases consumption expenditure and accumulating assets specifically and improve quality of life standard in general. The increase productions have great impact to food price in the market by balancing demand and supply. The supply increase the price of food in the opposite direction decrease, so the poor can afford and get access to the required food at fair prices (Huang et al. 2006). Irrigation has great opportunity to improve farmland productivity and produce high value cash crop production like perennial plant. Therefore, the people would be enabled turn people to gain nutritious food and keep good health status. To support this explanation, (Awulachew et al. 2007) elaborated that irrigation agriculture business heighten productivity, improve efficiency of agricultural inputs , mitigate vulnerability of rainfall variability, promote small agro industries ,alleviate rural poverty and promote rural dynamic economy. According to (Eshetu 2010) described the main small scale irrigation importance are improve farm land productivity, crop yields and use of modern farming practice, which, in turn, enables to diversify into non-conventional and market-oriented products (high value crops, cash crop, vegetables and fruits), in addition to that positively improves farm households' contributed diet (quality, quantity and time), incomes, health and food security (Torell and Ward 2010). In addition to that, according to studies conducted by (Zewdu Siraw 2016) irrigation user farmers has statistically significant difference in livestock holding, oxen ownership, crop production, consumption food supply and income compared with irrigation non-

user households. It indicates those farmers who possess small-scale irrigation could have best condition interim of agriculture farming production, substance assets (having livestock, quality of house and oxen ownership) and income comparing with their partners with no small irrigation.

Irrigation is one of the keys to improve the rural community well-being. Irrigation is not only using improve the amount of food available but also generate income to buy diversify food and nonfood commodities to the household families. The amount and diversity of homegrown food can improve as a result of having access to irrigation water, and households may be able to purchase more food as a result of having more income from the sale of irrigated products (Laia Domènech, 2015). As (Bacha 2011) description irrigation is able to a source of an additional income for the rural farmers. The demand and the supply equation are the two way of food measurement and evolution. All two equations have been its ways of measurement and evolution. The food supply equation side measurement and evolution linking with the food availability just like food production index, per capita consumption, food aid delivery, livestock index, crop index and etc. On the other hand food demand equation measuring and evaluating about the accessibility seems income, anthropometrics index, consumption expenditure, nutrition index, diet diversity score, calorie intake index, hunger index and other derived indicators (Norton et al. 2010). All the scholars and global origination describe the strong linkage of irrigation and food security particularly by increasing agriculture production. Many parts of Ethiopian individual Farmers are unable to produce adequate amounts agricultural products by the reasons of fluctuate and unseasonal rainfall. The peoples have been lead to food insecure by this incident. According (Seleshi et al, 2005), agricultural production in Ethiopia has been affected by deforestation, unseasonal rainfall, erratic rainfall rising of number population and land distribution. Ethiopia has been becoming an ordinary phenomenon that asks for emergency food aid for severely food insecure people. According to (Norton 2010), to tackle this challenge the usage of modern knowledge and innovation (e.g. irrigation and agriculture inputs) is the main driving force for agricultural production growth, poverty eradication and food security in rural area. This description indicates irrigation has positive impact for food security by increase and diversified income. Different scientific studies show strong linkages between irrigation developments, agricultural productivity, agricultural growth, rural job opportunity, and rural house hold income and food security. Recent years In Ethiopia Small scale irrigation

investment has impacts like increased irrigation areas, reduction in rainfall risk, increased water reliability, Farm household's decision on irrigation, enabled households to diversify production to new types of marketable, Increased yield of crops and marketing, reduced unemployment, Reduced inequality and poverty, high economic growth, improve food security and Reinvestment (Desta Dawit, Almaz Balta 2015). The research has been studied by different scholars affirms that irrigation had been great impact to food security.

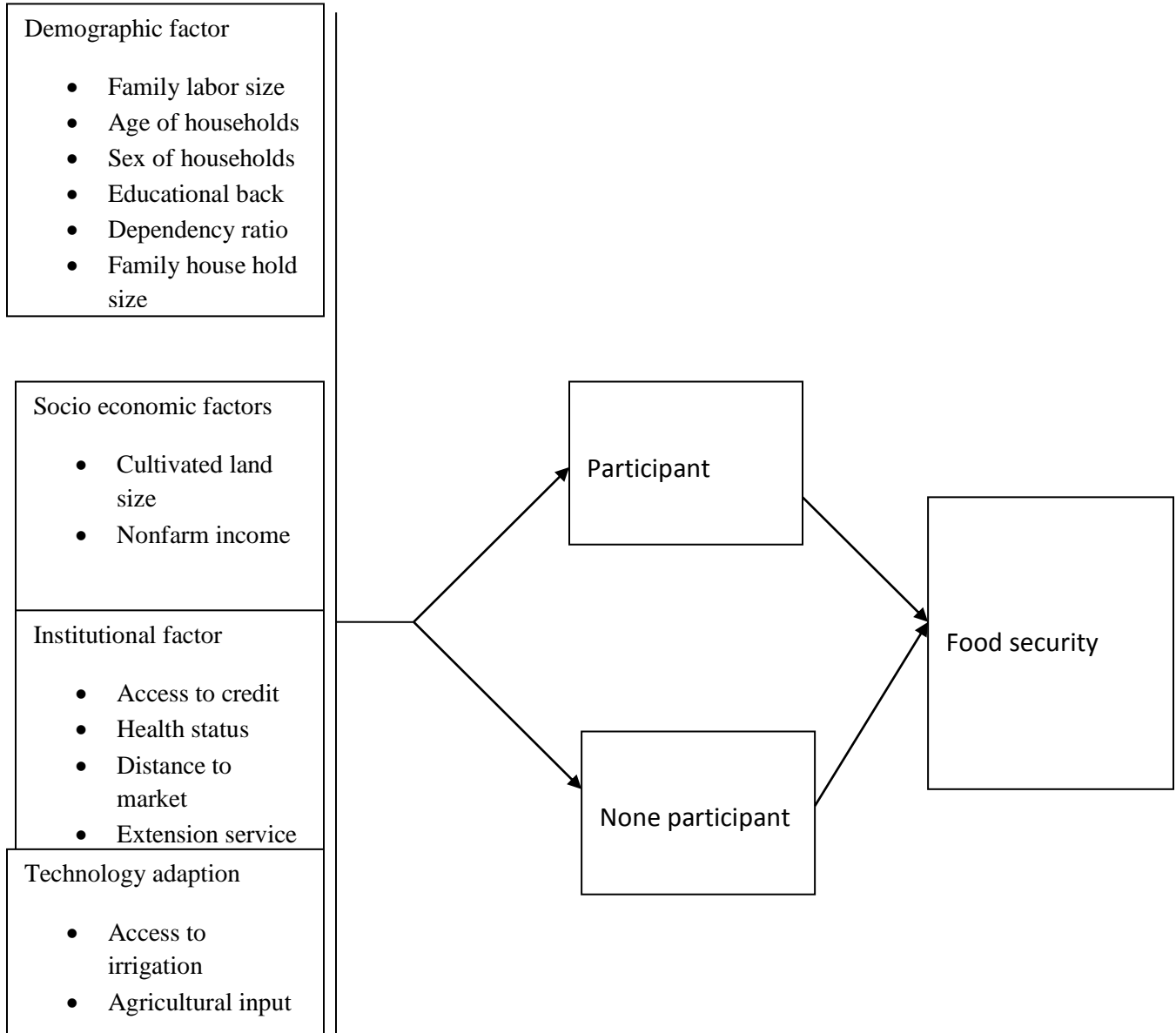
2.3 Conceptual Frameworks

As we have clearly discussed on the above section, that different factors are affect household food security. The conceptual framework indicates that the relationship between different covariant variables with household food security, and irrigation impacts. The central idea of all theoretical reviews focused on positive impacts and has strong linkage with food security interims of Diversification/commercialization/, alternative employment and reduction of rainfall risks.

Independent variable

inter dependent variables

dependent variable



Conceptual frameworks

Developed by the researcher (2019)

Chapter Three

3. Research Methodology

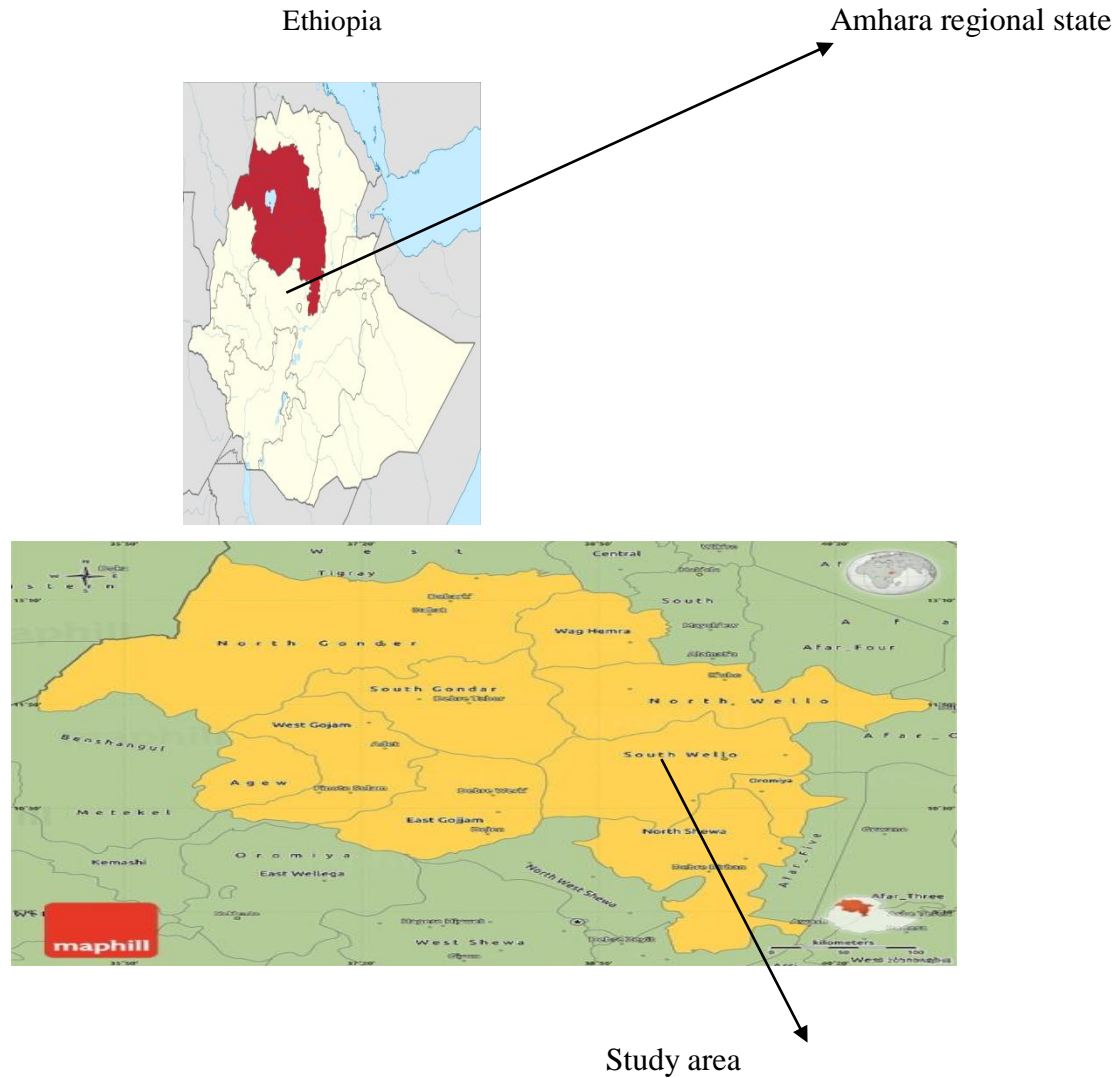
The focusing points of this chapter delineate how the research was conducted and the approaches use to do the research. As well as outlines the ethical issues was considered. The chapter outlines the data collection method used in the research and includes sampling and the method used to select the sample. It had further outlines design, plan, administration of the data gathering tools, and an analyze plan of the information that was gathered. The mixed methods approach was used to collecting the data on evaluating the impact of small-scale irrigation on food security. The researcher used a structured household questionnaire and focused group discussion. The detail discussions on the preferred data analyze method have also been given in this chapter.

3.1 Description of the Study Area

According to Mehal sayint worda administration office report (2019) it is located South Wollo Zone, Amhara regional state. The wordas is bordered to the south and west by Borena Worda, to the west by Enfsiesarmidir, and to north Sayint Worda. The zonal capital of the district is Dessie, which is found 401 km and the Worda 590 km away from the capital Addis Ababa. The total area the Worda cultivating land is 13987 hectare is lands. The district has a tropical heavy and erosive rainfall as well as cool to moderate climate. According to worda office of agriculture report (2019) The altitude of the area ranges from 500 m above to 390 m above sea level, the annual means temperature ranges from 18 °C to 39 °C, and the average annual rainfall ranges from 1250 mm. The rainfall pattern is bimodal which are short rainy season (Belg) and long rainy season (Meher)

The Worda has 17 Kebele administrations. According to CSA (2018) projection, the total population of the Worda is 85061 from this total number 41950 are male and 43,111 are female. From the population of the Worda, about 96.5 % lives in rural areas and the remaining proportion lives in urban areas. According to MWOA 2019 reports, 13987 hectare lands are cultivated by the natural rainy and 2112.8 hectare land is cultivated by irrigation. From the total population 37504 peoples are food insecure. Farmers in the area practice mixed type of farming. Major crops grown in the Worda are cereals (wheat, sorghum, teff and barley), pulses (haricot bean, bean, field pea and Fabian), and vegetables (onion, potato, cabbage and tomato)

Maps 1:- Study area location maps



Source Maps.com

3.2 Research Approach and Design

A research design is the program that guides the researcher in the process of collecting, analyzing and interpreting the data. A research design can be defined as the strategy, the plan, and the structure of conducting a research project majority (Mtonga 2014) cited (Carriger, 2000). The research design for this particular study was cross-sectional survey study and quasi-experimental with both quantitative and qualitative components were conducted. It is appropriate and suitable to use data collection tools such as questionnaires and focus group

discussions (FGD). For this study the research used mixed approaches that mean quantitative and qualitative approach had been applicable. For both quantitative and qualitative approach questioner, focus group discussion and document analyze data collocation instrument was used.

3.3 Data Sources and Types

The study used both primary and secondary data sources. Primary data was collected directly from the respondents who were selected from users and non-users of irrigation in each selected kebele on the way of questioners and focus group discussion. Both qualitative and quantitative data types were used. Quantitative data was done by administering structured questionnaires and qualitative data were taken from focused group discussion. The quantitative data used to assess socio-demographic, socio-economic characteristics, institutional aspect, technology and food security status both (treatment and control) groups of the households. Qualitative method was used to capture data pertaining to local perception and opinions the impact of irrigation on household food security. This was done by using one focused group discussion in each of the three selected Kebeles. One focus group discussions at each study areas was conducted and each focus group comprised six to eight individuals including two experts from two different departments. Secondary data was review and consolidate from different documents both published and unpublished materials, which were relevant to the study.

3.4 Methods of Data Collection Techniques

The method of data collection was used survey. This survey method used structured (questioner) and unstructured (focus group discussion). Primary data was collected through two data collection instruments such as questioners and Focus Group discussion. Secondary data was collected from different and relevant document review.

3.5 Sampling Procedure and Sample Size

3.5.1 Target Population

The target population is the total group of individuals from which the sample might be drawn. In the study area 7352 rural households have been using small-scale irrigation on the other hand 8880 rural households have not been using small-scale irrigation. The two target group of the total population 16335 households in the study area.

3.5.2 Sampling Techniques

In this studies two stage sampling procedure was followed to select the respondent household. In the first stage, three rural Kebele administrations were selected randomly from ten irrigation potential Kebeles of the study area. By this random sampling every ten irrigation potential Kebel had equal chance. After randomly selected the study had irrigation user and nonuse group who are living selected Kebele. So In the second stage, the research used stratified sampling techniques. Because stratified sampling is a one types of sampling techniques in which the total population is divided in two small group or strata to complete this research sampling process. There for in the three randomly selected Kebeles, households were stratified into two strata (small-scale irrigation users and non-irrigators). To end with, the researcher selected respondent that are using or not using irrigation household sampling random technique from each stratum.

3.5.3 Sampling Size Determination

Sample size was determined by using the simple formula developed by (Yemane 1967) at precision level of 90 %. Following this, to identify respective sample for each stratum in each Kebeles, sample proportion to the population were employed. Based on this, 99 households from irrigation users and 105 households from non-users total 204 and 10 % contingency 224 sample were identified. Finally, respondent households were selected by using the simple random sampling technique from each stratum.

$$n = \frac{N}{1+N(e)^2}$$

Where, n= sampling size

N= total population

e = error (above 90% level of confidence) the confidence level of this research is 90%

The household of irrigation using in the study area are 7352 and nonuser are 8880. So the sample by the above equation

$$n = \frac{7352}{1+7352(0.1)^2}$$

$$= 99 \text{ sample have been used from the total irrigation user household}$$

$$n = \frac{8880}{1+8880(0.1)^2}$$

$$= 105 \text{ sample have been used from the total nonuser household}$$

The total sampling both irrigation user and nonusers are 204 household and with 10% contingency 224 households are the sample size.

3.6. Method of Data Analyze

In this study both descriptive and econometric methods were used to analysis the data. After data collection by questioner, focused group discussion and relevant document review editing and coding were conducted, it had been the gathered data entered into computer using SPSS software version 25 and analyzed.

3.6.1 Descriptive Statistics

Descriptive statistics like mean, standard deviation, minimum, maximum, percentages, frequency, tables and graphs were used to describe the socioeconomic, demographic and institutional characteristics of the sampled households was applied.

3.6.2 Household Food Security Status Assessment Methods

3.6.2.1. Household Food Insecurity Access Scale (HFIAS)

According to (USAID 2007), Access Scale (HFIAS), which is used of the technique, to assessment the occurrence of food insecurity. The tequneques is grounded on the notion that the practice of food insecurity (access) reasons anticipated replies and answers that can be seized and calculated through an analysis and concise in a scale. The survey questionnaire contains nine occurrence questions that represent a generally growing level of severity of food insecurity (access) constantly happen through the earlier one year, and nine “frequency-of-occurrence” survey questions that are questioned as a follow-up to every occurrence question to determine how frequently the situation happened. The frequency-of happening survey question is jumped if the sample respondent reports that the situation described in the consistent occurrence question was not experienced in the previous one month (4 weeks). Some of the nine occurrence questions ask about the respondents’ perceptions of food vulnerability or stress and others nine questions inquire about the respondents’ behavioral responses to insecurity. All of the occurrence questions inquire whether the household headed or other household members either felt a certain way or accomplished a specific behavior over the earlier one month The HFIAS occurrence questions relate to three different domains of food insecurity (access) found to be common to the cultures examined. Each HFIAS frequency-of-occurrence question asks the respondent how often the condition reported in the previous occurrence question happened in the previous four weeks.

There are three response options representing a range of frequencies (1 = rarely, 2 = sometimes, 3 = often).

The HFIAS indicator categorizes households into four levels of household food insecurity (access): food secure and mild, moderately and severely food insecure. Households are categorized as increasingly food insecure as they respond affirmatively to more severe conditions and/or experience those conditions more frequently.

3.6.2.2 Household Dietary Diversity

Household dietary diversity - the amount of diverse food sets consumed completed a specified reference period, not about the occurrence of eating. HDDS is used to measure variety of diets in a sample household. The household dietary data was collected 24 hours of dietary consumption. More differentiated diet is an important result in and of itself. A more diversified diet is associated with a number of improved outcomes in areas such as birth weight, child anthropometric status, and improved hemoglobin concentrations. A more diversified diet is vastly interrelated with such factors as caloric and protein appropriateness, Percentage of protein from animal sources (high quality protein), and household income. Even in very poor households, increased food expenditure resulting from additional income is associated with increased quantity and quality of the diet.

When generating the household dietary diversity score (HDDS), however, the expanded set should be combined back into the original 12 food groups so that the total HDDS is based on the same 12 food groups. To assess HDDS twelve food groups are recommended. Those food groups are Cereals, White tubers and roots, Vegetables, Fruits, Meat, Eggs, Fish and other seafood, Pulse/ Legumes, Milk and milk products, Oils and fats, Sugar or Honey, Spices, condiments and beverages.

First, the HDDS variable is calculated for each household. The value of this variable was range from 0 to 12. Total number of food groups consumed by members of the household. Values for A through L have been either "0" or "1". Sum (A + B + C + D + E + F + G + H + I + J + K + L). According to USAID a HDDS of less than 3 food groups was regarded as low household dietary diversity. Four to five food groups was regarded as medium dietary diversity and ≥ 6 food groups was regarded as high dietary diversity.

3.6.3.3 Food Consumption Score

In all food security analyze developed by WFP, the FCS is used to dig out the most food insecure households. The prevalence of households with poor and borderline food consumption provides essential information on people’s current diets and is helpful in determining the most suitable type and scale of food security intervention. However, it remains a household level indicator and does not make the link between household access to food, individual dietary intake and nutritional outcomes - stunting, wasting and micronutrient deficiencies as shown in the WFP Food and Nutrition Security Framework (WFP 2015). The frequency weighted diet diversity scores or food consumption score is score calculating using the frequency of ate of diversified food groups utilized by a sample household during 7 consecutive day before the survey.

Table 1: Food Items, Food Groups and Weights for Design the FCS

Food items	Food group	Weight
Cereals: Corn, Wheat, Sorghum, Rice, Bread	Main Staples	2
Pulses/Beans/ Nuts Pulses	Pulses	3
Milk/ Milk Products Milk	Milk	4
Animal Proteins: Fish, Meat, Eggs	Meat and fish	4
Vegetables (including green, leafy vegetables)	Vegetables	1
Sugar/ Honey	Sugar	0.5
Fruits	Fruits	1
Oil and Fats	Oil	0.5
Spices, coffee	Condiment	0

Source: World Food Program (2008).

Once the food consumption score is calculated the thresholds for the food consumption groups should be determined based on the frequency of the score.

According to (WFP 2007), the most vital calculation equation for the Food Consumption Score used for this study $FCS = a \times f(\text{staple}) + \beta \times f(\text{pulse}) + \gamma \times f(\text{vegetables}) + \gamma \times f(\text{fruit}) + \delta \times f(\text{animal}) + \epsilon \times f(\text{sugar}) + \delta \times f(\text{dairy}) + \epsilon \times f(\text{oil})$, the equation is developed by WFP,

Where FCS indicates food consumption score and

f represents frequencies of food consumption that's equals sum of days for which each food set was eaten through the earlier 7 days.

$\alpha, \beta, \gamma, \delta$ and ε = weight/nutritional value of every food group, developed by WFP

As the document puts on (WFP, 2007) that the consumption of household 0-28 occurrences (2007) have poor food consumption, households with borderline food consumption have a food score of 28.5- 42 rates and households with adequate food consumption have a food score of above 42.

3.7 Econometric Models

3.7.1 Propensity Score Matching Technique

Propensity score matching is often used in a program evaluation setting, where the objective is to compare participant outcome with and without treatment. The method was initially proposed as a technique to reduce bias in estimation of treatment effects with observational data in the seminal work by (Rosenbaum and Rubin 1983). After that it has become a popular method to measure the impact of economic policy interventions (Becker and Ichino 2002). The idea is too important to create an index that summarizes observable characteristics of the household into a propensity score index. The households were then divided into two groups, those who use irrigation and those who do not use, and was ranked according to their propensity score. After that the households were matched with comparable households from the other group. In this way households in the treatment group matched and were compared with households from the control group, that have similar characteristics in every aspect except that they do not use irrigation. In equation form, our goal is to estimate the causal treatment effect following (Andersson 2012).

$$t_i = Y_{i1} - Y_{i0} \quad (1)$$

Where

Y_{i1} and Y_{i0} is the outcome treatment and without treatment group respectively for household i .

Consider $D = \{0,1\}$ to be a binary indicator where 1 equals being assigned into treatment and 0 means not being assigned treatment. The Average Treatment Effects (ATE) was estimated through:

$$ATE = E[Y_i | d_i=1] - E[Y_i | d_i=0] \quad (2)$$

ATE is hence the average difference between the treated households (in our context treated households are households who are using irrigation) and the non-treated households.

A preferred parameter to use instead of ATE is the Average Treatment Effect on the Treated (ATT), defined by:

$$ATT = [Y^1|D=1] - E[Y^0|D=1] \quad (3)$$

Where $[Y^1|D=1]$ is never observed. Replacing $[Y^0|D=1]$ by the expected value of $[Y^0|D=0]$, which is observable in ATE, Would not give an accurate estimate as long as Y^0 for the treated and comparison group systematically differs. The true parameter was only identified if:

$$[Y^0|D=1] - E[Y^0|D=0] = 0 \quad (4)$$

As discussed above, this is not very likely to hold in non-experimental studies. Instead, we rely on a matching approach to derive a counterfactual that enables us to match treated households with non-treated households with as similar characteristics as possible in order to reduce the bias from self-selection. The matching was made based on an index, the propensity score, summarizing the pre-treatment characteristics of each household. The propensity score is the probability of assignment into treatment, (X) , conditional on a set of pre-treatment characteristics, X , so that

$$(X) = \Pr[D=1|X] = E[D|X] \quad (5)$$

There are a few restrictions that should be fulfilled when implementing the propensity score procedure. The conditional independence assumption (CIA) requires that the outcome variable is independent of treatment conditional on the propensity score. The balancing property theorem tells us that two households with the same predicate probability of were treated (i.e. irrigation users) and belonging to two different groups (treated and non-treated) differ when it comes to the error term in the propensity score equation. The error term is furthermore approximately independent of the observed covariates. In other words, for balancing property to be satisfied, households with the same propensity score must have the same distribution of observable and unobservable characteristics irrespective of treatment status. The balancing property can be tested using a covariate imbalance test. Common support implies that analysis was carried out when there are sufficient data. Hence, there is no extrapolation outside the range of the observed data points. It is therefore advisable to impose a common support restriction when estimating the propensity score in order to improve the quality of matches.

The propensity score estimated using any discrete choice model using observable characteristics to reduce the bias that is attributable to unobservable factors. The extent to which the bias

reduces depends on the quality of the conditioning variables (Becker and Ichino 2002). In addition previous studies have shown that matching methods provide reliable estimates of impact provided that (1) the same data source is used for participants and non-participants (in this case households that using irrigation and that do not use); (2) treated and controls have access to the same markets; and (3) the data include meaningful variables capable of identifying program participation and outcomes (Heckman et al. 1997).

The treatment sample was designed to include an appropriate control group. The control and treatment sample draw exclusively from the Mehal Sayint Worda three Kebele who are not using irrigation and using irrigation respectively. Also, the questioners include a large set of variables affecting household food security. These variables include measures of household head age, sex, education background and level, household size, dependency ratio, area of cultivated land, off farm income, access to irrigation, agricultural input, and access to credit, health status, extension service and distance to markets. These would affect the food security conditions. It is assumed that for each irrigation users household and for all observable characteristics, a comparison group of irrigation non-user household with similar propensity scores exists. (Heckman et al 1998) emphasize that the quality of the match can be improved by ensuring that matches has formed only where the distribution of the density of the propensity scores overlap between treatment and comparison observations, or where the propensity score densities have “common support.” Common support has improved by dropping treatment observations whose estimated propensity score is greater than the maximum or less than the minimum of the comparison group propensity scores. Similarly, comparison group observations with a propensity score below the minimum or above the maximum of the treatment observations are also dropped. The balancing property of the logit specification was tested to ensure that sample of user households and the sample of nonuser households have similar mean propensity scores and observables at various levels of propensity scores (Becker and Ichino, 2002). Hence, the results was presented based on specifications that passed the balancing tests.

3.8 Descriptions of Variables

Different variables were anticipated to affect rural households to rural food security. The variables hypothesized to influence small-scale irrigation and food security status are explained in this section.

3.8.1 Dependent Variables

Small-scale irrigation users and nonusers are dependent variable that has cited on propensity score matching.

3.8.2 Independent Variable

The independent variables that are hypothesized to influence the household's small-scale irrigation and food security status are combined effects of various factors such as demographic, socioeconomic, technology and institutional factors

Demographic and Socioeconomic Variables

Household age: Age is a continuous variable measured in years. It is one of the factors that determine decision-making of a person. Different Previous studies found a two-way relationship between age and decision to participate in small-scale irrigation and other agricultural technologies. According to (Diederer 2003), Younger farmers are better creative and exposed to receive modern technological and be more ready to implement a new agriculture technology. Therefore, these studies assume negative relationship between age of the household head and participation in irrigation scheme. At younger ages the probability of participating in small-scale irrigation increases.

Sex of the household head: Male household heads are expected to have higher income compared to female household heads because of better labor inputs used and with regard to irrigation farming experience. Male headed farmers are also better than the female headed farmers since it is assumed that male household heads have more exposure and access to information and new interventions than female household heads, by different causes which might enable them to participate in the small-scale irrigation as early as possible and their income is higher than their counterpart. This study hypothesized male headed households more likely to participate in the small-scale irrigation scheme in the study area.

Household education level: this is measured the level of schooling from church education to collage education. That is the number of years of schooling attained by the sampled households' heads up to the time of the survey. Previous studies indicated that the possibility to adopt new methods of farming increased along with the education level. That is educated farmers had more willingly to adopt irrigation technology, may be easier to train through extension support and have a positive impact on irrigation participation. On the other hand, as the educational level of farmers is increased, their interest to work in non-agricultural activities may be increased that leads to the declining of the willingness to participate in contract farming program. According (Feder et al. 1985) farmers with more education have been shown to adopt modern agricultural technologies sooner. Therefore, the variables hypothesize to influence the participation decision on contract farming and gross margin earnings of the farmers in both negative and/or positive directions.

Family size: This is a continuous variable measured in total number of the household members live under the same roof adjusted to adult equivalent. Family size in adult equivalent of a household is calculated by using the conversion factor and multiplying each household member with respective conversion factor and then summing. Previous studies found a two-way relationship between family size and decision to participate in irrigation scheme and other agricultural technologies. Therefore, these variables have positive effect household heads decision to small-scale irrigation participation. According to (Shimelis 2009), a family with large work force can engage in small-scale irrigation more than a family with small- amount of work force.

Dependency ration: is an age population ratio of those typically not in the labor force and those typically not in the labor force and those typically in the labor force. The labor forces have impacted productivity and production.

Access to extension service: This indicates that whether the household head gets extension service from development agents (DAs) or not. Extension service provides the necessary information to acquire new skills and knowledge to farmers to improve agricultural production. (Bacha et al. 2011) found significant difference between irrigators and non-irrigators in access to extension. The higher is the probability for the farmers to access and use irrigated agriculture. It

is, therefore, this variable was hypothesized to positively influence participation in the small-scale irrigation scheme.

Access to credit: Access to credit is an important source of investment. Therefore, it is hypothesized that access to credit determines farmers' decision to participate in small-scale irrigation and food security status positively. This more implies that the formal and informal credit facilities that advantage for rural farmers are a very important asset in rural livelihoods to finance agricultural inputs activities.

Health status: any health problem affects the working ability and time. Agriculture business needs more energy and health condition. Health problems have negative contribution participant in the small-scale irrigation.

Distance to market: .it is important to know the distance between the sample household their production selling place. These shows access to the market to buy input and to sell output. As the farmer is nearer to a market had chance of participating in small-scale irrigation and selling farm income. It is, therefore, expected that households nearer to market center had better chance to participate in small-scale irrigation and improve household food security status.

Socio economic factors

Cultivated land holding: This is a continuous variable measured and it refers to the total cultivated land size of the household heads. In many previous studies, it has been noted that enough size of land holding is the basic requirement for adoption different agricultural technologies. It is thus assuming that the wider farm size holder households have big likelihood to use small-scale irrigation technology. Total cultivated lands have a positive relationship with income of a household (Kamara et al. 2001).

Off farm activity: - These activities have positive influence on the rural household.

Technology

Access to irrigation: the rainfall dependent agriculture has affected by erratic weather condition. To tackle this problem irrigation accessibility has advantage compare with non-accessibility. Access to irrigation assumed positive effect to rural household food security.

Agricultural input: to increasing of the production of agriculture depend on agricultural practice and agricultural inputs in addition to other factors. Today the agriculture sector needs modern inputs and agricultural practices, so the use of agricultural inputs expects to have positive impact to rural house hold.

3.8.3 Dependent Variable

All access to credit service, extension service, using agricultural inputs land size, family size, access to irrigation and others final outcome is achieved food security. All the above independent variables had great impact to dependent variable.

Chapter Four

4. Result and Discussion

4.1 Introductions

In this chapter describes the results and analyze of the survey data. The result discussion used descriptive statistics such as means, percentages, standard division and frequencies to describe the features of sample households by using descriptive variables to analysis both descriptive and economic model (Propensity score matching) are presented.

Inferential statistics such as t test and chi square tests are also conducted to compare treatment group and controls with respect to different variables. In order to analyze whether there is a significant difference between irrigation user and irrigation non-user. In terms of average score food security the propensity score matching method has been employed.

4.2 Descriptive Statistics

4. 2.1 Characteristics of Household Demographic

Table 2: Two groups' respondent distributions

irrigation user and non-user		
	Frequency	Percent
irrigation user	99	48.5
irrigation non user	105	51.5
Total	204	100.0

Source: Survey result 2020

In these research 99 (48.5 %) respondents are irrigation user and 105 (51.5 %) respondents are irrigation non-users both female and male household head.

Table 3: Sex ratio from respondent

	Irrigation user		Irrigation non user		Total		X ²
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
Male	95	96.0	91	86.7	186	91.2	5.69***
Female	4	4.0	14	13.3	18	8.8	
Total	99	100.0	105	100.0	204	100	

Source: Survey result 2020, ***1 percent significance difference

According to the result shows in table (3), from the total household sample 91 % (186 households) are male-headed and 8.8 % are female household head. From the irrigation users 95 (96.0 %) are male headed and 91(86.7%) irrigation non- users are male headed. This result shown, that both irrigation users and irrigation- non-users female households are small compare with males. However, this result presented that in the study area female and male have not equal participation on the farming activities. This finding shown, that the study area has highly gender division works. The chi square results indicates there is no significant different between the sex between user and non-user.

Table 4: Respondents by Age

	Irrigation user	irrigation non user	Total	X ²
Mean	44.8	45.5	45.2	7.6***
Std. deviation	10.4	10.6	10.5	
Median	46.0	47.0	46.0	
Mode	47	55	55	
Minimum	24	26	24	
Maximum	72	72	72	

Source: Survey result 2020, ***1 percent significant level

According to the result shows in table 4 the ages mean, Std. deviation, median and mode of the total respondent are 45.21, 10.53, 46 and, 55 respectively. The irrigation user age of mean, Std. deviation, median and mode of the total respondent are 45.21, 10.53, 46 and, 55 respectively. The irrigation- non-user age mean, Std. deviation, median and mode of the total respondent are 45.21, 10.53, 46 and, 55 respectively. The result indicates most respondents are adults. The minimum and maximum age of the respondent is 24 and 72 respectively as well as the range of the age 48 years. The irrigation non-user minimum and maximum age are 26 and 72 respectively and the irrigation user minimum and maximum age are 24 and 72 respectively. The age difference between the irrigation non-user and irrigation user headed found to be statistically insignificant telling age has no effect on the participation decision. This results point outs that high old family head has more farming familiarity to learn by doing. Older household headed were more vulnerable preventer, and frequently they build up and differentiate their farming production activities. Abebaw(2003).

Table 5: Family size

Variable	Irrigation user	Irrigation non user	Total	X ²
Mean of family size	5.1	5.2	5.2	8.2***
Mean of family size standard division standard	0.8	.76	0.8	
Mean of family size standard error	0.08	0.07	0.05	
Dependency ratio	1.67	1.8	1.8	7.3***

Source: Survey result 2020 *** 1 percent significant level

The table 5 presents the mean of irrigation user household and irrigation non-users household family sizes have insignificant difference. All two groups have almost had the same family size. As the 1 percent significant level chi square indicates there is no significance difference between user and non-user household dependency ratio and family size. The mean of the Ethiopian family size is 4.8 and the Amhara region household size 4.2 CSA (2016). However, the mean of the study area family size 5.2 is greater than the country and the region household size. According to Derebew (2015) family size had negative impact to food security in Ethiopia. Therefore in the study area family size may one key negative impact for food security.

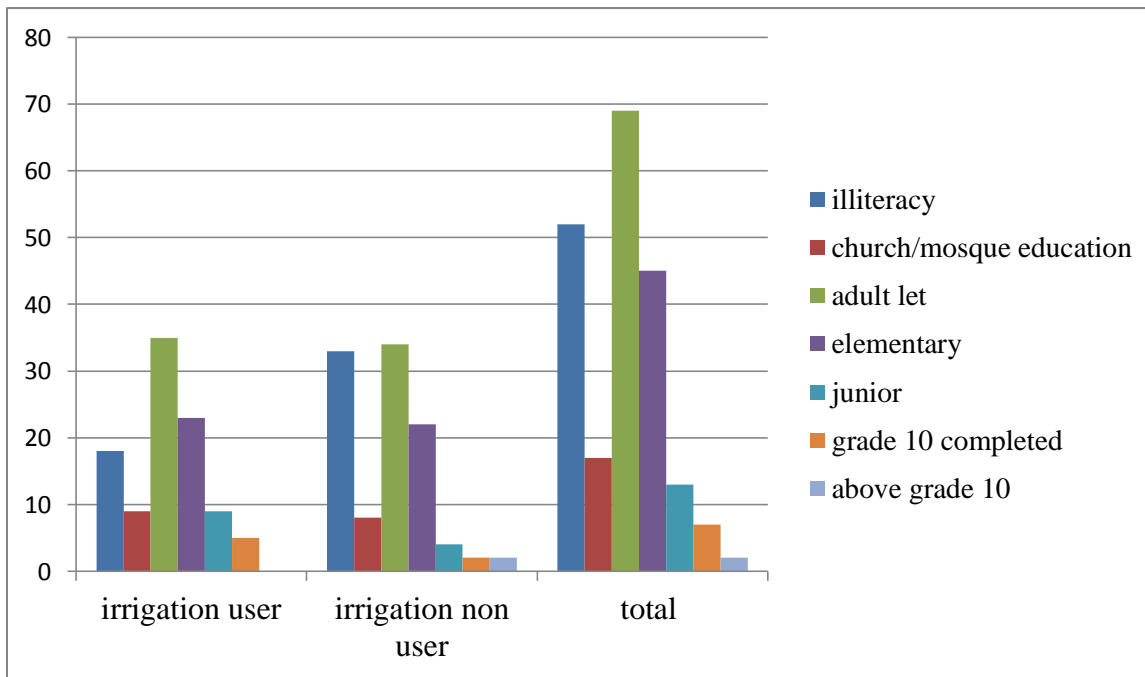
Table 6: Marital status the household headed

	Irrigation user		Irrigation non user		Total		X ²
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
Married	77	77.8	97	92.4	174	85.3	12.4***
Single	10	10.1	7	6.7	17	8.3	
Divorced	4	4.0	1	1.0	5	2.5	
Widowed	4	4.0			4	2.0	
Separated	2	2.0			2	1.0	
Others	2	2.0			2	1.0	
Total	99	100.0	105	100.0	204	100.0	

Source: Survey result 2020, *** 1 percent significant level

The marital statuses of respondents as shown in table 6 confirms the majority of the respondents 174 (85.3%) from those were married farmers who engage in farming to get income for the family. In addition to that 77 (77.8%) of irrigation users and 97 (92.4) irrigation non-users farmers were married. Irrigation non-users were more married compare with irrigation users. Married family headed had important to share works with families. This provides high work force to farming activities.

Figure 1: Education statuses



Source: Survey result 2020

The data in figure 1 shows that it has relationship between educational level and irrigation farming. From the total irrigation non-user 33 (31.4 %) are illiterate. However, from the irrigation users 18 (18.2 %) are illiterate. This statics shown irrigation non-users were more illiterate compare with irrigation user respondents. It was theorized that irrigation participation and education level of the household heads had positive relationship. Irrigation users have Church/mosque 9 (9%), 8,17 elementary 35 (35.35%) , 34, 69 junior 9 (9%),4,13 grade ten completed 5 (5%),2 7.above-4 education level. Irrigation non-users have Church/mosque 8 (7.61 %) elementary, 34(32.4%) junior 4(3.9%), grde10 6(5.8%) education level. Literate person is more ready to utilize new different agricultural inputs and technologies to improve

productions. According to Derbew (2015), new technology and inputs had positive impact to improve food security. Therefore, in this finding using agriculture inputs and technology have positive impacts to food security.

4.2.2 Socio Economy Characteristics

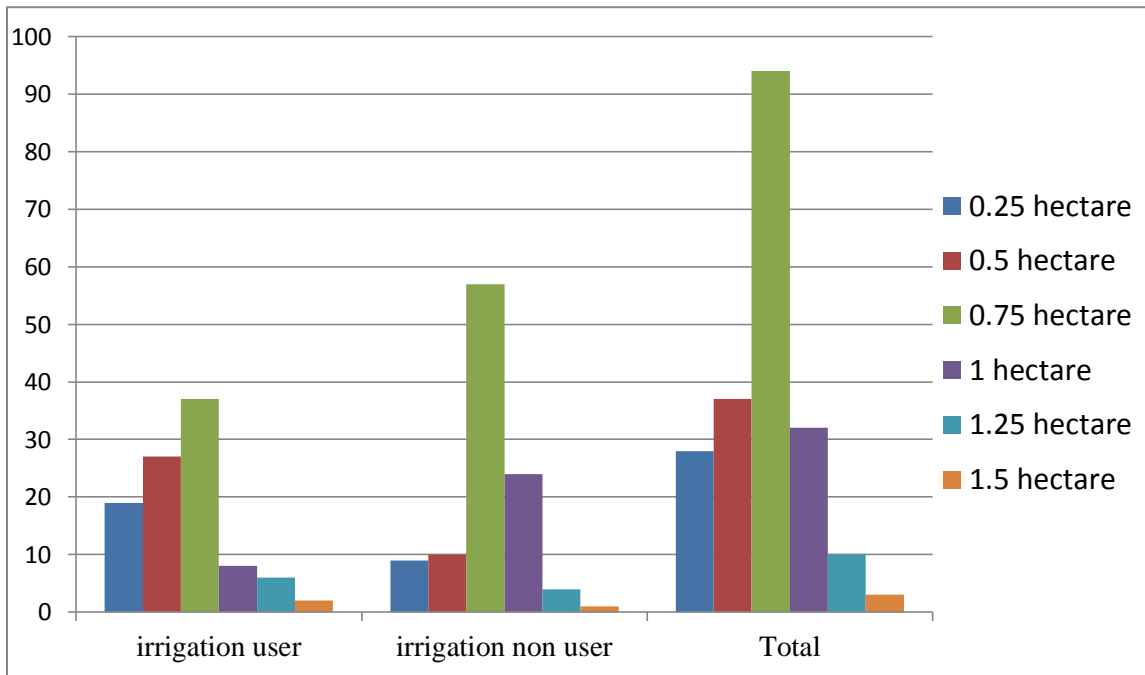
Table 7: Technical skills of the respondents

	Irrigation user		Irrigation non user		Total		X ²
	Frequenc y	Percen t	Frequenc y	Percen t	Frequ ency	Percent	
No special skill	95	96.0	99	94.3	194	95.1	6.7***
Mason	1	1.0	4	3.8	5	2.5	
Trader/merchan t	2	2.0			2	1.0	
Handicraft	1	1.0			1	.5	
Traditional healer			2	1.9	2	1.0	
Total	99	100	105	100.0	204	100.0	

Source: Survey result 2020 ***1 percent significant level

According to result shows in table 7 the majority of household 194 (95.1%) have not special skill. From irrigation user 95 (96 %) and 99(95.1%) irrigation non-users have not special skill. Special skill is important to get additional income. Both irrigation user households and irrigation non-users households are non-skilled. The chi-square 1% significant level result shows insignificant different between irrigation user and irrigation non-user. Technical skill is important to get additional income. According to Dereje Mengistie and Desale Kidane (2016) household technical skill had contribute to secure family foods. However, the study found household have low technical skill.it had not significant contribution to food security.

Figure 2: Land size



Source: survey result 2020

For any kinds of agriculture business Land is the core productive asset in any countries. These fundamental assets get from different sources. The survey result displays the sample household uses cultivation on own land, rented and shared lands. The figure 2 shows results from the total respondent 28 (13.7 %) farmers have 0.25 hectare lands 37 (18.1 %) have 0.5 hectare land, the majority farmers 94 (46.1 %) have 0.75 hectare lands, 32(15.7%) have 1 hectare lands. From the irrigation user 37 (37.4 %), households have 0.75 hectare lands, 27 (27.3 %) have 0.50 hectares land, 19 (19.2%) have 0.25 hectare lands land, 8(8.1%) have one hectares. The irrigation non-user landholders 57 (54.7%) and 24 (22.9%) have 0.75 hectare and 1 hectare respectively. The average size of the irrigation user land and irrigation non-user land is 0.61 hectare and 0.77 hectare respectively. The land size different between irrigation non-user household and irrigation users household had petty different. The t test 1% significant level result shows land size is insignificance different between irrigation users and non-users.

Table 8: One year total product by birr from farmland

	Irrigation user	irrigation non user	Total	X2
Mean	80085.9	30028.9	53931.1	185.72
Median	72000.0	22000.0	42250.0	
Mode	72000	21000	72000	
Std. deviation	94705.4	42789.588	76573.9	
Variance	8969122379	1830948858	5863573987	
Range	972000	393750	989500	
Minimum	18000	5000	500	
Maximum	990000	398750	990000	

Source: Survey result 2020, 1 percent significant level

Table 8 presents the mean of products household were 53931.18 birr. The mean of irrigation user and irrigation non-user that are produced by birr is 80085.92 birr and 30028.96 respectively. The production mean of irrigation user households greater than irrigation non-user households. The chi-square 1% significant level is significance difference between two groups. This indication irrigation had positive impact on household income. This result is similar with Haile Tadese (2008) irrigation user households were more income earned comparing with irrigation non-user households. Therefore irrigation user household had more chances to ensured food security.

Table 9: Off farm activity total income

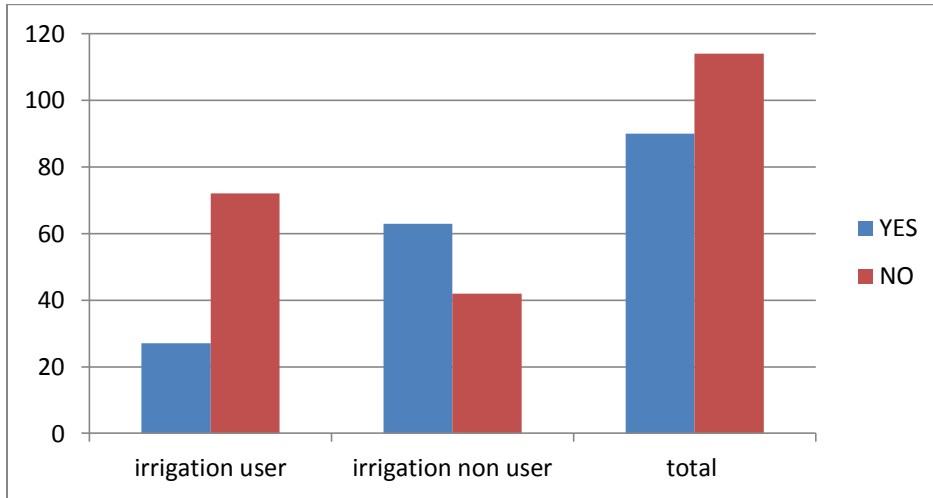
Total off farm income of birr	Irrigation use	irrigation non user	Total
Mean	8567.68	8779.6	8676.97
Media	6000	7200	6500
Standard division	8327.6	5528	7010.7
Standard error of mean	837	539.5	490.847

Source: Result survey 2020

According to presents table 9 that the mean income of the off farm activity is 8567.85 birr for irrigation user households .The mean income of the irrigation non user is 8779.6 birr.by off farm activity the total respondent income mean is 8676.6 birr. This result shown that irrigation user's

households spent times on their irrigation lands, but irrigation non-user household had to spent time off farm activity. Because irrigation user household farm activity income is greater than irrigation non-user. Off farm activity is important to ensure household food security. The chi square 1 % level of significant result presents there is significance between irrigation user household and irrigation non- user household.

Figure 3: Did you got aids by past one year



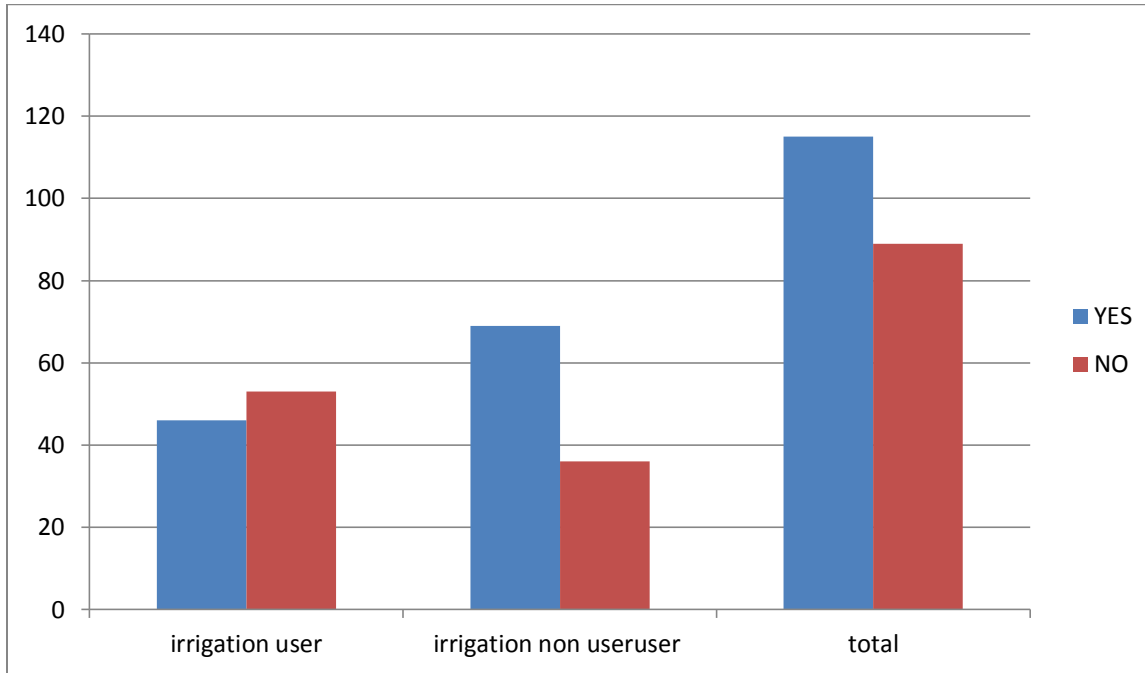
Source: Result survey 2020

According to the figure 3 results 72 (68 .6%) and 27 (27.5 %) of irrigation non-users and irrigation users have aid respectively. The irrigation user that have gotten from aid mean 1311 birr and the non-irrigation aids mean 2597 birr. This result presents Irrigation non-user aids could be the sign of food insecurity. More food insecure receives more aides. The chi square 1 % level of significant result presents there is significance between irrigation user household and irrigation non-user household. According to (Bhattarai 2007), more aid receivers were irrigation non-user households.

4.2.3 Institution

Have you over the last one year received credit for?

Figure 4: Credit



Source: Survey result 2020

As different studies Credit was too important for agrarians to provide finance to purchase agricultural technology and inputs to increase production and productivity. From the total samples 115 (56.4%) respondents have taken credit while 89 (43.6 %) respondent have not taken credit by last one year. The majority number 53 (53.5%) irrigation users have not taken credit comparing with 36 (34.3%) irrigation non-users have not taken credit. The majority of irrigation non-user 69 (65.7%) have taken credit. On the other hand the 46(46.5 %) irrigation users have taken credit. As indicates in the figure there is systematic association between irrigation non-user participation and credit access because from the credit user, 25 (36.23 %) irrigation non-users have taken credit for the consumption purpose. However, this number is greater than 8 (17.2 %) irrigation users have taken for consumption. Above one third of credit that has been taken by irrigation non-user is not invested on farming to improve production like agriculture input and technology. From the total irrigation users 21 (45.6%) and 17(37 %) credit uses for fertilizer and

improved seeds respectively. Irrigation non-user credit uses for fertilizer 22 (31.9%) and 22(31.9 %) for improved seeds. According to the data the majority irrigation users have used credit for agriculture technology and inputs to improve agriculture production, but the majority irrigation non-user used credit for consumption purpose. Credit has positive relationship with food security and income. Because households, that have access to credit has better possibility to getting farm inputs and technology. Credit helps farmers purchase inputs such as seeds, fertilizers, pumps and entirely irrigation technology. Therefore the probability of participation in small-scale irrigation food security was increased. The 1% (percent) significant level Chi-square test results indicates that there is substantial difference in access to credit between irrigation user household and irrigation non-user household.

Table 10: The purpose of used credit

	Irrigation user		Irrigation non user		Total		X ²
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
Fertilizer	21	45.6	22	31.9	43	37.4	8.16***
improved seeds	17	37	22	31.9	39	34	
Consumption	8	17.4	25	36.2	33	28.6	
Total	46	100	69	100	115	100	

Source: Survey result 2020 *** 1percent significant level

Table 11: Reasons didn't taken

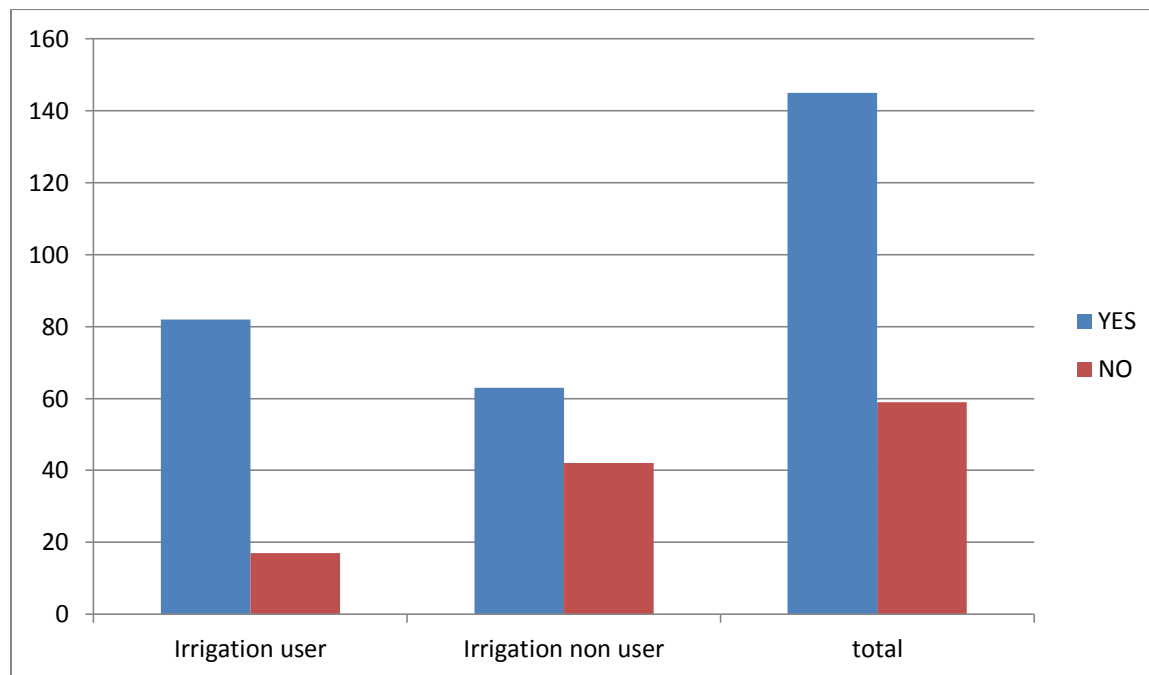
	Irrigation user		Irrigation non user		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Lack of access to credit	6	11	13	36.4	19	21.4
No need for credit	47	89	18	50	65	73
High interest rate			5	13.8	5	5.6
Total	53	100	36	100	89	100

Source: Survey result 2020

The survey results in table 11 shows that the reason of have not received credit, 47 (89 %) and 6(11 %) irrigation users are no need for credit and the lack of access to credit respectively (table

11). According to result shows in table 11 the reason of non-user irrigation did not taken credit is lack of access to credit 13 (36.5 %), No need for credit 18 (50 %) and High interest rate 5 (13.8 %).

Figure 5: Did you have get market information?



Source: Result survey 2020

Market information is vital to get solution how much, when and where could sell the product and bought technology and inputs. According to figure 5 from the irrigation user 82 (82.8 %) and 63 (60 %) irrigation non-users gets market information. Market information has positive relation with food security. More irrigation user households has market information compare with irrigation non-user household. Information has high impact to decide price and market to buy agriculture inputs and to sell agriculture products. Particularly perishable agricultural products producers should have market information when, where and how can they sell the product before they harvest. Without market information, the households do not get tantamount income. This affects household food security.

Table 12: Where did you sell your products?

	Irrigation user		Irrigation non user		Total		t-tests
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
at village market	54	54.5	51	48.6	105	51.5	1.05****
district market	35	35.3	36	34.3	71	34.8	
regional market	5	5.1	10	9.5	15	7.4	
national market	5	5.1	2	1.9	7	3.4	
No			6	5.7	6	2.9	
Total	99	100.0	105	100	204	100	

Source: Result survey 2020, ***1% significant level

As table 12 indicates that the sample households sell their agricultural products in different market center. From the total sample 105(51.5 %) household sell their product in the village market. This indicates the majority households sold for local customers. On the other side 71(34.8%) of households sell their product in the district market. The t test result shows there is no significant different between irrigation users and irrigation nonusers. The market distance from household resident has price, time, productivity and competitively impact. So all irrigation non-user and irrigation user household had equal positive or negative impact about market. Therefore, the market had not especial advantage for anyone.

Table 13: How far you residence from market

	Irrigation user		Irrigation non user		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
up to 3km	3	3.5	1	1.0	4	4.5
3- 6km	34	34.3	65	61.9	99	48.5
6-9 km	9	9.1	5	4.8	14	6.9
9-12 km	26	26.3	2	1.9	28	13.7
13-15 km	27	27.3	32	30.5	59	28.9
Total	99	100.0	105	100.0	204	100
Mean		3.45		2.99		3.2
SD		1.25		1.38		1.34

Source: Result survey 2020

The examination result presents that the respondent households are located on mean of 3.2 km away from Market (Table 13). The minimum distance of the respondent households from the

market is 3 km. In addition to that the respondent households are located maximum market distance is 15 km. the irrigation user and irrigation non-user average locate distance from the market is 3.45 km and 2.99 km respectively. The survey result showed that households sell their products in different market center. The standard division distance from market of the sample 1.25, 1.38 and, 1.34 are irrigation user, irrigation non-user and total respondents respectively. Distance from market affected the price of the operation cost of the production. More far from market low price and near from market got competitive price. Market information and market distance were key factor to produce agriculture production Lipton (2002)

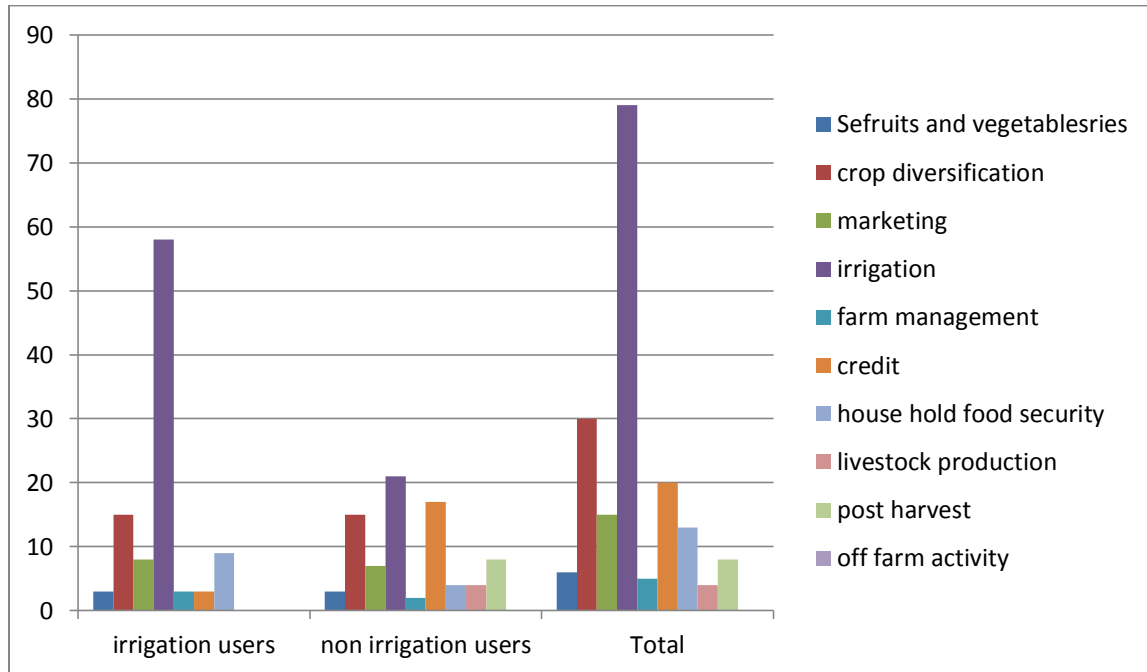
Table 14: How far is the FTC from your home?

	Irrigation user		Irrigation non user		total		t value
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
up to 1 km	58	58.6	57	54.3	114	55.9	1.27***
1-1.5 km	33	33.3	5	4.8	38	18.6	
1.5-2 km	3	3.0	15	14.3	3	1.5	
2--2.5 km	5	5.1	28	26.7	21	10.3	
Total	99	100.0	105	100.0	204	100.0	
Mean	1.55		2.54		2.07		
St. division	.079		1.803		1.942		

Source: Result survey 2020, *** 1 % significance

The result shows on table 14 distances from farmer training center mean of irrigation user resident is near for FTC. The mean distance of irrigation user is 1.55 km but the irrigation non-user distance mean is 2.54 km. The result tells that this variable has a significant (at 1% level significant level.). The possible explanation is that those farmers who had access to extension service were more likely to adopt irrigation than who had not access to extension services. The t test result shows insignificant difference between irrigation user and irrigation non-user. This indicates irrigation users and irrigation non-users household have relatively equal opportunity to get extension service from farmer training center.

Figure 6: Training



Source: Result survey 2020

The result shows from on figure 6 all 99 (100%) irrigation respondent take different training but 83(79%) of irrigation non-user take different training. Furthermore, a positive relationship between irrigation use and participation training indicate that household who often follows training may had better skill and knowledge on modern technology, input utilization and irrigation usage. Training had vital to improve household skill and aware creation about modern agriculture technology and new inputs utilization. The result indicated that irrigation user household had possibility more utilization agriculture inputs and technology. More technology and agriculture inputs utilization have got more production. More production leads to ensure household food security.

4.2.4 Irrigation Users

Table 15: How long you have been engaged in irrigation agriculture?

	Irrigation user	
	Frequency	Percent
up to 2 year	22	22.2
2-5 year	18	18.2
6-10 year	22	22.2
above 10 year	37	37.4
Total	99	100.0

Source: Result survey 2020

The result of survey in Table 15 shows that the majority 37 (37%) irrigation user households have engaged irrigation agriculture over ten years. The result of survey in Table 15 shows that 22(22.2%), 18(18.2) and 22.2 (22 %) of irrigation user households have engaged in irrigation agriculture for 2 years ,2-5 years and 6-10 years respectively. This different year engaging in irrigation agriculture was important to represent different situation and age.

Table 16: What are the major reasons for adopting the cropping pattern?

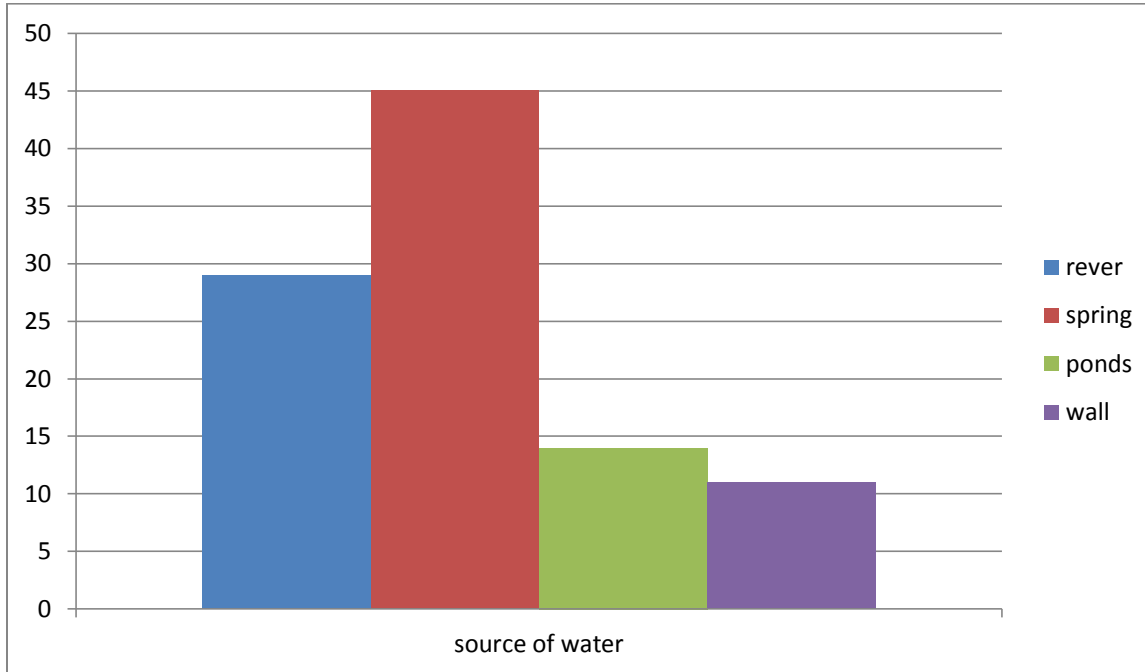
	Irrigation user		t test value
	Frequency	Percent	
good yield	30	30.3	1.4****
high profit/price	31	31.3	
since there is better availability	16	16.2	
appropriateness of the crop/biological nature for that time	22	22.2	
Total	99	100	

Source: Result survey 2020,*** 1 percent significance

The result shows table 16 the majority 31 (31.3%), 30(30.3%) 22(22 %) and 16(16.2%) irrigation user households select irrigation crops due to economic returns, good production potential, appropriateness of the crop/biological nature for that time and since there is better availability. The majority households prefer irrigation crops yield qualities and high profits. This was vital to

get high production and income. High production and high price value agriculture products contributes to insure households food.

Figure 7: Water source of irrigation



Source: Survey result, 2020

The survey result in figure 7 shows that from total irrigation user households, 29(29.3 %) gets irrigation water from rivers. On the other and 45(45.5%) of households got irrigation water from springs. 14 (14.1 %) of households has used their irrigation water from ponds while 11 (11.1 %) from wall. This result also indicated that the majority source of water to irrigation farming is spring. The study area has ten river but not as a major source of water to irrigation. This point out the local government and farmers has not used irrigation potentials to improve household food security.

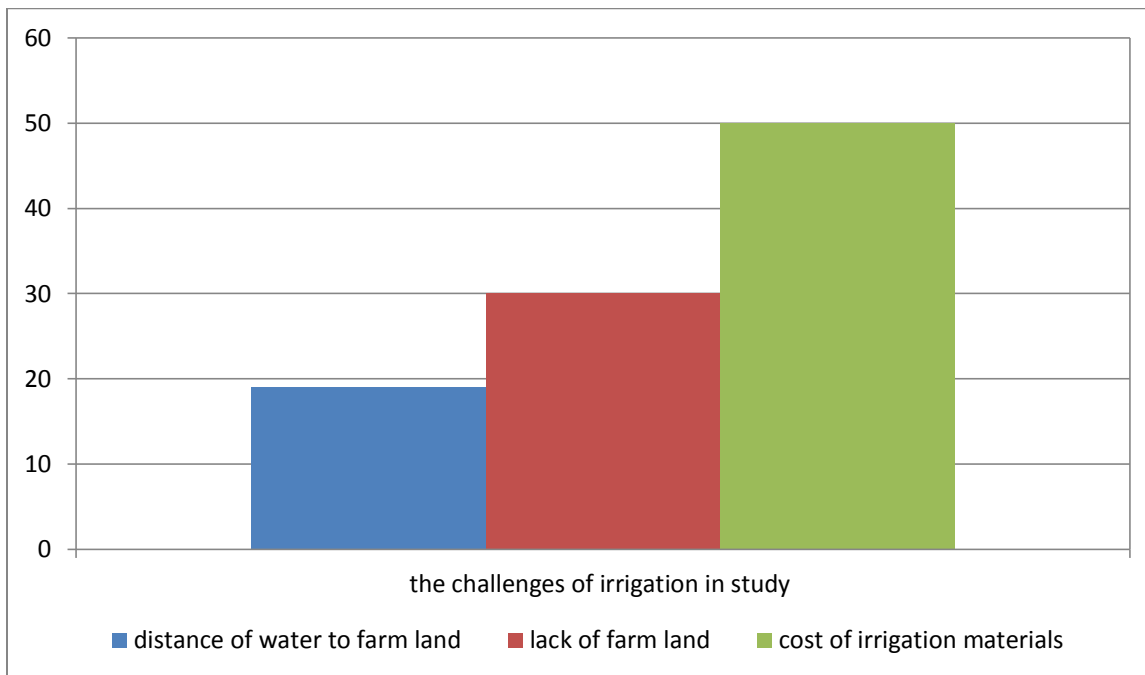
Table 17: Impacts of irrigation using

	Irrigation user	
	Frequency	Percent
Improved household food security	65	65.7
Create job opportunity for non-employment	19	19.2
Reduced dependency	15	15.2
Total	99	100.0

Source: Survey result, 2020

According to the result shows table 17 from the total irrigation user after engaged irrigation 65 (65.6 %) improves household food security while 19(19.2 %) have created job opportunity for non-employment. On the other hand 15 (15.2%) have reduced dependency. this result presents irrigation has positive impact to different aspects in the study area.

Figure 8: Challenges of irrigation



Source: Survey result, 2020

One of the objectives of this study is examine the challenge of irrigation practice in the study area. The investigation result shows that irrigation had positive impacts to improve the household income and food security. In the study area, irrigation practice is not easy by different reasons. The survey result identified main challenges using irrigation in the study area. The figure indicates that 19.2 % of respondents answer that distance from water source was major challenge. Farmers who had farmlands far from different irrigation water source did not use irrigation practice. The result indicates 30.3 % household report that the main challenge is lack of farmlands in the study area. The examination result indicates in figure10 that 50.5 % of the respondents have reported Cost of irrigation materials was irrigation challenge.

4.2.5 Food Security Status of Sample Households

One of this research objective analyses the impact of irrigation on food security of rural households in the study area. The household food insecurity access scale (HFIAS) applies to categorical household food security status base world food program on Food and Nutrition Technical Assistance (FANTA) project. The household food insecurity has measured by four levels of household food insecurity prevalence.

Table 18: Food Security

Do you worry about food by the past one year?

	Irrigation user		Irrigation non user		Total		X ²
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
Yes	19	19.2	75	71.4	94	46.1	55.9***
No	80	80.8	30	28.6	110	53.9	
Total	99	100.0	105	100.0	204	100.0	

Source: Survey result, 2020 ***, Significant at 1% level

According to the result presents at table, 18 that from total sampled households 94(46.1%) and 110(53.9%) households are insecure and food secured respectively. From irrigation users headed 80(80.8%) are food secured and the remaining 19(19.2 %) households are food insecure. That implies the majority of the irrigation user ensure food security at family level. On the other hand only 30 (28.6%) of irrigation non-user households are food secure. This indicates that from the opposite of irrigation user, the majority of irrigation non-user household 74 (72.4 %) are food

insecure. There results dig outs that in the study area Irrigation user households are more ensured food security than irrigation non user's households. The 1% level of significant Chi-square test results displays that in the study area there is high significant difference food security status between irrigation users household and irrigation non-user household

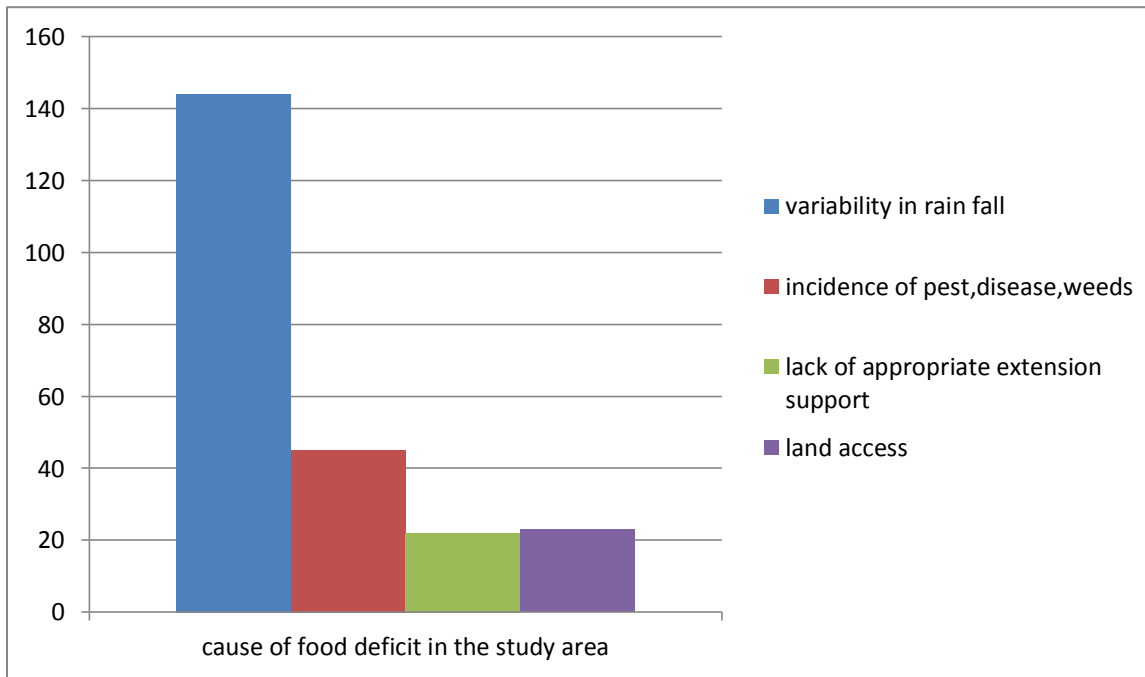
Table 19: Household food statuses

	Irrigation user		Irrigation non user		Total		X ²
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
Food secure	80	80.8	30	28.6	110	53.9	55.9***
Mildly food insecure	10	10.1	47	44.8	57	28	
moderately food insecure	5	5.1	20	19	25	12.1	
Sever food insecure	4	4	8	7.6	12	6	
Total	99	100	105	100	204	100	

Source: Survey result, 2020 *** Significant at 1% level

From the total food insecure 57 (28%) household are mildly foods insecure while in the study area 25(12.1%) and 12(6%) households are moderately food insecure and severely food insecure respectively. According to table 19 result shows 10(10.1%), 5(5.1%) and 4(4%) irrigation user household were mildly, moderately and sever food insecure respectively while 47(44.8%) mildly food insecure, 20(19 %) moderately and 8(7.6 %) sever food insecure are irrigation non-user. The 1% level of significant Chi-square test results displays that in the study area there is high significant difference food security status between irrigation users household and irrigation non-user household The result shown that irrigation user households more food secure than irrigation non-user households. It presented irrigation had positive impact to ensure household food security in the study area.

Figure 9: Cause of food deficit in the study area



Source: Survey result, 2020

As the figure shows from the total respondent 114 (55.9) household have thought that Variability in rainfall were the main causes of food deficit in the study area. 22(10%) sample responded the cause of food security problem in the study area is incidence of pest diseases and, weeds. While 23 (12.1 %) samples has answered the cause of food security problem is land access. The reaming 22 (10%) household has thought that land access is the main cause of food security problem. As the figure shown the majority household agreed that variability in rainfall was the cause of food security problem in the study area. This finding indicated to reduce this rainfall problem irrigation is crucial to improving household food security in the study area. Du to this irrigation user's household had opportunity to improve food security compare with irrigation non-user.

4.2.5 Household Food Consumption Score

The FCS is a composite score based on dietary diversify food frequency, and relative nutritional importance of importance of different food groups. To evaluation the food consumption score, foods were regrouped into eight standard food groups. WFP developed food consumption score by 2008 that is universally used as a representation pointer for access to food. The interview was asked about frequency of consumption (in days) over a recall period of the last 7 consecutive days.

Table 20: Food consumption score

Food consumption score thresholds	Irrigation user		Irrigation non user		total		X ²
	Frequency	Percent	Frequency	Percent	Frequency	Percent	
Acceptable food consumption (>42)	23	23.2	10	9.5	33	16.2	33.58***
Borderline food consumption (28.5-42)	52	52.6	35	33.3	87	42.6	
Poor food consumption (0-28)	24	24.2	60	57.2	84	41.2	
Total	99	100	105	100	204	100	
Mean	3.05		2.60		2.89		
SD	0.889		0.865		0.878		

Source: Survey result, 2020 *** 1% significant level

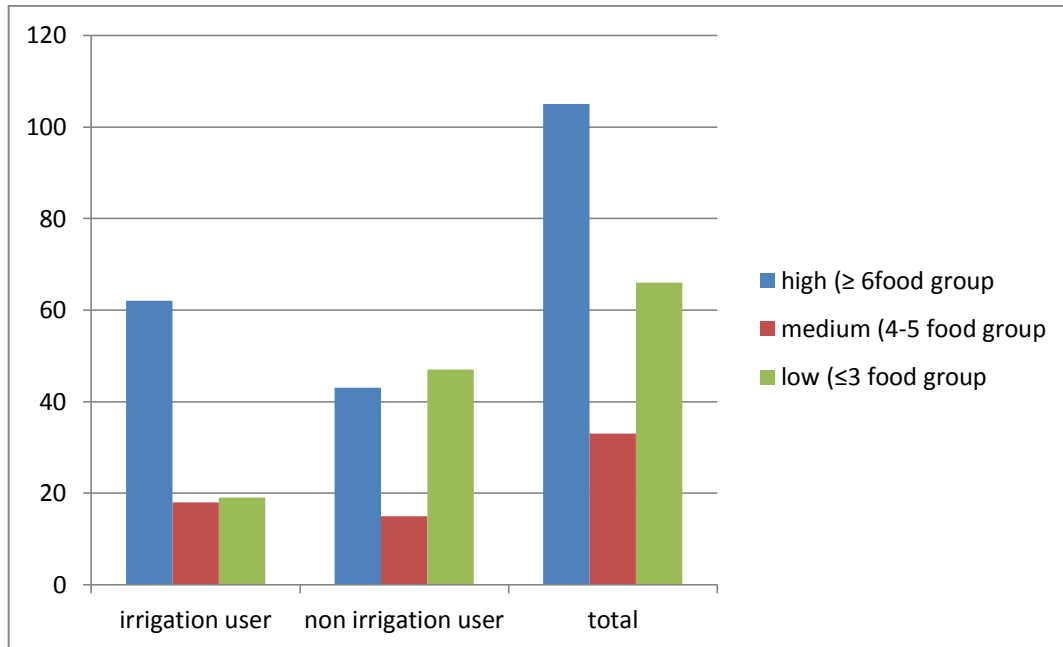
The data has taken from 204 samples 99 (48.5 %), 105(51.5%) irrigation user and irrigation non-user household respectively. According to the table 20 the study shows the Food Consumption Score cut-off results indicates that irrigation user's households with acceptable food Consumption are 23(23.2%) while 52(52.6%) and 24 (24.5%) irrigation user households are borderline consumption and with poor food consumption score respectively.

From the total irrigation non-users 10(9.5 %) are acceptable food consumption. On the other hand the survey result shows 35 (33.3%) irrigation non user households have borderline food consumption and 60(57.2%) with poor food consumption score. Food Consumption Score is useful to measure dietary diversity in addition to food frequency. The study found irrigation user households more diversification dietary than irrigation non-users household and it is important to provide balanced dietary to the family. This diversification dietary has impact on entire family

health. The mean Food Consumption Score for irrigation user households and irrigation non-user households is 3.05 and 2.6 respectively. As well as the total sample household mean food consumption score was 2.89. There is high significance difference dietary diversity between irrigation user household and irrigation non-user at 1% level of significant.

4.2.6 Household Dietary Diversity

Figure 10: Household Dietary Diversity



Source: Survey result, 2020

According to the sample result shows in figure 10 from the total irrigation user household 62 (62.6%) has eaten high dietary (≥ 6 food group variety), while 43(40.9 %) irrigation non users households has eaten high dietary diversity of greater or equal six food groups variety. In addition to that 18(18.2%) and 15 (14.2%) irrigation users household and irrigation non users has eaten medium dietary variety of four up to five food groups respectively. On the other hand 19 (19.2 %) irrigation user's household and 47 (44.9%) irrigation non-user has eaten low dietary diversity of less than three food group's variety. From the total irrigation user and irrigation non-user 105 (51.4 %) has eaten high dietary variety of more or equal to six food groups variety. In the same way 33(16.2%), and 66 (32.4%) household consumed medium dietary variety of four up to five food groups and low dietary diversity of less than three food group's variety. The result displays in the study area the average mean diet diversity score is 1.49. The mean of food variety score of irrigation users household is 1.68 while that of irrigation non-user household

1.38. This result displayed that irrigation user households had high mean dietary variety score than irrigation non-user households. This result presented that irrigation user households consumed more variety of diet groups than irrigation nonuser households. The implication of these results is irrigation has impacts on household dietary diversification. The difference between irrigation user household and irrigation non-user household Dietary Diversity score is significant at 1% significant level chi square results.

4.3 Econometric Estimation Results

4.3.1 Estimating a Model of Irrigation User

The binary logistic regression model was used to estimate propensity scores for matching the treated with untreated households. In this study irrigation user households are the dependent variable and has taken value 1 and 0 if the respondents are irrigation non-user .For estimating propensity scores, the study has used different observable characteristics, both from irrigation user households and irrigation non-user households. Sex, ages, education level, land size, livestock ownerships, distance to market, family size and dependency ratio was taken to estimate.

Table 21: The logit model analyze

Independent variables	Coif.	Wald	p-Value
Sex	-2.071	4.586	0.032**
Age of house holds	0.007	0.241	0.623
Education level	0.59	0.176	0.674
Landholding size	0.406	8.662	0.003**
Livestock	0.774	0.432	0.073*
Market	0.170	20.361	0.000***
Access to credit	0.792	7.573	0.006***
Extension service	3.524	11.76	0.001***
Off farm activity participation	-0.102	4.224	0.04**
Got food aids	-0.098	3.259	0.071*
Dependence	0.422	3.526	0.06**
Family lm	1.88	5.198	0.023**
_cons	0.59	0.174	0.674
N	204		
LR chi2(45.8		
Prob > chi2	000		
-2Log likelihood	-117.2222		
Pseudo R2	0.1608		

*** P<0.01 and ** P<0.05 and *P < 0.1 significant value

4.3.2 Common Support and Balancing Tests

Table 22 below, describes the common support of the untreated and treated group for the outcome variables. Accordingly, 12 households or 5.9% of the observations is off support. From the total sampled household 192 observations (94.1%) are on support from both the treated and untreated group. This result presents the off support observation was discarded from the both from treated and control group. The decisions for the off and on support observations is based on the summarized p scores in the treatment and untreated groups and count how many units are off support.

Table 22: Common support region

Psmach2 treatment assignment	Off	On	Total
Untreated	9	96	105
Treated	3	96	99
Total	12	192	204

Source: Own survey result 2020

Every treated unit is matched only with the control units whose propensity score falls into a predefined common support region of the propensity score matching. As we can see from the ATT result, on common support region, the irrigation user household's food security mean is greater than by the mean 50 % comparing with irrigation non-users. The statics is significant at 1 % significant level.

About food consumption, as we can see from the ATT result, the irrigation users (treated group) food consumption score greater than by 23.163 % when it compared with the control irrigation user. The difference is statistically significant at 1% significant level.

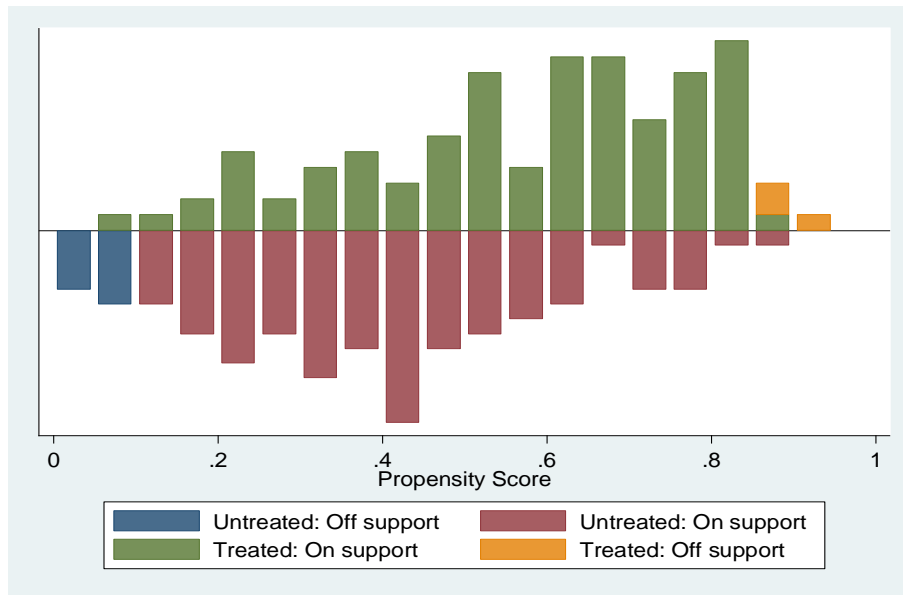
Table 23: ATT within the common support region

Variable	Sample	Treated	Control	Difference	S.e	T-stat
Food security	Unmatched	1.81632653	1.28571429	0.530612245	0.059543025	8.91***
	ATT	1.81632653	1.31632653	.5	0.10861979	4.60***
	ATE			.476439791		
Food consumption	Unmatched	4.836733469	2.26865672	2.56807798	0.261793574	9.81***
	ATT	4.83673469	3.06122449	1.7755102	0.451923376	3.93***
	ATE			2.3496454		

Source: Own survey result 2020 ***1 % significant level

The figure below tells between the regions of common support using color codes. The upper green color shows the treated on support observations. The upper yellow color one indicates the treated off support, the lower blue color indicates the untreated off support and the lower read color represents untreated on support. Therefore majority of the observation is in the common support region of the region This confirmed that there is adequate intersection in the features of treated and untreated components to find sufficient matches Heckman (1997),. Hence, the common support assumption has been maintained.

Figure 11: Histogram of propensity scores with common (off) support regions



4.3.3 Matching Treatment and Control Groups

After finding of common support region, different matching algorithm was applied to match irrigation user households with irrigation non-user households' in common support region. Khandker et al (2010) explain that benefit and disadvantage of every algorithm are clear in theoretical and simulation studies, but practically there is always uncertainty about which one is the best method for matching.

The final choice of a matching estimator was guided by different criteria such as equal means test referred to as the balancing test pseudo-R2 and matched sample size. Specifically, a matching estimator which balances all explanatory variables (i.e., results in insignificant mean differences between the two groups), bears a low R2 value and results in large matched sample size is preferable .Dehejia and Wahba, (1999),

This study has used three matching methods (Nearest neighbor matching, radius matching, Kernel matching) to estimate the average treatment effect of irrigation. After analyze the outcomes it has been found that nearest neighbored matching with large matched sample size is the best estimator for the data at hand.

4.4 The Effect of Irrigation on Food Security

In order to estimate the average treatment effect of the small-scale irrigation on the user (treated group) different types matching algorithms were used. These include nearest-neighbor matching (“attnd”), radius matching (“attr”), and Kernel matching (“atk”).

The ATT treated household’s food security higher than the control households by 51.1%, 49.1% and 45.5 % in nearest neighbor matching (NNM), in kernel matching (KM) and in radius matching (RM) respectively. The ATT is significant at the 1 % level of difference.

Table 24: Average treatment effect of food security

Matching methods	Number of treatments	Number of controls	ATT	Standard Error	T value
Nearest neighbor matching	99	95	0.511	1.212	8.19***
Kernel matching	99	93	0.491	1.321	7.12***
radius matching	85	65	0.45	1.62	6.3***

Source: Own Survey result, 2020 Note: *** statistically significant at 1 percent probability of significance.

4.4.1 The Effect of Food Consumption

The propensity score matching result indicates that an irrigation user household has a significant effect on their food consumption scale. The food consumption of irrigation household food is higher (Treated) than the irrigation non-user household (control) by 45.71%, 35.3 % and 43.75 % in nearest neighbor matching (NNM) kernel matching (KM) and in radius matching (RM) respectively. On the average treatment effect on the treated group is 45.71% in nearest neighbor matching. This indicates 45.71 irrigation households have more food consumed than irrigation non-user. The result shows that irrigation ram has had a significant impact irrigation household regarding to food consumption.

Table 25: Average treatment food consumption

Matching methods	Number of treatments	Number of controls	ATT	Standard Error	T value
Nearest neighbor matching	99	95	0.4571	1.222	9.19***
Kernel matching	99	93	0.355	1.311	7.12***
radius matching	85	65	0.4375	1.52	8.3***

Source: Own survey result, 2020

Remark: ***, means significant at 1%, 5% and 10% significance levels respectively

4.4.2 Balancing Test for Propensity Scores and Covariates

According to the table below, the t values of all the covariates are statistically insignificant, which mean after matching the difference between the means of the treatments and the comparison groups has been minimized. Therefore the matching quality or balancing of propensity score for all covariates has been gratified.

Table 26: Balancing test for propensity score food security outcomes

Variable	Unmatched	Mean		%bias	t-test		V(T)/
	Matched	Treated	Control		T	p>t	V(C)
Age head	Unmatched	44.857	45.562	-6.7	-0.47	0.636	0.97
	Matched	44.952	44.715	2.3	0.16	0.871	1.13
Sex	Unmatched	1.0408	1.1333	-33.1	-2.34	0.020	0.34*
	Matched	1.0421	1.0606	-6.6	-0.58	0.566	0.71
Family size	Unmatched	5.1939	5.2762	-9.9	-0.71	0.481	1.36
	Matched	5.1789	5.24	-7.3	-0.50	0.619	1.23
Dependency ratio	Unmatched	1.6735	2.1429	-20.9	-1.47	0.144	0.05*
	Matched	1.6947	1.6928	0.1	0.02	0.984	1.04
Land size	Unmatched	2.602	3.0667	-43.1	-3.08	0.002	1.56*
	Matched	2.6526	2.7959	13.3	-0.94	0.348	1.67*
Livestock	Unmatched	2.7143	2.5905	17.3	1.23	0.220	0.62*
	Matched	2.7053	2.7876	-11.5	-0.93	0.354	1.17
Extension works	Unmatched	1	1	-	-	-	.*
	Matched	1	1	-	-	-	.*
Education stat	Unmatched	3.1327	2.7905	21.8	1.55	0.124	.60*
	Matched	3.1053	3.1131	-0.5	-0.03	0.974	0.50*

Source: Own survey result 2020

Chi Test for joint significance

In this context chi square test is a combined test for the equality of means between irrigation user and irrigation non-user for all the covariates. The result signifies that there is fairly low pseudo R2 value and insignificant likelihood ratio (LR) test, hence after matching; there is insignificant mean difference between the treatment groups and control groups.

Table 27: Chi square test for joint significance

Ps R2	LR Chi2	p>chi2	Mean Bias	MEd Bias	B	R	%Var
0.011	2.94	0.983	5.5	5.1	24.8	1.15	0.6

Source: Own survey result 2020

4.4.3 Treatment and Control Group Food Security Comparison

The two sample t-test presents irrigation user's households mean greater than irrigation non-user households in the study area. This result implies irrigation have positive impacts for food security and dietary diversification of foods

Table -28 Two-Sample t test for Food Security, food consumption and food dietary with Equal Variances

Variables	Group	Obs	Mean	Std.Dev.	Std.er rs.	Twos ample T test	[95% Conf.	Interv al]
Food security	Control	105	1.29	0.454	0.044	8.732***	1.2	1.37
	Treated	99	1.81	0.396	0.04		1.73	1.89
	Combined	204	1.54	0.500	0.035		1.47	1.61
	Diff		-0.52	0.085	0.4		-0.5	-0.8
Food consumption	Control	105	2.27	1.462	0.179	9.752***	1.45	1.56
	Treated	99	5.37	1.084	0.109		1.66	1.79
	Combined	204	3.39	2.071	0.16		1.55	1.67
	Diff		-3.1	0.378	0.07		-0.09	-0.07

Source: Own survey result 2020, ***1% significance level

Chapter Five

5. Conclusions and Recommendation

5.1 Conclusions

Cross sectional data was gathered using structured questionnaires from the sample of 99 irrigation user and 105 irrigation non-user households. In this research attempts have been made to evaluate the significance of irrigation farming in Mehal Sayint worda, south Wollo zone Amhara region. The study result found that the irrigation has significantly positive relationships with household food security and nutrition's.

The main research question of the study was what would have happened to an outcome of irrigation for household food security in the study area. To give response this research main question requires taken sample from irrigation user and irrigation non-user that were the same household. However, it is impossible to observe the same object in two states simultaneously.

In this study design, the impact of irrigation can be predicted by a simple difference in means between treatment and control outcomes. However, in quasi -experimental design, since the program placement creates selection effect, simple with-and-without comparison of means for irrigation user and non-user households would make the biased estimates.

The study has used a propensity score matching technique econometric model that is often used in impact evaluation setting, where the objective is to compare participant outcome with and without treatment.

The researcher used widely acknowledged known as household food insecurity and access scale Food security measurement tequneques to identify food security status and food consumption. Based on this measurement 53.9 % household in the study area were food secure. The remaining 46.1 % households were food insecure. From the total irrigation user 80.8 % of the study area households were food secure. While from the total irrigation non-user households only 28.5 % were food secure. The percentages presents irrigation user were more food secure then irrigation non-user. The diet diversity result had significant different between irrigation user and irrigation

non-user. Irrigation user ate more diversified foods compare with irrigation non-user. The propensity score machining results indicated that the average treatment effects of the irrigation user households are higher than from irrigation non-user household.

This results irrigation had positive impacts to food security in the study area. In addition to this it had impact diversification of diets (nutrition value) to minimize malnutrition and stunt growth.

5.2 Recommendation

The following recommendations were made from the findings of this study to improve household food security in the study area.

- All government body's and non-governmental organization should have encourage all farmers to join in small-scale irrigation agriculture because this study has found the potential of irrigation to improve food security and dietary diversification foods.
- This study has found the study area the major cause of food insecurity is variability of rainfall.to minimize this food security causes. Government and all concerned body's should build small, medium and large irrigation schemes in the area
- The government and other participants should access, irrigation technology and inputs in the study area

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Appendixes

Questionnaire for Respondents

Dear Respondent

The rationale of this questionnaire is to meet up information which will be used for title of study “the impact of small scale Irrigation on household food security in Mehal Sayint Worda”. This study will be conducted for the partial fulfillment of MA degree in rural livelihood and Development at Addis Ababa University. Your full support and willingness’ to respond to the question is very decisive for the achievement of the study. For that reason, you are kindly requested to answer every part of questions provide clear, appropriate and reliable information on the issues. Be confident that the information you provide is only for the purpose of this study.

Thanks you.

Worda : _____

Kebele: - _____

Name of data collector: - _____ Signature _____

Date of data collected (dd/mm/yy) _____ / _____ / _____

Code: **1**. Participate in irrigation **0**. Non participate in irrigation

Demographic characteristics

1. Household head’s Name: _____ Sex: 1= Male, 2= Female
2. Household ID -----
3. Household Characteristics: Please list *all* household member

1.Sex:	2 Marital status	3 Relationship to head of household (HH)	4 Religion	5 Educational status
1=Male	1= single	1=Household head(HH)	1= Orthodox	1=Illiterate
2=Female	2=married	2=Spouse	2= Islam	2=Church/mosque education`
	3=divorced	3=Son	3=Catholic	3=Adult litracy
	4=widowed	4=Daughter	4=Protestant	4=Elementary
	5=separated	5=Brother or sister	5=Other	5=Junior Complete
	6=other (specify)	6=Mother/Father		6=10 Complete
		7=In-law		7= 12 complete
		8=Relatives		8=College graduate
		9= Hired helper		9=Other (specify)
		10=Other (specify)		

6 Income source (P= Primary, S= Secondary)	7Special skill	8.Presence	9.Reason for absence
1=Farming)	0= No special skill	Number of months during 2019. (0-12 months	1=Visiting family
2=Civil Servant	1=Mason		2=Away for school
3=Housewife	2=Trader/merchant		3= Away for work
4=Daily laborer	3=Handicraft		4=Looking for work
5=PA/village official	4=Carpenter		5=Health treatment
6=Hand craft	5=Traditional) healer		6=Other (specify
7=Herder	6=Other (specify		
8=Stone/sand mining and sale			
9=Trader			
10. =Other (specify			

	3.1 Name	3.2 Sex	3.3 age	3.4 Martial status	3.5 Relation to the head3	3.5 Relation to the head3	3.6 Religion4	3.7 Education status8 (> 7 yrs)	3.8 Income source (> 15 yrs) (P= primary, S)	3.9 Skill7 (> 15 yrs)	3.10 Presence	3.11 Reasons for absence1
01												
02												
03												
04												
05												
06												
07												

4. Household land holding and crop production

Plot no	4.1 Size of the plot in gmed	4.2. Distance from home	4.3. Slope of the plot (see	4.4. Soil depth condition	4.5. Degree of erosivity	4.6. Irrigated land 1=yes,	4.7. Land tenure system	4.8. Crop type grown	4.9. If not cultivated the	4.10. What is the main	4.11. Household/hired labor used for plowing		4.12. Household /hired labor for cultivation		4.13. Household /hired labor used for harvesting		4.14. Average price for labor man days (LMD)		
											M	F	M	F	M	F	M	F	

4.3. Slope 1= flat, 2= slight slope, 3= moderate slope, 4= steep slope

4.4. Soil depth code: 1= shallow, 2= medium, 3= deep

4.5 Erosion severity: 1=No erosion, 2= Less erosion; 3=Medium erosion; 4= High erosion; 5= extremely eroded, 6= other (specify)

4.7. Land tenure code: 1= own land, 2= rented-in, 3= rented out, 4= other

4.8. Crops: 1= teff, 2= wheat, 3= barley, 4= maize, 5= millet, 6= sorghum, 8=Faba bean 9 =field pea, 10=cheak pea, 12== haricot bean, 13 = Vegetables and tubers, 14= Fruit trees (specify), 15= Following 16= other (specify).

4.9. Land use code: 1= restricted grazing, 2= non restricted grazing, 3= forest/woodlot, 4= Bush/shrubs, 5= other (specify)

4.10. Reasons code: 1=fertility decline /for fallowing purpose, 2=lack of oxen for cultivation, 3=unable to afford fertilizer inputs, 4=Others,(specify)

Parcel	Plot	4.15 Oxen days for plowing/ cultivation	4.16 Oxen day price/day	4.17 seed type 1= local, 2= improved	4.18 Seed qty (in KG)	4.19 Seed price Birr/kg	4.20 Source of seed	4.21 Use organic fertilizer 1= yes, 0= No. If No, list to 4.24	4.22 Source of manure/compost (1= own, 2= neighbor)	4.23 Input source for compost making	4.24 Use inorganic fertilizer 1= yes, 0= No. If No, list to 4.27	4.25 Amount of Fertilizer (DAP, UREA etc.) used (in KG)	4.26 Price of fertilizer (in Birr/kg)	4.27 Source of fertilizer (Use code)
1	1													
	2													
	3													
2	1													
	2													
	3													
3	1													
	2													

4.20. Source code: 1= Own, 2= Neighbor, 3= Open market, 4= Cooperatives/union, 5= Service cooperatives, 6= other (specify)

4.21 M= manure, C= compost

4.22=own, 2=neighbor

4.23. Compost making code: 1=crop residues (specify), 2= tree leaves (specify), 3= animal dung, 4=Combination of these inputs, 5= other (specify)'

4.25 D= Dap, U= UR
4.27. Source of fertilizer code: 1= Neighbor, 2= Open market, 3= Cooperatives/union, 4=Service cooperative 5. Other (specify)

Parcel	Plot	4.28 Used pesticide/insecticide 1= yes, 0= No. If No skip to 4.34	4.29 Amount of pesticide used (in KG)	4.30 Price of pesticide (in Birr)/kg	4.31 Amount of insecticide (in ltr)	4.32 Price of insecticide (in Birr/ltr)	4.33 Source of insecticide/pesticide	4.34 Other expenses (in Birr)	4.35 Total output quantity (Kg)	4.36. Quantity sold (in Kg)
1	1									
	2									
	3									
2	1									
	2									
	3									
3	1									
	2									
	3									

4.33 Source of insecticide/pesticide code: 1= Neighbor, 2= Open market, 3= Cooperatives/union, 4= Service cooperatives, 5= others

Livestock holding

5. Does Place of sell (see code) your household own livestock? 1. Yes 0.No

5.1. If yes to Q. 5. give details on the table below

Type of Livestock	Number owned during last year	Number of livestock died during last year	Number of livestock bought during last year	Number of livestock sold during last year	Total value(Birr)

Codes: 1. No Livestock 2.Oxen 3.Cows 4. Calves 5. Heifers 6.Sheep

7. Goats 8. Chicken 9.Horse 10.Mule 11.Donkey 12.Camel 13.Others

Institutional factor

6 Have you over the last one year’s received credit for? Yes _____ No _____

7 If yes ,for what purpose used

A. Fertilizer _____ amount _____ birr

B. improved seeds _____ amount _____ birr

C. consumption _____ amount _____ birr

D. others specify _____ amount _____ birr

8. If you have taken credited from which credit institution

A. Banks

B. Micro finance

C. Relatives

D. Others specify

9. If you haven't received why?
- a. Lack of access to credit
 - b. No need for credit
 - c. High interest rate
 - d. Other spcfiiy _____

Agricultural Extension service

10. Is there farmers training center (FTC) in your surrounding? a. Yes__ b. No____
11. How far is the FTC from your home _____ in Km?
12. . How long do you take from your home to FTC _____ in minutes?
13. Is there an Agricultural Development Agent in your kebele ? a. Yes__ b. No ____
14. If yes, had you get an extension support during the last one year ? a. Yes__ b. No __
15. If yes, question number 14 have you participated in the training program organized last year? a. Yes_____ b. No __
16. If yes, in which topics you had been trained from the lists mentioned in the table below (see codes listed under the table).

topics of Training	How many times you have been trained (numbers)	For how long you have just taken (days)	

1=livestock production 2= fruits and vegetables 3=crop diversification 4=marketing 5=irrigation
6=post harvest handling 7=farm management 8= credit 9= household food security 10 off farm
activity 11=others

17. .Did you have some Social Networks in the community? a. Yes ___ b. No___

18. . Did you have some social position in the community? a. Yes ___ b. No ___

19. If yes, what is your position? _____

20. If yes, what is your Social Network?

a. Edir yes ___ no___

b. Equib yes ___ no___

c. . Unions yes ___ no___

d. cooperatives yes ___ no___

e. Other specify _____

Distance to market

21. Did you get market information about

A. Price yes _____ no _____

B. Agricultural inputs Yes _____ no _____

22. If yes, what is the source information?

a. Radio b. Television c. Newspaper

d. Mobile

e. Others specify _ _____

23. Where did you sell your product? a. At village market b. At district market

c. At regional market d. At national market e. Others (specify)

24. What is the distance of your residence from the market _____ (in Km)?

25. What means of transport do you use to transport your product to the market? a. vehicles

b. Animal labor c. Human labor d. Others (specify) _____

26. When did you sell most part of your produce? _____ (months)

27. Did you get fair price for your produce at this particular time? a. Yes b. No

28.

Use of small scale irrigation (Only for irrigator)

29. How long you have been engaged in irrigation agriculture? _____

30. How did you get the irrigated land?

- A. government redistribution
- B. Inherited from family
- C. gift from relatives
- D. share cropping/purchase
- E.) other (specify) _____

30 What type of cropping patter you prefer in your irrigable land?

- A. growing for subsistence or direct consumable crops
- B. growing of commercial/ high value crops
- C. diversifying both cash and consumable crops
- D. other (specify)_____

31. What are the major reasons for adopting the cropping pattern you mentioned above?

- A. good yield
- B. high profit/price
- C. since there is better availability of inputs
- D. appropriateness of the crop/biological nature for that time
- E. others (specify) _____

32. Have you ever faced a problem of crop failure while you are using irrigation?

Yes _____. No _____

33. If your answer for question number 32 is yes, what were the possible causes for this problem of crop failure last year?

- A. . Water shortage
- B. Damaged by disease
- C. .Poor adaptation of varieties used
- D. Poor administration of water distribution
- E. Others, specify _____

34. What is the source of water for your irrigation?

- A. Rivers
- B. Springs
- C. Ponds
- D. Well
- E. Other, specify _____

35. How much the distance between the sources of water to your irrigated land? ____ (in km).

36. If no use irrigation technology, why not you use irrigation technology?

- A. Distance of water to farm land
- B. Lack of farm land
- C. Cost of irrigation materials
- D. Overall cost of technology

37. After you have used irrigation what is the change on your live?

- A. Improved household food security
- B. Increase the productivity
- C. Create job opportunity for non- employment
- D. Reduced dependency
- E. Other specify _____

39 .Off/non-farm income

Now I will ask you about whether you participated in nonfarm business and got some income in 2018. [Please first ask type of employment and then the rest].

Source	39.1 Who earned (HH member ID)	39.2 # of months/days per yrs.	39.3 Quantity	39.4 Wage (cash) in Birr	39.5. Wage (kind) in Birr
Safety net program					
Cash for work					
Hire out labor					
Part time job					
Remittance income					
Food aid					

Self-employment					
Sale of Firewood					
Sale of Handicraft					
Sale of beverages					
Village shop					

40. Have you received any aid in the last year? 1. Yes 0. No

41. If yes to question 40., please indicate the type and amount receive.

Type of aid items received	Amount of Aid Received per month	Unit price	Total income received	
total				

Code: 1.Wheat 2.Cash 3.Oil 4.Other

42. Number of food servings per day [First check the composition of the household members in the household]

Household members	Number/frequency of meals	
Children under five		
Adolescent girls (10-19 years)		
Adolescent boys (10-19 years)		
Lactating mother		
Pregnant mother		
Non lactating /non pregnant mother		
Husband		

Code: 1= Once, 2= Twice, 3= Three times, 4= More than three times

43.. Did your household face food shortages in the last 5 years? 1= Yes 0= No]

44. If yes to Q. 43, how often has the household faced food shortages? _____

1= Sometimes (once in 5 years), 2= Often (2-3 times in 5 years), 3= Very often (3-4 times in 5 years), 4= Always (continuous/chronic problem)

45. When is food shortage more serious in the household? _____

Household Food Insecurity Access Scale Measurement Tool

For each of the next questions, think about what happened over the past one year. give pleasure to answer if this has “ever” happened yes or no, if No, go to the next main question; if yes, answer the sub question is rarely (only one or two times over the past one year), « sometimes », (every now and then during the past month) or “often” (almost every day), indicate the answers to below

Number	Question	Response	Code
1	In the past one year, did you worry that your household would not have enough food	1 yes 2 no	1./___/ 2./___/
2	If your answer yes on question number 1,how frequently this did happen	1 .Rarely (once or twice in the past one year) 2. Sometimes (three to ten times in the past one year) 3. Often (more than ten times in the past year)	1/___/ 2/___/ 3/___/
3	In the past one year, were you or any household member not able to eat the kinds of foods you preferred because of a lack resources?	0. No 1.Yes	0/___/ 1 /___/
4	If your answer yes on question number 3,how frequently this did happen	1. Rarely (once or twice in the past one year) 2. Sometimes (three to ten times in the past one year) 3. Often (more than ten times in the one year)	1 /___/ 2 /___/ 3 /___/

5	In the past one year, did you or any household member have to eat a limited variety of foods due to lack resources?	0 = No 1 .Yes	0 /__/ 1 /__/
6	If your answer yes on question number 5,how frequently this did happen	1. Rarely (once or twice in the past one year) 2. Sometimes (three to ten times in the past one year) 3. Often (more than ten times in the past year)	1 /__/ 2 /__/ 3 /__/
7	In the past one year, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0. No 1. Yes	0 /__/ 1 /__/
8	If your answer yes on question number 7,how frequently this did happen	1. Rarely (once or twice in the past one year) 2. Sometimes (three to ten times in the past one year) 3. Often (more than ten times in the past one year)	1 /__/ 2 /__/ 3 /__/
9	In the past one year, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No 1 = Yes	0 /__/ 1 /__/
10	If your answer yes on question number 9,how frequently this did happen	1. Rarely (once or twice in the past one year) 2. Sometimes (three to ten times in the past one year) 3. Often (more than ten times in the past one year)	1 /__/ 2 /__/ 3 /__/
11	In the past one year, was there ever no food to eat of any kind	0 = No 1 = Yes	0 /__/ 1 /__/

	in your household because of lack of resources to get food?		
12	If your answer yes on question number 11 ,how frequently this did happen	1. Rarely (once or twice in the past one year) 2. Sometimes (three to ten times in the past one year) 3. Often (more than ten times in the past one year)	1 /__/ 2 /__/ 3 /__/
13	In the past one year, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No 1 = Yes	0 /__/ 1 /__/
14	If your answer yes on question number 13 ,how frequently this did happen	1. Rarely (once or twice in the past one year) 2. Sometimes (three to ten times in the past one year) 3. Often (more than ten times in the past one year)	1 /__/ 2 /__/ 3 /__/
15	In the past one year, did you or any household member go a whole day and night without eating anything because there was not enough	0 = No 1 = Yes	0 /__/ 1 /__/
16	If your answer yes on question number 15,how frequently this did happen	1. Rarely (once or twice in the past one year) 2. Sometimes (three to ten times in the past one year) 3. Often (more than ten times in the past one year)	1 /__/ 2 /__/ 3 /__/

17. What do you think the main causes of food deficit in your particular area?

- a. Variability in rainfall
- b. Incidence of pest, diseases, weeds etc.
- c. Lack of access to credit
- d. Lack of appropriate extension support
- f. land access
- e. Other_____

Objective four: - To determine whether diet diversity between irrigators and non- irrigators are different

. Household dietary diversity (HDD) score questionnaire

No	Food item	Yes 1 No 0
1	Any Bread or any other foods made from wheat, sorghum, and maize, Barely, e.g. Beso, Kolo, porridge, enjera or other locally available grains.	
2	Any potatoes or any other foods made from roots or tubers?	
3	Any vegetables?	
4	Any fruits?	
5	Any beef, lamb, goat, wild game, chicken?	
6	Any eggs?	
7	Any fresh or dried fish or shellfish	
8	Any foods made from Beans, peas, cowpeas, pigeon peas nuts, haricot bean, chick bean seeds?	
9	Any cheese, yogurt, milk or other milk products?	
10	Any food made with oil, fat, or butter	
11	Any sugar or honey?	
12	Any other foods, such as condiments, coffee, tea?	

Household Food Consumption

Food groups	Food item	How many days in the past one week your household has eaten							
		No eat	1	2	3	4	5	6	7
Cereals	Any food prepared from wheat, sorghum, and maize, Barely, e.g. Beso, Kolo, porridge, enjera or other locally available grains.								
Tubers/ Root	Any potatoes, enset, or any other foods made from roots or tubers?								
vegetables	Dark green vegetable – leafy								
Fruit	fruit								
Meat and fish	Any beef, lamb, goat, chicken, liver, kidney, heart, or other organ meats								
	Eggs								
	Any fresh or dried fish or shellfish								
Pulses	Any foods made from Beans, peas, cowpeas, pigeon peas nuts, haricot bean, chick bean seeds?								
Milk/ Milk Products	Any cheese, yogurt, milk or other milk products								
Oil/fat	Any food made with oil, fat, or butter								
Sugar	Any sugar or honey								

Checklists for Focus Group Discussion (FGD)

1. What are the major types of farming activities practiced by smallholders in the area?
2. How do you see the function of the small scale irrigation in availing of enough food for target community?
3. What are the major challenges observed underutilizing the small-scale irrigation?
4. What is the influence of access to irrigation on crop production for rural household in the area?
5. Does small irrigation have impact to food security? How?
6. Do they have used technology for irrigation?
7. Is there any difference between irrigation user and non-user regarding to food security? How?
8. What are the major constraints or draw backs of to use irrigation water in order of importance?
9. How is water distribution handled for all beneficiaries? Who is more favored and who is not? Why?
10. Are households making nonfarm business?