



DAIRY TECHNOLOGY ADOPTION AND ITS IMPACT ON HOUSEHOLD  
FOOD SECURITY: THE CASE OF BASONA WARENA *WOREDA*, AMHARA  
REGION, ETHIOPIA

BY  
HANA YESHITILA TADDESE

ADDIS ABABA, ETHIOPIA

JUNE, 2019



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A THESIS SUBMITTED TO CENTER FOR FOOD SECURITY STUDIES OF  
THE COLLEGE OF DEVELOPMENT STUDIES, ADDIS ABABA  
UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR  
THE DEGREE OF MASTER OF SCIENCE IN FOOD SECURITY AND  
DEVELOPMENT

ADDIS ABABA, ETHIOPIA

JUNE, 2019

**ADDIS ABABA UNIVERSITY**  
**COLLEGE OF DEVELOPMENTAL STUDIES**  
**CENTER FOR FOOD SECURITY STUDIES**

**Declaration**

This thesis is my original work and has not been presented for 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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## *Dedication*

*This thesis is especially dedicated to my family who fulfilled my desire and supported my success.*

## Acknowledgments

First of all; many thanks is directed to our Lord, the Almighty God, for allowing me to make my dream come true.

Secondly, I express my deepest gratitude to my advisors Dr. Messay Mulugeta and Dr. Solomon Tsehay for a continuous and profound commitment and encouragements that I have got throughout my study period. I would not have been able to complete this routine study to its standard without their guidance. Besides, I want to thank all staffs at Center of Food Security Studies for their dedication and tireless efforts and kind support. I am also acknowledging Agajie Tesfaye (from EIAR) for his immeasurable advice, comments and suggestions throughout the whole work of this thesis. I am very grateful to the Ethiopian Institute of Agricultural Research (EIAR) in particular for allowing me to join MSc. study at Addis Ababa University.

Very exceptional thanks goes to Dagm Zewdu, Dreba Tadese, Abiro Tigabie for their direct or indirect support at the early stage of the study and the research work. Moreover, thanks for Basona Worena *woreda* office of agriculture for their assistance at high time when every facility is needed. I am very glad to acknowledge the sample households for their willingness and patience in responding to my questionnaire at the expense of their invaluable time. I also extend my grateful thanks to those enumerators for their effort devoted in collecting the data from the respondents with full willingness.

Last but not least, I would like to express my heart-felt thanks, gratitude and appreciation to my beloved families and friends for their generous assistance, moral support and helpful encouragement during my graduate study with all their kindness and affection.

HANA YESHITILA TADDESE

JUNE, 2019

## Acronyms and Abbreviation

AI:	Adoption Index
AIS:	Artificial Insemination service
ATT	Average Treatment Effect
CSA:	Central Statistics Agency
EIAR:	Ethiopian Institute of Agricultural Research
FAO:	Food and Agriculture Organization
FCS:	Food Consumption Score
FGD:	Focus Group Discussion
GDP:	Growth Domestic Product
HDDS	Household Dietary Score
IFAD:	International Fund for Agricultural Development
IFPRI:	International Food and Policy Research Institute
IGAD:	Inter-Governmental Authority on Development
ILRI:	International Livestock Research Institute
KII:	Key Informant Interview
MoALR	Ministry of Agriculture Livestock Resource
NGO:	Non-Governmental Organization
NMA:	National Metrological Agency
PSM:	Propensity Score Matching
SSA:	Sub Saharan Africa
TLU:	Total Livestock Unit
VIF	Variable Inflation Factor
WFP:	World Food Program

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## Abstract

*The objective of the research is to examine dairy production technology adoption impact on rural household food security and identify factors affecting adoption in Ethiopia evidence from Basona Worena woreda, Amhara regional state. A multistage sampling procedure was employed to draw 283 sample households from one woreda and two kebeles. The kebeles were selected in random sampling procedure and within the kebeles sample household were grouped in two strata (adopters and non-adopters). To analyze the data both descriptive and inferential statistics were employed to characterize and analyze dairy technology adoption and food security of the households. Food consumption score and household dietary diversity scores were employed to examine the food security status of the sample households. The statistical models namely, binary logistic regression, Tobit and propensity score matching were used to determine factors affecting the decision of farm households who participate (adopt) dairy technologies, extents of dairy technology adoption and impact of technology adoption on household food security respectively. The descriptive result indicated that dairy technology adopters were food secured as compared to non-adopter households in terms of food consumption score. The dietary diversity results also indicate that there is a significant mean difference between two group in main food group. The binary logit result revealed that, frequency of extension service, membership of milk collection center and input access positively affect the adoption decision. While age of the household head negatively affects the decision to adopt. The result from propensity score matching indicated that dairy technology adoption has positive impact on household food security. The impact of dairy technology adoption on household food security in terms of food consumption score has an effect on the household frequency of food consumption per week. Similarly, the dietary diversity of the household has an effect on the intake of diversified food in 24-hour recall on the household food security. using kernel, nearest neighbor and radius respectively. Finally, the average treatment effect on treated (ATT) revealed that, the dairy technology adoption has increased the household food consumption score and dietary diversity by 23.19% and 13.7% respectively. The study concludes that dairy technology adoption has remarkable effect on the household food security status. Based on the finding of this study it is recommended that, improving farmers awareness and perception through training, strengthen developmental agents capacity, introducing and disseminating and different improved variety dairy technologies with reasonable cost, continuous follow-up, improvement in input supply, and interventions that deal constraints related to dairy technology adoption.*

**Keywords:** *Basona worena, technology adoption, food security, FCS, HDDS, PSM*

# CHAPTER ONE: INTRODUCTION

## 1.1 Background of the study

For most of the developing countries including Africa, agriculture is the one of the leading sources of employment, income and even it is a means of living for the rural households. Particularly in sub-Saharan African (SSA) country agriculture is an important motor for realizing economic development. According to World Bank (2008), increasing the productivity in rural household's agriculture through adoption of new technologies is considered as an important in the sub-sector, in order to reduce the prevalence of rural poverty and large productivity gap in developing countries.

Agriculture contributes that 47% of total Growth Domestic Product (GDP) in Ethiopia (CSA, 2011/12). According to (IGAD, 2010/11). In Ethiopia around, 80 percent of the population economic growth is depending on agricultural activities. According to the World Bank 2013, report Ethiopia could potentially reach middle-income status by 2025 with an emphasis on boosting domestic savings rates, private sector development and improving the trade logistics. The agricultural sector in the country includes both crop and livestock production. Among the two sectors, livestock production plays a vital role in Ethiopian agriculture system.

According to FAO (2011), the livestock population of Ethiopia is very high and its estimated to be about 53.9 million. From this amount the indigenous breeds accounted for 98.98 percent, while the remaining amount is hybrid and pure exotic. Out of the total livestock population, female cattle consist about 55.4 percent. According to Mihret *et al.*, (2017) finding the livestock sector particularly dairy and dairy products have a huge contribution regarding to smallholders as income generation and employment creation and similarly the dairy sector can contribute immensely to poverty alleviation and household food and nutrition security in the country.

Although the country holds large potential for dairy development, the sector is not developed to the expected level. Low productivity of indigenous livestock is attributed to poor genetic potential for productive traits, inadequate feeding source both in quality and quantity, health problems, and poor management practice (Mihret and Tamiru, 2017). Milk production is 1.54 liters per cow per day. The current per capita consumption of milk and meat is 16 liters and 13.9 kg/year, respectively; being lower than the African and the world per capita consumption of

meat, which is 27 kg/year and 100 kg/year, respectively (FAO, 2009). The recent study of CSA (2014/2015) estimation indicated that the total population of cow milk is about 3.03 billion liters, and this translates to an average dairy milk production/cow of 1.35 liters/day. As a result, per-capita milk consumption of the country is only 19.2kg (MOA, 2012), which is still much lower than Africa and world per-capita average of 27kg/year and 100kg/year respectively (CSA, 2014/2015). As a result, Ethiopia is classified as having the lowest per capita consumption of meat and milk, even among neighboring countries like Kenya.

In Ethiopia, dairy production is mainly of subsistent type and largely dominated by indigenous breed of cattle. The production generated from this system is low to support the demands of the continuously increasing human population. Hence to increase production and productivity of the sector; introducing improved method of forage production for dairy cattle, introducing cross breed heifer, providing bull service for farmers, delivering pure-bred Friesian and Jersey breeding bulls to villages and increasing adoption level of farmers for improved breed are of the main practices employed. In addition to this, they also improve the food and nutritional status of the rural households (Dehinet, 2014).

Since then different dairy technologies have been transferred through governmental, NGOs and private sectors. Even though large efforts have been made to disseminate dairy technologies through the support of governmental and non-governmental organizations in different parts of the country, the rate of adoption of dairy technologies by farm households varies widely across different agro-ecologies and within the same agro-ecology based on various technical and non-technical factors. Accordingly, the contribution and benefits of dairy technologies differ among farm households. For instance, the long-term research program initiated between the International Livestock Research Institute (ILRI) and the Ethiopian Institute of Agricultural Research (EAIR) was aimed at increasing milk and meat production, household income, use of dairy cows for traction and nutritional status of household members. The results of the program were relevant for nutrition and food security policies in the East African region in general and Ethiopia in particular.

On the other hand, the policy design and effective management of extension programs, information on the impact of dairy technology on the livelihoods of smallholder farmers is very important and would help to come up with workable recommendations in order to improve the

performance of the sector. Recognizing this, improved dairy technologies are widely considered as the key means of addressing most of the problems of low livestock productivity throughout the regions of the country.

Therefore, this study is aimed to examine the role of adopting improved dairy technologies in increasing the rural household dairy production and their food security as well as to investigate factors that determine the households' technology adoption and examine the intensity of adoptions of the household in the study area.

## **1.2 Statements of the problem**

Poverty and food insecurity are quite pervasive in the Amhara regional state where more than 27% of the national population lives. The level of poverty in the region was 36.1% in 2011. The figure was as high as 41.1% in the rural areas. Even though food poverty declined in all regions of Ethiopia, exceptionally, it has been increasing from 32.5% in 1999/00 to 38.8% in 2004/5 and to 42.6% in 2010/11, consecutively, in the Amhara regional state. In addition to this, the region has the highest rate of stunting, which is nearly 42%, in the country (CSA, 2014). The same pattern of realities holds true in Basona Worena in Northern Showa zone of the Amhara regional state.

The consumption pattern of dwellers in central highlands area, where Basona Worena is located, largely confined to cereals crop and their products. However, the diets from those crops are recognized as monotonous and lacking essential micronutrients and contributing to malnutrition and micronutrient deficiencies, especially in children, who need energy and nutrient-dense food to grow and develop both physically and mentally (Megersa, *et al.*, 2016). In terms of energy source, dairy products contribute very high in Ethiopia. This is evidenced by the fact that dairy accounts only 7% of the total energy requirements of households (Zewdu & Peacock, 2012). This is accounted to low level of dairy productivity emanating from low level of technology adoption (Kebebe, 2018).

In order to ameliorate the productivity of dairy in a bid to combating food insecurity, new technologies mainly the provisions of improved breed dairy cattle have been introduced in Basona Worena *Woreda* where there is immense potential of livestock production.

There are a number of questions that require rigorous assessment which adhere to what extent the provision and adoption of improved dairy technology reduced food security? Does the adoption of such improved dairy technology enhance the food security status of the household?

The few research studies have been carried out on improved dairy cattle production and their associated effects on households (Amanuel, *et al*, 2018; Melesse and Jemal, 2012, Muuz 2018, (Mekonnen, *et al*, 2010; and Samuel, *et al.*, 2016). These researches have been mainly describing the effect of improved dairy farming on poverty and the challenges of adopting improved dairy farming. The impact of improved dairy farming on food security and its associated impact are at rarity.

This research is therefore, an attempt to bridge such knowledge gap by examining the impact of adoption of improved dairy technology on household food security and extent of adopting dairy technologies among the adopter's group. The study also identifies the determinants of dairy technology adoption in the study area.

## **1.3 Objectives**

### **1.3.1 General objective**

The overriding objective of this study is to examine the adoption of dairy technology and its impact on rural household food security in Basona Worana *Woreda*.

### **1.3.2 Specific objectives**

More specifically, the study planned to:

- identify the determinants of dairy technology adoption in Basona Worena *woreda*.
- examine the intensity of dairy technology adoption among rural households and
- examine the impacts of dairy production technologies adoption on household food security

## **1.4 Research questions**

This research was intended to answer the following basic questions which are derivatives of the above-mentioned research objectives:

1. What are the determinant factors of dairy technology adoption?
2. How much is the rate and extent of dairy production technologies adoption in the study area?
3. What is the implication of dairy technologies adoption on farm household's food security?
4. How is the household food consumption status among adopters and non-adopter respondents?
5. What are the main constraints in the area that the household not adopt the technologies?
6. What is the implication of dairy technology adoption on household dietary diversity?

## **1.5 Significance of the study**

Studying the impact of dairy technology adoption on household food security particular to the community of Basona Worena *woreda* at large applauded. Therefore, the output of this research would improve the knowledge about the role that the sector plays in rural farmers food security, and would also add information to the limited research done so far on the role of dairy technology adoption and its impact in the region. Thus, this research was not aimed to replicate or duplicate what has been done by the others but to fill the gaps that were not observed in other research works. In addition to this, it helps to better design development projects or programs for the farmers to improve their livelihood options. Policy makers also benefit from the research output because they require information to formulate suitable policies with regard to farmers' adoption, and identifying major factors that influence uptake of improved dairy technologies as well as its impact on household food security. The result of this study would be together used as a reference for other similar areas for further study. In general, the study was expected to generate grass root information for different stakeholders in order to develop sustainable strategies that decrease drawbacks and other associated issues in this study.

## **1.6 Scope of the study**

The study was conducted on adoption of dairy technology and its impact on household food security. Socioeconomic factors, institutional and demographic related factors that determine household technology adoption were considered in this study. The study focused on households who participated in dairy production and potential dairy producing *kebeles* namely Angolela and Birbisa of the Basona Werena *woreda*.

## **1.7 Limitation of the study**

This study was limited to identify factors that determine dairy technologies adoption and its impact on rural household food security in a single *woreda* of Amhara Regional State. The adoption of dairy technologies in the district was studied in two representative *kebeles* by surveying a sample of 283 households. Since it was not possible to study factors and impacts of all livestock technology on household food security, dairy technologies adoption was the only technology considered in this study. Methodologically, this study used cross-sectional data gathered from sample households as well as the variables included were focused on socioeconomic, institutional and demographic related factors.

## **1.8 Organization of the thesis**

This thesis has five chapters. Chapter one presents the background of the study, statement of the problem, objective of the study, research questions, scope and limitation, significance of the study. Chapter two deals with theoretical, empirical and conceptual literature review related to dairy technology adoption and food security as well as conceptual framework for the study. The third chapter depicts study area description, research design, sampling method, procedure, and method of data analysis. Chapter Four presents the result of the study and discussion. The last chapter deals with conclusion and recommendations.

## **CHAPTER TWO: RELATED LITERATURE REVIEW**

This chapter presents about conceptual and theoretical literature review related to technology adoption and food security. The empirical literature review on the factors affecting dairy technology adoption and food security around the world and Ethiopia in particular. At the end the chapter, conceptual framework on the characteristics of food security and dairy technology adoption and factors that determine dairy technology adoption were discussed.

### **2.1. Theoretical foundation and the concept of technology adoption**

Innovation diffusion model Feder *et al.*, (1985) studies that adoption is an integration of an innovation in to farmers activity for a period of time, in this regard farmers may not be longer in the adoption process because of different constraints like institutional personal and social reason. According to Carr (1999), technology adoption as a stage of selecting a technology by individual or group of peoples. On the other hand, the theory regarding to technology adoption basically it is a process of members or groups of a social system communicated an innovation through a certain channel Feder *et al.*, (1985). According to Rajesh (2016), technology adoption is one of the mature areas of research in information system.

The innovation decision model commonly consists of five conceptual stages. Those stages area knowledge, persuasion, decision, implementation and confirmation. Knowledge occurs when an individual exposed to new innovation and gain some understanding about the innovation. The persuasion indicates when the decision-making unit forms a favorable or unfavorable attitude towards the innovation. The other one is decision; it occur when an individual make a decision to adopt or reject the innovation. The implementation stage is the decision-making unit puts an innovation in to practice. The last stage of innovation decision model is confirmation, this occur when an individual seeks reinforcement of an innovation decision that made (Rogers, 1983) and (Andesine and Zinnah, 1993).

Further, the aggregate diffusion theory, indicates a process of technology adoption that an individual understood in terms of some kind of behavioral change. The individual level changes express as the degree of use of new technologies and its potential. On the other hand, the process of adoption behavior is a spread of new technology within the region. This implies that aggregate diffusion level for new technologies measured in a given area within a given population (PC Lai, 2017).

Adoption is a mental process through which an individual pass from hearing about an innovation information gathering, learning by doing and resource accumulation to the adoption stage. It implies the decision to use new technology or practice by economic units on a regular basis. Technology adoption can help in increasing productivity and consumption expenditure which affects farmers welfare (Samuel *et al.*,2016). Immediate and uniform adoption in agriculture is rare with rate usually differing across socioeconomic groups and over time (Khanal, 2010). Adoption of any agricultural innovation can be measured in terms of number of farmers who adopt the innovation and total area on which the innovation is adopted.

On the other hand, the concept of technology adoption in agriculture perspective is a general package of different technological elements that increase production and productivity, technical practice and knowledge and skill that are needed for effective and efficient use to be implemented by individuals or a group (Shahin, 2004).

Various researchers defined adoption at different time. According to Rajesh (2016) technology adoption is one of the mature areas of research in information system. The other definition is developed by Feder *et al.* (1985), adoption is an integration of an innovation in to farmers activity for a period of time, in this regard farmers may not be longer in the adoption process because of different constraints like institutional personal and social reason. According to (Carr, 1999), definition technology adoption as a stage of selecting a technology by an individual or group of people. Sometimes adoption is defined as a mental process through which individual passes from knowledge of innovation from knowing or hearing about the innovation to the final decision to adopt and reject the technologies. This shows that the adoption process takes time of acceptance by farmers; it is not an immediate process (Rogers, 1983).

### **2.1.1. The concept of food security**

The earliest definition and concept of food security was considered as availability of sufficient food supply at global, national and regional level. the (Maxwell & Smith, 1992), focused was on the supply of food for global market to meet the demand of the population. After that the World Food Conference of 1974 emphasized that in order to alleviate food crises, the increments of production and productivity specially in developing country is crucial. However, the availability of food at larger scale alone is not the guarantee for food security at household and individual level. After that the concept of food security has simply shifted from availability of food (at

national and local level) to a more complex and specific issue of access of food at the household and individual level (Margaret, 2016).

The concept of food security at an individual and household level comes from the realization of the problem of hunger distributed to accessing of food rather the availability of food. In 1986 the World Bank further added the dimension of activity level and defined food security as secure access at all times to sufficient food for a healthy and active life. Based on that assumption (FAO, 2003), stated food security is very flexible and has different explanations in different times however, food security is explained by four major dimensions; availability, accessibility, utilization and sustainability of food at all time and place. However, is used to emphasis access to food rather than mere availability of food. It also incorporates the need for a healthy food.

The issue of food security really come to the fore in the 1970s and at the 1974 World Food Conference in Rome the first explicit acknowledgement was made that this issue concerned the whole of mankind. Since the 1974 Rome conference the whole concept has evolved, developed, multiplied and diversified. There are a lot of definition of food security, almost two hundred definitions. However, the definition that has acquired the broadest acceptance is that the world Food Summit (WFS) in November 1996.

*Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life (FAO, 1996: p,1.).*

Food security is a difficult concept to measure since it deals in very broad terms with the production, distribution and consumption perspective. From the given definition, there are four basic pillars or dimension of food security, those pillars are food availability, accessibility, utilization and stability (FAO, 1996).

**Food availability** is the first pillars of food security, which is defined as the presence of food that is a country or household level though all form of domestic production, food aid, and commercialization import and purchase (WFP, 2012). At microlevel (household), food availability is the extent of which food is within reach of households through production and market (Pieters *et al.*, 2013).

**Food access** it defined as the household ability to acquire adequate amount of food, through own production, purchase, gift and other. The household level food access expressed in terms of the access of food regarding both sufficient quality and quantity to insure a safe and nutritious diet (FAO, 2006; WFP, 2012). Hence, it affected by logistic, economical or sociocultural reasons. The household which has a greater resource have a greater success to food, either directly and indirectly though food production and income generation respectively (Pieters *et al.*, 2013).

**Food utilization** it refers to the ability of members of a household to make use of the food to which they have access. Particularly to the deity diversity intake and to the individual's ability to absorb nutrients contained in the food that is eaten (WFP, 2012). When the household income enhanced by the technologies permit the purchase of diversified food items.

**Food stability** it takes into account the change of household food security condition over time. Stability describe for the three basic dimensions of food security; availability, access and utilization. Periodic inadequate access to food because of adverse weather condition, political instability, or economic factor exposed the household for food insecurity. Such risk of the household severely damage in its food security status of the households. The household can ease the welfare impact and reduce their vulnerability to food insecurity by adopting and coping strategies (Pieters *et al.*, 2013).

In Ethiopia the food security status of the households is different from region to region as well it varies within the region because the majority of the economy of Ethiopians mainly depends on agriculture which is vulnerable to different shocks, seasonality and trends (Sani, 2017). Moreover, as FAO (2012), finding the majority of food insecure people in the country resides in rural area. About 52% of the rural population and 36% of urban population consume under minimum recommendation daily intake of 2100 kcal/person/day.

### **2.1.2. The concepts of dairy production**

### **2.1.3. Overview of livestock and dairy production in Ethiopia**

The sector of livestock in Ethiopia has the potential to decrease poverty, improve the food security of both rural and urban peoples and it contribute for the country GDP growth. Ethiopia livestock master plan brief August (2015), Livestock is a primary livelihood source for many low-income rural farmers particularly in sab-Saharan African country. In line with this the

livestock production contribute up to 80% of farmers income 16% share in export of the country economy, nevertheless, the contribution of the sub sector is below the expected level (Hadus, 2018).

The livestock sector provides a massive service for smallholder households economy by providing food, as input for their crop production, source of cash income especially source of sales of dairy products and as well as employment. With this wide array of functions, livestock can be considered as improving the household food security and create better livelihood for the rural populations (Tamiru and Amza, 2017). In Ethiopia dairy production is an important component of livestock farming. The favorable agroecological condition of the country is suitable for dairy production in both rural, peri-urban and urban areas. In the other hand the consumption of the dairy product in all setting is very high. However, the productivity of dairy animals in general is limited. This result shortage of supply of dairy products as compared to the demand of the population and requires to spend a lot of currency to import dairy products aboard (Tegegn *et al.*, 2000). The annual growth of milk production rate of the country is 1.2 percent falls behind the annual human population growth estimated at 3 percent (Levitt *et al.*, 2011).

The sector is dominated by traditional milk production system and indigenous breeds of low genetic potential for milk production, accounts for about 97 percent of the country's total annual milk production (Felleke, 2003). According to FAO (2011) finding the low productivity of the livestock sector in general and the traditional production system in particular is mainly attributed to shortage of crossbreed, lack of quality and quantity of feed resource, poor animal husbandry system are some of constraints of the sector. In Ethiopia indigenous cow national average milk yield per day is 1.35 liters and the per-capita milk consumption in country is about 19.24kg/year respectively (MoALR, 2012; CSA, 2010) suggested that the indigenous cattle breeds accounted for 99.1%, while the hybrid and pure exotic breeds accounted for about 0.72% and 0.9% respectively.

#### **2.1.4. Dairy production system in Ethiopia**

In Ethiopia dairy production can be categorized in to four major systems. These categories are low land pastoral dairy production system, rural highland smallholder dairy production system, urban and peri-urban small-scale dairy production system and large-scale dairy production system (Mihret, 2017).

In Ethiopia, the lowland pastoral livestock population is estimated about 30% of the total livestock population (Guadu, 2016). The pastoral milk production system in the low land region of Ethiopia where the livelihood security of the people relies on their stock, the milk production is very low due to the environmental factors and the major system of milk production plays a vital role in their pastoralist community livelihood. Because of limited rainfall that leads to shortage of feed availability, milk production is low.

The highland mixed farming is an integrated crop-livestock system and about 97% of total milk production in Ethiopia is found from this area. The highland smallholder milk producer is found in central parts of Ethiopia (Tamiru, 2017). The livestock mainly graze on natural pastures non-arable in addition to feeding on crop residue. In this rural highland dairy farming system, there are two types of farming: traditional (based on indigenous; milk mainly for home consumption) and market-oriented system (based on cross breed cows) (Gizaw, 2016). In highland household's milk production is one of the income sources. However, the sector is not developed because of several problems like poor quality and quantity of feed source, poor production and low productive and reproductive performance; it means that less adoption of improved breed and economic and technical problems (Guadu, 2016).

Livestock and crop farming in the town and city are considered as urban agriculture. Urban agriculture in Ethiopia plays an important role in the economy of people that live in urban and peri-urban area, crop and livestock farming in peri-urban area and specialized farms within the urban area. There are around 40,000 cross breed and exotic dairy cattle found in urban and peri-urban areas that are used for milk production purpose (Tegegne *et al.*, 2000). In Ethiopia livestock keepers in urban area are still receiving less attention in terms of policy, institutional and technical support targeted at their needs. The urban milk production has different constraints regarding to lack of adequate quality and quantity of feed, prevalence of disease and poor health service and poor genetic potential.

Large scale dairy farming system is specialized in market oriented dairy operation practiced by the state sectors and very few private commercial farms. Most of these farms are located in and around Addis Ababa and basically keep exotic dairy stock (Ketema and Tsehay, 1995).

### **2.1.5. Components of dairy production technologies**

There are different dairy technology packages focusing on breeding, management, husbandry, feed and health that have been identified and introduced to optimize the production as well as reproduction performance of both local and cross breed dairy animals. Such technological intervention methods can result in improvement of the production and the livelihood of rural farmers.

Dairy breed technology developments of livestock project and breeding strategies have been carried out with the aim of introducing cross breed animals in terms of improving milk and milk productivity of households. Cross breeding is one of breeding strategies that increase the production and productivity of dairy products in milk production and at same time increase the profitability of the households to create market opportunity (Kebede, *et al.*, 2018). Cross breeding in Ethiopia has been started by Ethiopian Institute of Agricultural Research (EIAR) through the establishment of station dairy cattle crossbreeding program, using improved Friesian, Jersey and Simmental sires that were cross with local Horro, Arsi, Fogera, Horro, Ogaden, Borena and Barka dams with the goal of increasing productivity of cross breed dairy cows with different level of exotic blood level (EIAR, 2001). Those resources are influenced by different factors like climate altitude, feed availability, disease, lack of appropriate breeding strategy, poor infrastructure and lack of funding which are some of the problems in implementation of cross breeding in Ethiopia. Around 99% of the cattle population in Ethiopia are indigenous and the rest is improved. Most of the local indigenous cattle belong to Zebu type (Tadesse Guadu and Abebaw, 2016).

In Ethiopia, Artificial Insemination service is mainly provided by a governmental institute named National Artificial Insemination Center (NAIC). Cattle breed improvement and multiplication center were established with the aim of distributing improved animals to smallholders around the country (Tegegne, *et al.*, 2010). Most of artificial insemination were done in Addis Ababa, Oromia, Amhara, SNNPR in (33.7%), (37.5%), (13.9%) and (9.4%) respectively. Accordingly, the households have benefited from the AI. Some developing countries AI have failed due to lack of infrastructure, communication, inefficiency of AI service and high cost of liquid nitrogen transport and storage.

In the dairy sector, feed is the major input in milk production activity. Many highlands of the Ethiopia are natural pasture, crop residue, and stable grazing. The animal feed includes crop residues including cereal straws of teff, barley, wheat, oats and cereal stoves from maize, sorghum and millet and haulms from pulse crops including peas, beans, lentils, chick peas and vetch are very important feed resources (Mesfine, 2014). However, the feed supply is seasonal and the shortage of green grass is one of the major causes of drastic deterioration of livestock nutrition. Due to this insufficient feeding of livestock has been attributed to 40% of low productivity (Negash, 2018).

Animal healthcare and management is the major constraint in developing countries, same as other countries Ethiopia also faces several animal health problems. Such problems are caused by the poor performance across the production system. Most of the time such problems are categorized in technical and non-technical constraints. For instance, poorly fed animals have low disease resistance, fertility problems and poor grazing management system which will cause high mortality and morbidity of cattle. Likewise, many of the disease constrains which affect are also a consequence of non-technical constraints (Tonamo, 2016). According to (Zelege *et al.*, 2000) the most serious animal disease constraints to livestock productivity are parasitic and viral diseases. Many are vector-transmitted that have a wide geographic distribution and those severities are strongly influenced by environment.

Housing management is varied place to place with their farming system. Currently in Ethiopia, most farmers in urban areas keep their cows in separate improved housing and the roof is made of iron sheet, and the wall of the house is built from wood, mud or block based on the economic status of the household. Whereas, in rural parts of the country it has irregularity in the type of production and most of them dispose the slurry in inappropriate place outside their compound; which contaminates nearby water reserve, lake or well. Many research results suggest that some farmers have not fully gripped the importance of proper housing of dairy animals. Inadequate roofing and poor drainage can result in accumulation of slurry during the rainy season, which would be hard to clean given that the farmers need to perform many tasks, particularly, within the time of year once crop production could be a primary issue.

### **2.1.6. Determinants of adoption of dairy technologies**

The adoption of new technologies often influenced by the farmer's access to extension service. The extension service has an important role in order to transfer the technologies to the farmers and creating awareness on the importance of adoption of technologies for production and productivity of farmers yield (fita *et al.*, 2015).

Introduction of new technology to smallholder farmers by itself does not guarantee for a wide spread adoption and efficient use of technologies. The adoption decision of farmers is influenced by different factors associated with economic, institutional demographic and physical on adoption of agricultural innovations (Wongelu, 2014). In Ethiopia most studies show that credit, farm size, labor availability, and human capital, land tenure and education are main factors affecting technological adoption. For this study the independent variables identified as having relationship with adoption are categorized as household personal, economic factors, institutional factors, also this concept draws in conceptual framework (Dehinenet, 2014).

### **2.1.7. Feed and feeding of dairy cows**

Pro action (2016), states quality of feed has a major impact on the cow's health and productivity. In similar, dairy farmers' intention to cover about 50 – 60% of the diet from forage. Forage refers to plants consumed by grazing like grass or hay. Forage can be wet or dry. Wet forage could be silage which consist barley, corn or alfalfa and dry forage could be pasture, grass hay or straw.

Also stated in the article is the other type of diet named concentrate. Concentrate can be carbohydrates, proteins, fats and minerals and vitamins. Barley, corn, oats, wheat, molasses, beat pulp and soy hulls are of the major carbohydrate sources. They can be processed by the farmers in order to feed the cows. Feed mills also provide some of them. They are employed as a supplement in addition to the forage aiming to meet nutritional requirements. Proteins can be found from canola meal, distillers' grains, soybean meal and corn gluten meal. Vegetable oil, tallow and protected fatty acids are sources linked to fat. Balanced supply of minerals and vitamins such as Calcium, Phosphorus, Magnesium, Sodium, Chloride, Potassium, Sulphur, Iron, Zinc, Manganese, Copper, Vitamins A, D, E and some B vitamins are essential in maintaining health and productivity (Negash, 2018).

The article continues in stating the advantage obtained by farmers living closer to large centers. Living close to areas where food processing plants are located ensures the availability of getting by-products. These could be potato waste, fruit and vegetable waste and alike. This has a huge effect on the intake of grains as a result of the usage of the by-products of these production facilities since they have high nutritional value.

According to Abebe *et al.*, (2014), natural pasture grazing and browsing fallow lands and stubble grazing following crop harvest constituted the majority of feed resources. The study undertaken by him showed that most portion of feed of dairy cattle involved natural grazing, crop residues and conserved hay. Since cost of feeding accounts for 40-60 % of milk production cost improving feeding system plays a very important role in increasing profits. Even though this stands true in theory most farmers did not follow recommended feeding practices which would have negative impacts on the outcomes (Quddus, 2012).

From a paper published by Demissie (2018), agro-ecology, type of crop produced, accessibility and production system affected the contributions of the major feed resources in Ethiopia such as pastures, crop residues, forage crops, agro-industrial by-products and non-conventional feeds. It also states that due to decreasing of grazing lands due to farmers using more land for farming, occupation of land for living purposes and land degradation natural pasture is becoming less available.

It also states that concentrates provide low fiber content and a high protein or energy content. And a high fiber content and low nutrient density can also be found in roughages which serve dominant feeds for ruminant and non-ruminant herbivores. Also found on the paper is that pastoral and agro pastoral areas introduce very little planting to acquire more pasture or forage crops. In the mixed crop-livestock system crop residue and agro industrial by-products hold much portion of feeding source.

Ergano (2015), stated citing Peden *et al.*, (2007) and Amede *et al.*, (2009), the very much linked relationship between water use efficiency and feed availability. Shown on the document is that efficient use of water made it possible for the farmers to keep their farms and grazing lands fertile over longer periods of time.

According to Lukuyu (2012), states carbohydrates as the major source of energy in the diet of dairy cows. They constitute 50-80% of the dry matter in forage and grains. It also states there should be a balanced intake of forages and concentrates. This is because too much forage limits energy intake while too much concentrate results in fat depression, rumen acidosis and other health problems. Proteins are also major components of milk and their absence has a negative impact in milk production. Lactating cows may be prone to decrease in milk production and weigh loss if there is significant lack of protein.

On the other hand, too much protein feeding causes financial problems. Excessive protein can also result in excessive body weight loss as the cow metabolizes the extra protein. Avoid feeding high protein diets during the breeding season. Both macro minerals and micro minerals should also be supplied guaranteeing there would be no deficiency at a certain time. This is because minerals are engaged in milk synthesis. Mineral intake requirement is affected by age, psychological status and level of production. Highly productive cows should be supplied with large quantities of calcium. So, deficiency in minerals will cause low milk production. Vitamins should also be presented to the dairy cows even though they are required in small amount. Since vitamins are directly related to appetite, they play a major role in the feed intake of the cows. Also, here vitamins should be introduced in the proper amount to balance the requirements and cost incurred in getting them. Water is also a major part of processed milk covering up to 87%. Intake of water depends on moisture content of feed, milk yield, environmental temperature and salt intake which are all directly related to the amount of consumption of water (Lukuyu, 2012).

Dairy cows can drink more than half of their water needs within a few hours of milking. Cows can drink quickly – up to 14 liters (3 gallons)/minute. It is important that the infrastructure and water flow rates adequate to meet the demands of the herd (Siobhan, 2006).

Grazed grass is the cheapest feed and should make up as much of the cow's diet as possible. Forages such as whole crop forage maize, whole crop cereal silage, fodder beet or other wet feeds can have only a limited role in spring calving herds, except at high stocking rates. At high stocking rates their use will be decided by their value relative to concentrate feeds. Fixed costs, as well as variable costs tend to increase where alternative feeds are used. In order to optimize feeding cost, keep feeding simple, limit feed categories 3-4, learn to budget grass, maximize

grass utilization, buildup grass for autumn season and use concentrate feeds strategically (Collins, *et al.*, 2006).

### **2.1.8. Constraints of dairy sector in Ethiopia**

Technical, socio-economic and institutional constraints were noticed by the study undertaken by Minale and Yilikal (2015). Their findings showed that feed shortage, disease and parasite, lack of extension support, poor knowledge in animal management and inadequate capital were among the major constraints. The study was undertaken in two districts named Chench and Kunch. Agro-ecological differences accounted for the major constraints in the area. Feed shortage was more severe problem in Chench and disease took the high rank in Kunch. Highly rising feed prices, poor pasture development and inadequate feed resources accounted for reduced milk production. More cattle numbers that exceeded the providing capacity of the grazing lands accounted for degraded pastures. Moreover, since those stock numbers were kept over the dry season overgrazing occurred. Increasing number of populations caused expansion of cultivation land which resulted in reduced grazing lands.

According to Demissie (2018), qualitative and quantitative shortage of roughage and concentrate feed suppressed milk productivity. In his study he also clarifies that inadequate supply of quality feed and minimal productivity of indigenous cattle added up to deprive dairy production in the study region. The study further showed financial limitations had influenced the availability of feed which dragged down productivity.

Citing findings of the study of Tegegne (2013), unavailability of cross breed cows in kind, insufficient AIS, lack of milk market and feed shortage were major constraints noticed in the study area. Industrial feed by products were not available in the local markets leading to farmers to travel long distances in pursuit of purchasing the feed products from private merchants who sold the products with high prices. Moreover, the long commute incurred extra costs due to transportation to towns where they could find the products they needed. On the other hand, they could not use cross-bred heifers because of the high prices when purchased from private sellers. They were forced to purchase from private merchants because district office of Agriculture did not provide the amount, they needed even though the price was good.

In addition to these AIS services were not satisfactory because the service was not provided continuously. Sometimes the office is closed, the technicians may not be available or they may not have frozen semen in stock. After going through all these difficulties finding satisfactory market was not an easy task. First, they may not get sustainable markets that can take the produced milk off their hands. And the second and most problematic situation was the selling price. Most of them joined cooperatives to sell their products but the cooperatives were not that organized in addition to low prices for the milk products. The farmers also stated their frustrations towards the selling of the produced milk only in the morning. Anthrax and internal parasites accounted for the majority of the diseases that affected the study area according to the study of (Jiregna, 2013). Also, in the same paper the study showed external parasite infection also had a significant impact on the health of the livestock. Black leg and tick infestation were among the major health problems in the study undertaken by (Tesfaye, 2007).

In the dry season of the study area tick had very deep problems since milking was impossible if the cattle were infected with it (Tegegne, 2003). Also stated here was that farmers who had less financial status were not able to get better breeds and vaccination to the required amount. Reproductive problems, low rate of consumption and limited capacity of AI technicians also had severe impacts in the study area (Minale and Yilikal, 2015).

#### **2.1.9. Dairy technology and food security**

Household food security is expressed in terms of physical availability of food, the ability of household to access the available food and the ability of household individuals in particular those vulnerable to food deficits such as women, infant and children to secure their entitlement. The availability and getting enough food in the rural household mostly depends on their production and productivity amount. Improving the production and diversified household food intakes, depends on adoption of improved technology in both urban, peri-urban and rural farmers. Adopting of improved technologies has vital role on production and food security of households (Beyene, 2010).

The impacts of improved technology on rural livelihood of farmers in terms of income diversity of the farmers, source of cash for family need, asset availability and expenditure for school fee by increasing production and productivity. On the other hand, household food diversity and food availability are the criterion for the nutritional effects of adoption (Samuel *et al.*, 2016).

Individuals can not only consume sufficient amount of calorie but also protein, fats, vitamins, and minerals to support growth and development throughout their life cycle.

The prevalence of malnutrition varies with in the household members based on their age, gender, location (rural and urban) and region. According to Lemma (2015), research findings Amhara and Oromia regions are the ones that produce adequate food, but at the same time high prevalence rate of stunting as compared to less productive region. This indicates while household food security is necessary, it is not the only determining factor for ensuring nutrition security.

Dairy and other livestock products can be important in meeting the micronutrients of individuals in particular, women and children. In addition to the plant base diet, adding the small amount of animal-based food can improve in maternal health and child development mentally and physically. Inadequate diet also hampers both mental and physical development of children and result in increased morbidity and mortality from infectious disease (Gerosa and Skoet, 2012).

#### **2.1.10. Impacts of dairy on household food security**

Employing dairy technology has a positive impact on smallholder livelihood since it enables them to increase income and milk productivity. Continuous training or technical follow up on the provided technology is very vital (Dehininet *et al.*, 2014).

Livestock provided income for many smallholder farmers (Sansoucy *et al.*, 1995). In their study on the districts where cross-breed dairy cows were being used there was better income generation since the milk yield was better and the farmers benefited from it. By adopting better dairy technologies it was made possible to increase the income of the households. In addition to this adopting of technologies improve households' incomes sustainable and permanent manner. This was achieved through market-oriented dairy production system and the using of cross-bred cows (Temesgen *et al.*, 2015).

Family members of the households benefited from an increase in milk consumption that resulted from the adoption of dairy technologies. The increased milk consumption led to improved nutrition of the whole family specially children since dairy products have a huge impact on growth and development of both body and mind of the children (Sansoucy *et al.*, 1995). Quality nutrition was achieved by intake of the dairy products directly or through the purchase of better nutritional elements from the money acquired from the selling of the products (Towns, 2013).

Adopting improved dairy technologies made the farmers spend more on household items, educate their kids, increase per capita intake of milk and by products, spend on health and sanitation and achieve better nutrition. The additional income generated from adopting better dairy technologies diversified the income of the farmers which in turn made assets to be available, clothing, medical fees and seed purchase were all possible (Samuel *et al.*, 2016).

## **2.2. Review of empirical studies**

### **2.2.1. Determinants of dairy technology adoption**

As stated in the study of Dehinenet *et al.*, (2014), there is a difference between dairy technology adopter and non-adopter in terms of production and productivity. Adopter smallholder farmers could get more milk production on average than non-adopter farmers. The role of extension is very important in order to address the gap. Recent studies conducted by Bereda *et al.*, (2017) showed that most central highlands of Ethiopia have different constraints that impeded the dairy production and productivity; including shortage of feed, poor nutritional quality, high veterinary cost and shortage of veterinary clinic. In addition to this, family size of the household implies that a good source of family labor to utilize other out farm activities. Dairy production has been a source of income for dairy producing households and it contributed 62% and 66% of the total monthly income of households (Melesse & Jemal, 2012). This shows that significant raise in the household income of smallholder dairy farmers in the rural Ethiopia due to adoption of cross breed improved dairy technologies.

According to Ergano (2015), education level of household has a positive influence on the adoption of dairy technologies because of knowledge and ability to read technical materials. In the other hand, larger active workforce in the household also affects the decision of adopting dairy technologies positively. A study in Bangladesh confirmed that the adoption of dairy farming technologies by small farm holders in particular cross breed, the age of farmer and their past experience in dairying were interrelated with technology adoption (Quddus, 2012), has shown that sex is positively and statistically significant on identified technologies thus the household head and source of information were the most frequent factor that influence the decision of household to choose new technologies.

As reported by Ahmed (2002), the size of cultivated area, herd size and purchased input are positively and strongly associated with the level of income. This income also has a significant influence on the expenditure of food and non-food items. However, on the other side, the price of food has a negative and significant impact on households' expenditures Berhanu (2002), has shown that total livestock holding and off-farm income has significant effect on the adoption of cross breed dairy cows. According to Yenealem (2006), TLU of a household has a positive and significant influence on the adoption decision of the households as well as household capital influences the adoption decision of the households like machinery, breeding equipment cost and even though technology cost contribute significantly towards the lowering of economic cost of producer.

Economic, social, physical and technical aspects of farming influence the adoption of agricultural production technologies. According to Dehinet, (2014), the availability of cross breed cows and accessibility of credit institute were positively associated with farmers likelihood to adopt dairy technology. If the technology is available in the area, their adoption probability increases. This is because it reduces the transportation cost and frequent contacts of learning about the technologies. Having access to informal saving institute like Iqub and Edir creates a good opportunity for farmers to have asset and to purchase different agricultural technologies including cross breed cows (Melesse and jemal, 2016).

The availability of livestock training also increases the level of dairy technology adoption through creating awareness on the advantages of the technology and then improve the farm management skill. Dehinet *et al*, (2014) and Samuel *et al*, (2016) reported that farmers near to training center could adopt more improved livestock technology and get continuous technical assistance, timely provision of medicine, increasing AI facility than farm households that are far from the training centers accordingly, farmers in the areas of training availability could adopt more and owned more dairy technology than non-training areas` farmers. On the other hand, distance to access extension service such as improved dairy technologies (artificial insemination service) and other breed technologies have a negative and significant impact on probability of the household adoption for technologies by decreasing the accessibility of farmers for such technologies (Quddus, 2013).

Improved breed dairy cattle are important in increasing production and productivity of the dairy products and are also used as source of income for households in order to diversify the household food security status. It also increases nutrient intake and better health from cash coming from income sales of dairy products. In addition to this increase the adoption of cross breed cows develop household food intake by diversified food intake, through increasing the production and productivity (Ahmed *et al.*, 2008). Genetic limitation for milk production, in adequate feed resources which is poor pasture development, absence of effective genetic program and animal disease are constraints that rural farmers mostly faced in different agro climatic condition of the country. Beside this, lack of breeding policy in the country and poor linkage between research and extension and technology user highly affect the rural household and the country economy (Tamiru, 2017; Mihret, 2017).

### **2.3. Literature gap**

From the above theoretical and empirical literature reviewed, it can be understood that, most of the study focused on either on identifying the determining factors or implication of rural household income and asset development. But this study has tried to examine factors that affect the adoption of dairy technology, to what extent is the adoption of the household, as well as its implication (impact) on the rural household food security. It is intended to contribute the knowledge gap regarding to food security and dairy technology adoption.

### **2.4. Conceptual framework**

The framework is constructed based on experiences and reading of various literatures related to dairy technology adoption in different time and place. The framework contains different factors that mainly determine the technology adoption of rural households in dairy farming. These are institutional, socioeconomic, policy framework, environmental factors and the demographic profiles. Socioeconomic factors that relate to social activities and capital of farmers like price of agricultural inputs, the household total livestock unit, labor availability, land holding, farming experience and engagements with off-farm activities. The other major factors of household adoption for technologies are institutional factors. Such factors include credit availability and access, extension services in the dairy sub-sector, the availability of input like artificial insemination and selected bull services and market distance from the farmer's home are the major factors farmers faced in the institution side. The last one is demographic factors like

education level of farmers, the age and sex of the household head also have a big role in the adoption process of the rural households. Different countries revealed that demographic, socioeconomic and institutions affect adoption of improved agricultural technologies more specifically dairy technologies and few of those studies will be discussed below.

According to Dehinenet, *et al.*, (2014) age of the household head and off-farm income activities negatively and significantly related to adoption of improved dairy technologies. Unlikely the age of the household head and off-farm income activities, family size, farming experience, availability of dairy extension services, training and accessibility of credit and saving institution have a positive and significant effect on the adoption of technologies. Howley *et al.*, (2012) research finding shows that the household that has large family size can have a high probability of dairy technology adoption and farmers with children are much more likely to use breeding service. Lemma *et al.*, (2012) revealed that, access to information like being exposed to mass media and farmers training on improved dairy breed technologies practice have a positive and significant relationship with the adoption of improved breeds practice. Likewise, education status of the household members, experiences of the dairy farming practices and participation of the farmers in various organization (such as farm association, unions and farm cooperatives and other social institutions also have a positive and significant relationship with adoption of improved dairy production technologies (Quddus, 2013). On the other hand; an increase in the age of household head, inadequate farming experience, and low level of farmers' education have less probability for the adoption of breed technologies. Alternatively, the livestock ownership of the households directly or indirectly relates with the household food security. A household benefiting from the livestock has the capacity to contribute and fulfill its requirements in view of the four components of household food security which are availability, access, utilization and stability.

The conceptual framework of this study is discussed and revealed (Figure1) based on the assumption of the adoption of dairy technology and its impact on rural smallholder food security as well as the determinant factors that affect adoption decision. The dairy technology adoption might influence by institutional, socioeconomic, policy framework, and the demographic profile.

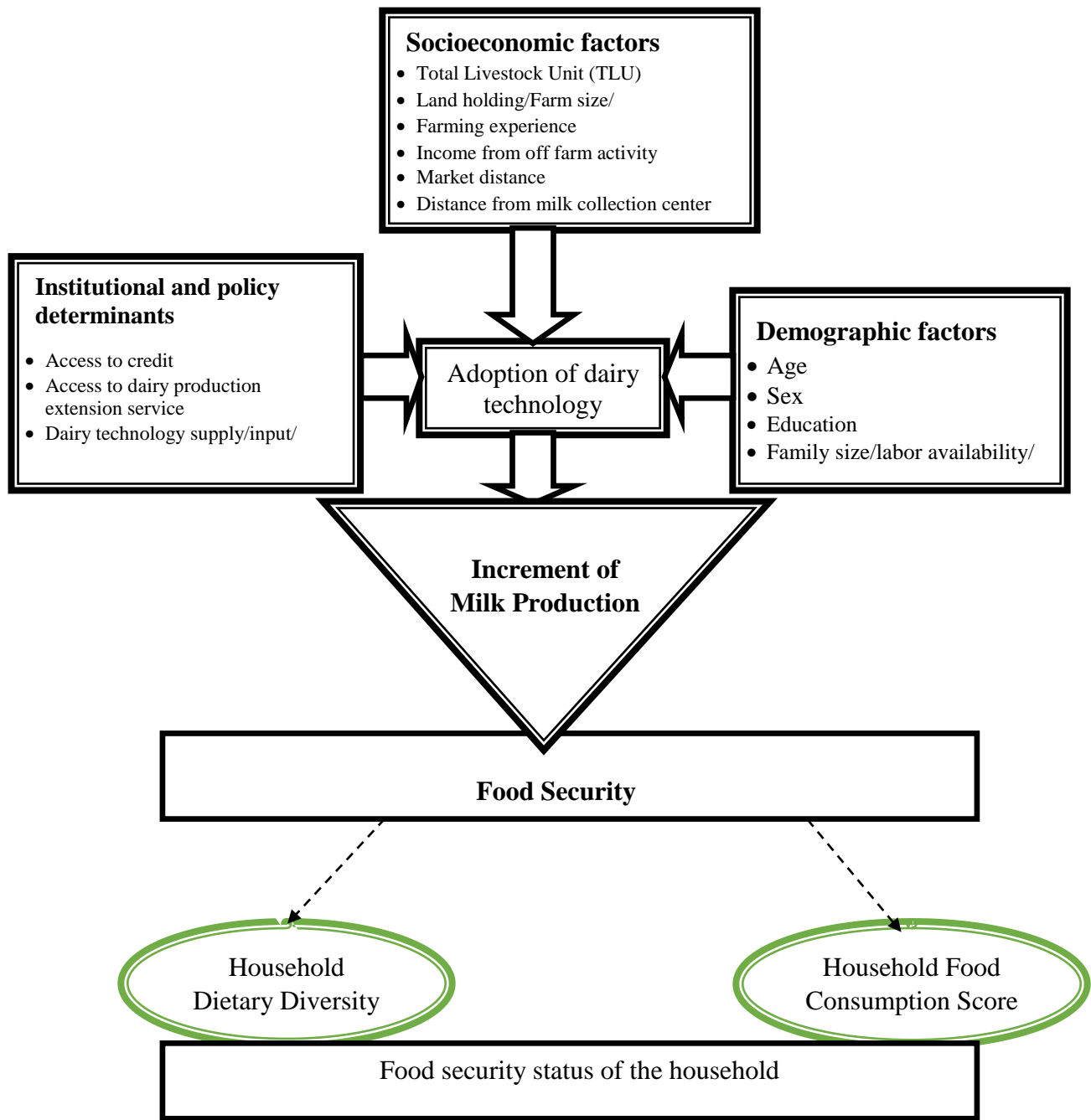


Figure 1 : Conceptual framework of improved dairy technology adoption for dairy production and impact on rural household food security.

(Source: Own construction based on the literature and experience).

# CHAPTER THREE: RESEARCH METHODS AND MATERIALS

## 3.1. Description of the study area

### 3.1.1. Location of Basona Worena *woreda*

This study was carried out in two *kebeles* in the *woreda* Basona Worena. The *woreda* is one of the 10 *woredas* of the North Shewa Zone in Amhara National Regional State. The *woreda* is located in the north at a distance of 130 km from Addis Ababa on the main road to Dessie. It is located between 9°38'00"-09°41'00" North Latitude and 39°30'00"-39°32'00" East longitude (MoA, 2016).

This study was conducted at Angolela and Birbisa as depicted below.

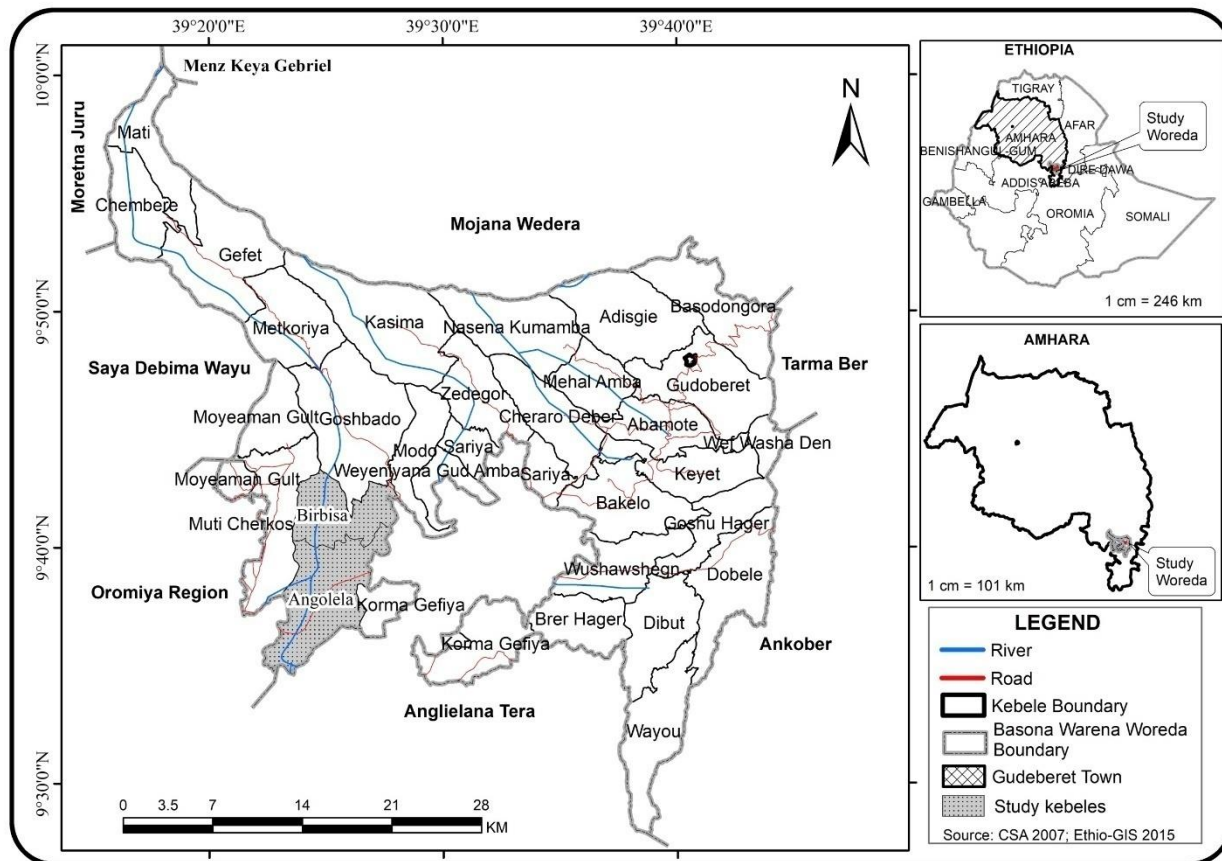


Figure 2: Map of the study area

(Source: CSA 2007, Ethio-GIS 2015)

### **3.1.2. Topography and climate**

The *woreda* has different agro ecological zones that varies from *dega*, *kolla* and *Woyinadega*. In terms of the topography, most parts of the zone are hilly or mountainous, but there are some plains. The soil in most places is black and vertisol, however, there is clay loam in few areas. The area is known for its moderately good productivity and is considered to be self-sufficient in grain. The average elevation of 2750 meter above sea level (m.a.s.l) with an average maximum temperature of 16c° and average minimum temperature of 19c°, the town has got mean annual temperature of 13.3c° (2008 to 2013), with mean annual rainfall of 900-1500mm between 2013-2017 (Amdetsion, 2017).

### **3.1.3. Demographic characteristics and major economic activities**

According to CSA (2017), the total population of the *woreda* is 140,386. The total number of agricultural households is 138,264 of the total rural households, 71,439 are male and 68,947 are female headed. The majority of the rural people generate their livelihood from agriculture and agriculture related activities. The major means of livelihood of the study area are mixed agricultural practices (crop production and livestock rearing). Dairy cows, sheep and goat and in somehow fattening is the main livestock production system in the area. Beside of livestock sector, crop production is also the major agricultural activity in the study area. Growing of cereal crops and pulses such as malt and food barley, wheat, Teff, Faba bean and Field pea are some of the crop production practiced in the area. More than half of the population engaged in agricultural activities based on the data found from *woreda* administrative office.

According to *woreda* agricultural office, crop and livestock production today continue to be the major economic activity in the area. Type of livestock kept by farmers include cattle, mule, donkey, poultry are important species that reared. These are ranked in importance in terms of cash earned from sales. With the exception of land preparation which is done by men, all other agricultural activities are done by both sexes. The source of animal feed is pasture and crop residues. Both livestock and butter, eggs and skins are sold. Common livestock diseases are blackleg, pasteurellosis and sheep oxen. Other important in cash income generating activities particularly for poorer wealth groups are paid work in local agriculture (weeding and harvesting), sale of firewood and work migration this last being rather small-scale and to neighboring areas like Bishofitu, Addis Ababa and Adama for urban and agricultural labor.

### **3.2. Research design**

This research designed for this particular study was cross-sectional survey design that encompasses adopter and non-adopter that means the treatment group (technology user household) and control groups (non-user households) would be analyzed. Based on the objectives of the study, quantitative data was collected and analytic result supplemented by qualitative data in order to make the result sound.

### **3.3. Sampling technique and sample size determination**

Basona Worena *woreda* is one of the 10 *woredas* of North Shewa Zone of Amhara National Regional State. According to the data obtained from the *woreda* administration office, there are 30 rural *kebeles* and one urban center in the *woreda*. The sampling size and sample household selection was done in representative approach. In general, multi-stage sampling procedure was employed in this specific study. In the first stage, the study area was selected from North Shewa region purposively based on its dairy production potential and number of dairy technologies availability and practiced in the area. At the second stage, two *kebeles* were randomly selected from the *woreda* among potential dairy producer *kebeles*. Thirdly, within the two *kebeles*, the respondent households were stratified in to two groups: dairy technology adopters and non-adopters. Within the two strata, the households selected randomly. These sample *kebeles* were Angolela and Birbisa. At the end, simple random sampling was applied to select the sample household farmers. A total of 283 samples were selected and out of which 128 are adopters and 155 non-adopters farm households participated in the process.

The sample of the respondent households was selected representative way of selection with  $\pm 5\%$  precision level and 95% confidence interval. The main reason was to get enough number of matches that enabled to give generation on research objectives. To determine respective samples from two *kebeles* for each stratum, selected by using probability proportional to size of population. Finally, representative sample for each stratum was selected by using probability proportional to size was applied across each category.

$$n = \frac{z^2 pq}{d^2} \text{-----(Kothari's (2004))}$$

Where,

n = The desire sample size;

Z= Standard normal variable at the required level of confidence;

p= The proportion in the target population estimated to have characteristic being measured;

d= The level of tactical significance set

q=1-p

Table 1: Distribution of sample respondent probability proportional to size by KA's.

Kebele's name	Total households in each KA's	Adopter Households		Non-adopter households		Total Sample size
		Total	Sample	Total	Sample	
Angolela	772	300	92	472	112	204
Birbisa	300	111	36	189	43	79
Total	1,072	411	128	661	155	283

Source: Computed based on data obtained from Basona Worena *woreda* administration.

### 3.4. Data types, source and collection techniques

All relevant primary and secondary data source were employed in the study. Where primary data was collected from household survey, direct observation, key informant discussion, structured interview, focusing group discussion. while secondary data were collected from published and unpublished work on dairy technology adoption and food security related materials. Such data included books, journal, research works, articles, statistical report, and official world-wide web sites for literature review and information about the study area.

The research study data were collected by using household survey, FGDs, field observation, and key format interview. To collect the information tools such as guidelines and checklist were applied to guide the household survey.

### **3.4.1. Household survey**

The household survey was collected by using the structured questionnaire. With this technique data related to socioeconomic, institutional, demographic features that listed in the explanatory variables includes the determinant factors that affect adoption decision of dairy technology as well as the impacts of dairy technology on farm household's food security. The questioner was translated in to Amharic for the purpose of simplicity of communication between enumerators and respondent. Data collectors were oriented on issues related to data collection procedures and ethics. Pilot study was undertaken for pre-testing the questionnaire in order to estimate the time needed to complete and implement it. The data collection conducted based on socioeconomic, institutional, demographic features that listed in the explanatory variables includes distributional impacts of dairy technologies among household members, factors that influence the adoption of improved dairy technology as well as the impacts of improved dairy technologies on farm household food security.

### **3.4.2. Focus Group Discussion (FGD)**

Focusing group discussion was carried out with the six individual in each group such as dairy producer households from both group (adopters and non-adopters), and agricultural extensionist in order to collect opinion, qualitative and quantitative description about the dairy production status and the factors that influenced the adoption of technologies as well as the impacts of adoption on household food security. In addition to this, in the focusing group discussion challenges and opportunities regarding to adoption in the study area were administrated. The discussion was carried out by using focus group discussion guide.

### **3.4.3. Key Informant Interview (KII)**

Key informant interview was carried out to collect required primary data that led to discussion with concerned bodies to obtain information about the issue related to the study objectives and description of study area. The key informant of this particular study were Zonal administrative directors, *woreda* level livestock directorate experts and kebele level extension agents. The interview was recorded by using checklist.

### **3.4.4. Observation**

In addition to the above data collection method, the field observation was carried out to validate the information provided through primary and secondary data collection tools. As well as information like socioeconomic condition of the study area was explored by field visit.

### **3.4.5. Secondary data**

With regard to secondary sources, data was collected from review of different documents including research works, books, office documents, journals, articles, report that had been written by different scholars on related issues. Documents from various official websites such as; Ministry of Agriculture, Livestock Resource (MoALR), Ethiopian Institute of Agricultural Research (EIAR), Central Statistical Agency (CSA), National Metrological Agency (NMA) were reviewed.

### **3.5. Ethical consideration**

In the time of data collection, ethical considerations were seriously taken into account to ensure the respondent confidentiality. Similarly, the respondent's identity was not identified during interview and discussion. And also, the researcher did not use any of the respondent's photo and other confidential identities in the time of data analysis and report.

### **3.6. Technique of data analysis**

The data analysis employed both qualitative and quantitative research approach. Various studies have been conducted on the influence of socioeconomic characteristics on the willingness of farmers to adopt dairy technologies. The rural household decision to adopt or reject new technologies is influenced by the combined effects of factors related to different constraints. In this study the hypotheses were "Does adoption of dairy technologies have impact on the smallholder food security or not?" The quantitative data analysis involved descriptive statistics such as mean, standard deviation percentage and frequency distribution. Inferential statistics such as chi-square test (for categorical variables and F-score and/or t-test (for continuous variable) were applied. In addition to this, according to this study it also needed Econometrics Models to do analysis, based on the objective. In this regard, Tobit model, binary logistic regression model and Propensity Score Matching (PSM) econometric model were used for this study. The model helped to describe the relationship between the outcome variable and a set of explanatory variables as well as impacts of dairy technologies on household food security respectively. The relationships of variable and adoption impact were analyzed using "STATA Version 14" software.

### **3.6.1. Analysis of food security**

Food security is supposed to measure the availability, accessibility, consumption and stability of food at the global, national household and individual levels. A state of food insecurity also expressed when the people lack of access to adequate and safe supply of food on stable basis. In other word access to food at all times to enough food nutritionally a good quality for active and healthy life. To assess the food security status, there are a number of measurement tools available of household and it differ based on the scope and purpose of the assessment. Likewise, a combination of tools was used to generate data. In this study, the two food security measurements were applied, i.e., the Food Consumption Score and Dietary Diversity Score.

#### **Food Consumption Score (FCS)**

The Food Consumption Score (FCS), a tool developed by WFP, is commonly used as a proxy indicator for access to food. It is a weighted score based on dietary diversity, food frequency and the nutritional importance of food groups consumed. Data were collected on the number of days in the last 7 days a household ate specific food items. A seven-day recall period is used to make the FCS as precise as possible and reduce recall bias (WFP, 2009)

The FCS of a household is calculated by multiplying the frequency of foods consumed in the last seven days with the weighting of each food group. The weighting of food groups has been determined by WFP according to the nutrition density of the food group. In this case the household food security status was evaluated by collecting household food consumption in the study area. The sum of the scores is then used to determine the FCS. According to WFP, (2009), The maximum FCS has a value of 112 which would be achieved if a household ate each food group every day during the last 7 days. The total scores are then compared to pre-established thresholds:

Poor food consumption 0 to 21

Borderline food consumption 21.5 to 35

Accepted food consumption >35

#### **Household Dietary Diversity Score (HDDS)**

It is a measurement of household food access and availability through measuring the quality and quantity of food to meet all household members nutritional requirement for productive lives. In this case, it helps to provide an approach to measure households dietary diversity. HDDS is

measured by a number of food group consumed over a given reference period. The reference period can vary, but is most often the previous day or week (FAO & WFP 2009).

HDDS reflects a quality diet, the number of different food groups consumed is calculated, rather than the number of different foods consumed. The following set of 12 food group were used to calculate the HDDS; cereals, root and tubers, vegetables, fruit, meat, poultry and offal, egg, fish and seafood, pulses/legume/ nuts, milk and milk products, oil/fat/, sugar/honey/, miscellaneous. Data for HDDS indicator were collected by using the respondent a series of yes or no question. First, the HDDS variable is calculated for each household. The value of this variable will range from 0 to 12.

HDDS value were 12 food group (0-12)

Total number of food groups consumed by members of the household, will be “0” or “1”

$$Sum (A + B + C + D + E + F + G + H + I + J + K + L) \text{ -----} (3)$$

Second, the average HDDS indicator is calculated for the sample population.

$$Avarage(HDDS) = \frac{Sum (HDDS)}{Total\ number\ of\ household} \text{ -----} (3.1)$$

### 3.6.2. Method of data analysis

It was applied for summary of statistics such as, percentage, table of frequency distribution, mean and standard deviations. Inferential statistics such as chi-square and t-test, were used to see the difference between adopter and non-adopter households across dummy and continuous explanatory variables respectively.

### 3.6.3. Statistical model specification

#### Logit Econometric Model

In this study binary logistic regression model was used. The model helped to estimate the relationship between the dependent and independent variables. Binary logit was preferred to others because it gives standard result for discrete choice estimation. In order to identify the factors influencing adoption of improved technology, and to estimate the probability of adoption between the two groups (Gujarati, 2004).

$$\text{Logit}(p_i) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + e_i \quad (3.2)$$

**Where,**

$P_i$  = a dichotomous dependent variable (1 if technology adoption takes place, 0 otherwise)

$p(i)$  = is the  $i^{\text{th}}$  value of dependent variable

$X_i = X$  is the  $i^{\text{th}}$  value of the independent variable

$\beta_i$  = parameters to be estimated

$e_i$  = is “error” variability of the dependent variable not explained by independent variable term

$n$  = is the number of independent variables.

$$\text{Odds} = \frac{p_i}{1-p_i} \quad (3.3)$$

Odds ratio is the way to present the probability of the event. The adoption of dairy technology indicates the probability the household to adopt dairy technology or not.

In order to know the probability of technology adoption for each farm household, the predictable probability was calculated as suggested by Rosenbaum and Rubin (1985); Baker (2000); Walle (2001). According to them, the treatment groups were compared with control groups using Logistic regression.

Similarly, in this study, the marginal effect of explanatory variables was estimated as follows:

1. The dependent variable  $y$  is modeled as follows:

$$y = E(y|X) + \varepsilon \quad (3.4)$$

Where,  $E(y|X)$  is the conditional mean function,  $x$  is the vector explanatory variable and  $\varepsilon$  is the error term.

2. Marginal effect is measured as the instantaneous effect that change in particular explanatory variable has predicted probability of  $y$  when the other covariates kept constant.

$$\frac{\partial E(y|x)}{\partial x} = \left[ \frac{\partial F(\beta'X)}{\partial \beta'X} \right] \beta \quad (3.5)$$

## Tobit econometric model

For this study, the Tobit model was used to analyze factors affecting the adoption and its intensity of use of dairy technologies. The model measures not only the probability that farmers to adopt the new practice but also the intensity of use once they adopted the technologies. Therefore, the application of Tobit model provides the needed information on probability and intensity of adoption of technologies. Thus, it depends on the intensity to use of the technologies (Maddala, 1997).

### Estimation of Tobit model

The econometric model was applied in this study to analyze factor affecting adoption and intensity of adoption of improved dairy technologies. In addition to this the model helped to conduct the adoption decision on whether to adopt and how much to adopt. Therefore, a direct application of the Tobit estimation sufficiently provides the needed information on the probability and intensity of dairy technology adoption.

Tobit model for the continuous variable adoption index

$$AI_i = B_0 + B_i X_i + U_i$$

$$AI_i = AI \text{ if } B_0 + B_i X_i + U_i > 0 \text{ ----- (3.6)}$$

To compute the derivatives of estimated Tobit model to predict the effect of change in explanatory variable. Thus, proposed the following techniques to decompose the effects of explanatory variable in to adoption and intensity effect (Maddala, 1997) & (Johnston and Dinardo, 1997). It affects the conditional mean of AI in the positive part of distribution and it affects the probability that the observation will fall apart of distribution. In this study, the marginal effect of explanatory variables was estimated as follows:

1. The marginal effect of explanatory variable on the expected value of dependent variable is

$$\frac{\partial (AI_i)}{\partial X_i} = F(z) \beta_i \text{ ----- (3.4)}$$

2. The change in the probability of adopting a technology as independent variable  $X_i$  change is

$$\frac{\partial F(z)}{\partial X_i} = F(z) \frac{\beta_i}{\sigma} \text{ ----- (3.5)}$$

3. The change in the intensity of adoption with respect to a change in an explanatory variable among adopters is

$$\frac{\partial E \left( \frac{AI_i}{AI_i} \right)}{\partial X_i} = \beta_i \left[ 1 - Z \frac{f(z)}{F(z)} - \left( \frac{f(z)}{F(z)} \right)^2 \right] \text{----- (3.6)}$$

Where, F(z) is the cumulative normal distribution of Z, f(z) is the value of derivative of the normal curve at a given point and Z is the z-score for the area under normal curve β is a vector of Tobit maximum likelihood estimate and σ is the standard error of the error term.

To check the collinearity of variables, there are two measures that are often suggested to test the existence multicollinearity of the variables. Variance Inflation Factor (VIF) for association among the explanatory variables and the contingency for dummy variables in this study. Variance inflation factor was used to test multicollinearity problem for continuous and dummy variables.

Following (Gujarati 1995; Maddala 1992), VIF is defined as:

$$VIF(X_j) = \left[ \frac{1}{1 - R_j^2} \right] \text{----- (3.7)}$$

X<sub>j</sub> = the jth quantitative explanatory variable regressed on the other quantitative explanatory variables. R<sub>j</sub><sup>2</sup> = the coefficient of determination when the variable X<sub>j</sub> regressed on the remaining explanatory variables. As a rule of thumb, if the VIF of a variable exceeds 10 that variable is said to be highly collinear and it can be concluded that multicollinearity is a problem, if the values around 1, we are in good shape, and can proceed with our regression (Gujarati, 1995).

Adoption is a decision household to accept innovation (Rogers, 1983:176). In this study to measure the bundle of technology; it includes (artificial insemination, feed technology, housing and veterinary service) and it applied adoption index. AI= measure the extent of adoption at the time of the survey. Thus, it showed to what extent the respondent farmer will adopt the whole set of technology package.

In this study, the package of dairy technology components were taken under consideration. Those components are; breed (cross breed), feeding (forage legume, standardize crop, hay supplement), housing (gutter, floor, side wall, roofing), AIS (synchronization, bull service, and

regular insemination services), veterinary service (prevalence diseases or any disease). Accordingly, the adoption index score 0 point implies non-adoption of dairy technological package component and the adoption index score of 1 implies the respondent household adopted all practices according to the recommendation. Therefore, the actual adoption index score ranges from 0 to 1. In this study, adoption index shows the respondent farmers probability of adoption the whole set of technology package calculated using the following formula.

$$AI_i = \sum_{j=1}^{M,N} \left( \frac{\frac{Breed\ Adop\ Score_{ji}}{Breed\ Adop\ Recomm_j} + \frac{Feed\ Adop\ Score_{ji}}{Feed\ Adop\ Recomm_j} + \frac{House\ Adop\ Score_{ji}}{House\ Adop\ Recomm_j} + \frac{AIS\ Adop\ Score_{ji}}{AIS\ Adop\ Recomm_j} + \frac{Vet\ Adop\ Score_{ji}}{Vet\ Adop\ Recomm_j}}{NTP} \right)$$

**Where:**

$AI_i$  = Adoption index of the  $i^{th}$  farmer

$i = 1, 2, 3, 4, 5 - n$ , and  $n$  = total number of respondents

$j = 1, 2, 3, 4, 5 - m$ , and  $m$  = total number of major components of the improved dairy technology

Adop score $_{ji}$  = improved dairy technologies adoption score of  $i^{th}$  farmer

$X_i$  = the maximum potential score for recommended improved dairy technologies components

$X_j$  = the maximum potential score for

$NTP$  = Number of technology component

### **ANOVA (Analysis of Variance)**

The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the means of two or more independent (unrelated) groups (although you tend to only see it used when there are a minimum of three, rather than two groups). In this study the one-way ANOVA was used to do the analysis the significance effect of dairy technologies adoption of each technology component among the adopter group.

### **Propensity Score Matching (PSM)**

It employed Propensity Score Matching (PSM) approaches that select, match, and compare dairy producing households and without improved dairy technologies with similar characteristics. This is used to measure the impact of dairy technology adoption on household food security.

Match treated (adopters) and untreated (non-adopters) observations on the estimated probability of being treated (propensity score). Enables matching not just at the mean but balances the distribution of observed characteristics across treatment and control. It is used to match each

adopter with an identical non-adopter and then measure the average difference in the outcome variable between the adopter and the non-adopter.

### Estimation of propensity score

The first one is concerning the model used for the estimation of variable, and the second is about the variable to be included in the model. In this case application of logit model was appropriate in estimating the logit model. Since this study had binary treatments adopter and non-adopter of improved dairy technologies. The dependent variable was dummy variable (dairy technology adopter in this case). Adopters took a value of one if the households adopt improved dairy technologies and zero otherwise (caliendo and kopeinig, 2008).

$$P_i = \frac{e^{z_i}}{1 + e^{z_i}} \text{-----(3.9)}$$

Where,

P<sub>i</sub> is the probability of adoption of improved dairy technology

$$Z_i = \beta_0 + \sum \beta_i X_i + u_i \text{----- (3.10)}$$

Where, β<sub>0</sub> = intercept, β<sub>0</sub>= Regression coefficient to be estimated, X<sub>i</sub>= Variable, U<sub>i</sub>= Disturbance term

The probability that a household belongs to the non-adopter's group is:

$$1 - P_i = \frac{1}{1 + e^{z_i}} \text{-----(3.11)}$$

The odds ratio can be written as

$$\frac{p_i}{1 - p_i} = \frac{1 + e^{z_i}}{1 + e^{-z_i}} = e^{z_i} \text{-----(3.12)}$$

Therefore, to estimate average impact of dairy technology adoption on household food security

$$E\{Y_1 - Y_0 | D_i = 1\} = E[Y_1 | D = 1] - E[Y_0 | D = 1] \dots \dots \dots (3.13)$$

Where, Y<sub>1</sub> is expected average consumption score of adopter households

Y<sub>0</sub> is expected average consumption score of non-adopter households

Three matching methods were employed under this study. Namely, kernel matching which matches each participant using weighted average over multiple persons in the comparison group. The second one is nearest neighbor matching which match for each treated group find a non-treated group that is closest in terms of propensity score. The last one is radius matching method which match to all controls with a certain radius (Cochran & Rubin, 1973, Smith & Todd, 2005).

**Model specification for matching algorithm**

**Kernel Matching**

The model is applied to pooled data from both treated and untreated subjects an estimated probability of participation for each subject.

$$E y_i^1 - y_i^0 = \int p(x_i) T_i = 1 = \frac{1}{n^1}, \sum_{t=1}^{n^1} [y_i^1(x_i) - w_j(p(x_i)) y_j^0] \dots\dots\dots (3.14)$$

Associate to the outcome  $y_i$  of treated unit  $i$ . the matched outcome given by kernel- weighted average of the outcome of all non-treated units. Where the weight given to non-treated unit  $j$  is in proportional to the closeness between  $i$  and  $j$ .

**Nearest Neighbor model specification**

$C$  is the set of control (non-adopters) unit, denoted by  $C(i)$  the set of control units matched to treated unit  $i$  with an estimated value of the propensity score  $p_i$ . Nearest Neighbor matching set

$$C(i) = \min_j ||p_i - p_j|| \dots\dots\dots (3.15)$$

**Radius matching**

If the control units with estimated propensity scores falling within a radius  $r$  from  $p_i$  are matched to the treated unit  $i$ .

$$C(i) = \{p_j | ||p_i - p_j|| < r\} \dots\dots\dots (3.16)$$

Each treated unit is matched only with the control unit whose propensity score falls into a predefined neighborhood of the propensity score of the treated unit.

**3.7. Definition of variable and working hypothesis**

The data covered the information necessary to make farm level indices of demographic, institutional, socioeconomic factors that influence adoption of improved dairy technology adoption in the study area. In this study, we used a sub-sample of 283 households, which contained household’s dairy and dairy product producers during the production season all over the study area. The variables were continuous and discrete variables in order to finding to answer the research questions of the study, the following variable were identified.

### **3.7.1. Dependent variables**

A bundle of technology of different technological elements such as improved breed, improved forage, artificial insemination (AIS), improved housing and regular veterinary vaccination were provided to smallholder farmers. The household who adopted dairy technology, variables take on the value of one and value of zero for the household that did not adopt. However, cross breed cow adoption took the proxy for this study.

#### **Adoption index (AI):**

It was another dependent variable that employed to see the proportion or extent of improved dairy technologies adoption among adopters' group. The adoption intensity refers adoption index indicating the farmers level of use of package from the recommended improved dairy technologies components (breed, feed, AIS, housing and veterinary service). One farmer at least one improved dairy cow, current level of AIS, current level use of recommended feed practice, current level use of improved dairy housing, current level use regular vaccination activities.

### **3.7.2. Outcome variables**

It represents the probability of the household whether they can be benefited from improved breed technology or not. This can be a continuous variable. The impact of the benefits was examined in household food security by using household food consumption core and dietary diversity. Based on the scope of the study the following hypothesis was made for outcome variable.

**Household food security:** Household food security expressed in acquiring adequate food in both qualitative term in caloric sufficiency and in qualitative terms in variety, safety and culturally acceptable food from crop and livestock products. Food consumption score and household dietary diversity score are the proxy to measure the household food security.

**Food Consumption Score (FCS):** is measured by the household consumption or utilization of particular nutrient rich food groups for the continuous seven days. It assigns a food security score based on food consumption diet. Household food consumption is a continuous variable and it measured as the frequency of food groups consumed over the previous seven days. Through the above explanation, it was expected that adopter households and non-adopter household will have a significant difference in their food security status and dietary diversity. Thus, the hypothesis is that improved dairy technologies adoption have a positive influence on household food security.

**Household Dietary Diversity (HDDS):** which is an indicator to measure household food security status is measured by the household intake of diversified food group over 24-hour recall, it reflects food access and availability. It was expected the adopter household and non-adopter household will have a significant difference in their food security status and dietary diversity diet among households.

### **3.7.3. Independent variables**

The independent variables are variables that stand alone and are not changed by other variable cause change in dependent variables. The independent variable for the study identified based on reviewing the different literature and those are affecting the household decision to adopt dairy technologies and implication on the outcome variable. Based on this, household socioeconomic, institutional, and demographic variables are identified as independent variable. The independent variables are clearly shown in both empirical literature review and conceptual framework. Those variables influenced the household's decision in adopting of dairy technologies and they had impact on production and household food security. The independent variables are;

**Age of the household head (AGEHH):** It is continuous variable and it is measured in number of years. In this study, age of the household head is expected to affect the dairy technology adoption. As the age of the household increase the probability of adoption decreases. Because with the age, a farmer becomes inactive in participation on the technology issue or becoming risk averse for new technologies. Therefore, age of the household head more likely affected dairy technologies positively/ negatively. In addition to this, the household headed be higher aged, the household has more chance to be food insecure (Awoke, et al, 2019).

**Sex of the household head (SEX):** It is a dummy variable; it is maleness and femaleness of the household head. Due to socio-economic activity and engagement, the role of male and female involvement in technology adoption process through different extension program and access to information, male farm headed are expose for information.

**Education level of the household head (EDU):** It is a continuous variable, the year of education in grade maintained by the respondents. Education is very vital to adopt new technology and also education improve the readiness of farmers for acceptance of new technologies. In addition to this it increases the willingness of the farmers to adopt improved dairy technology helps to decide. In this case, household education status was expected to influence the probability of

adoption of improved dairy technologies positively. According to Koffio-Tessio et al. (2005) report, in rural areas, education improves agricultural productivity, leading to food security.

**Farm size/Land holding/ (FAMSIZE):** It is a continuous variable. The farm size measured in hectares, it may be owned land or rented. It was expected that less land will not be willing to adopt the dairy technology since the technology adoption need more land. The hypothesis for this relationship between the size of land held by the household and dairy technology adoption was direct. Therefore, the farm size initiated to adopt improved dairy technologies.

**Family size (FAMSIZE):** It is a continuous variable. Those farmers who have access to labor are expected to adopt new idea than who lack of labor. As active labor accessibility increase, it also will have a positive influence on the adoption of improved dairy technology. This hypothesis was similar to the study conducted in Uganda by Bukusuba et al. (2007). The study reveled that large household has a potential of obtaining sufficient labor which is capable of producing more food and becomes food secure.

**Income from off-farm activity of households (OFFFARM):** It is a dummy variable that will take the value one if the household engaged in of off-farm activities and zero otherwise. Most of farmers who has an access to off-farm employment had a positive effect to adopt dairy technologies and also, another source of income that used for technology expenditure like hay and crossbreed heifers. Due to this, a number of household members that involve in off-farm activities, expected to have more chance to get more income. According to Amha (2004) study, off-farm income opportunities is important means of securing food security. In this regard, participating in income generating activities influencing household food security status.

**Farming experience of the household head (EXPDAIRY):** It is a continuous variable and expressed in years that the farmer experienced. It may expect it has a direct relationship between the farming experience and dairy technology adoption as well as, willingness to adopt a dairy technology since they have experience in dairy production.

**Market distance (MARKDIS):** It is the location of farm household from the market to buy dairy input and sale of the product. It is a continuous variable and measured by kilometers. Distance from market center was expected to affect the adoption of dairy technologies while household located near to market tend to access inputs and they can easy access to sale their

dairy products. Better access to market information and facilities, expected to improve return to labor and capital, increase farm gate price and incentive to participate in dairy technology adoption.

**Membership of milk collection center (MEMILK):** It is a dummy variable which takes the value one if a farmer is a member of milk collection center and zero otherwise. This determine the farm households in terms of access and utilization of different dairy technologies. due to this, farmer who is a member of milk collection center has more chance to get credit and farm input and improve their livelihood and food security.

**Access to dairy technology input (INPTACSS):** The availability of input for dairy technologies is very important in dairy cows raring. Inputs such as cross breed cow, artificial insemination and bull service are very crucial for who those engaged in the activities. However, the input may not be available in the nearby local market. The availability and accessibility of input in the market, significantly influence the adoption of the household and it measured as a dummy variable as if the household that have input access or not. Consequently, input access was expected to have a positive influence on the adoption of dairy technology. And also, this will have a positive relation with adoption of dairy technologies.

**Access to credit (CREDIT):** It measured as a dummy variable, taking a value 0 if not have access and 1 otherwise, if the household get access to credit or not access to credit. The variable were expected to influence the dairy technology adoption because of high investment cost which the household may not afford easily. Credit institution helps to cover the household financial expenditure for dairy technology adoption. A study carried out by Pappoe (2011), found that access to credit improves the food security status of farming households among biofuel producers in the central region of Ghana.

**Extension contact (EXT):** It refers to a contact between extension agent and the farmers. If the farmers contact extensionist frequently, they will be more expose to get access information and they more likely are to be influenced in using the technology and create farmers awareness about new technologies. In this regard it was expected to affect dairy technology adoption by extension service frequent contact. The household head that have frequent contact with extension service may exposed to for technology adoption than who has no contact. The variable measured in continuous value of the household contact to dairy production extension service. Therefore, the

farmer who had frequent contact to extension service was expected to increase the adoption of improved dairy production technology and influence positively.

**Total Livestock Unit (TLU):** Households that have large number of livestock are likely to adopt more innovations than who have a smaller number of livestock. The farmer with a greater number of livestock's have better opportunity to get credit. It is a continuous variable and measured in Tropical Livestock Unit and it was expected that livestock ownership and adoption had positive relation. Therefore, it was expected that a number of live stocks owned had positive influence on the adoption of dairy technologies.

Table 2: Explanatory variable description and its expected sign.

Explanatory variables	Nature of variable	Unit of Measurements	Expected sign
Age of the household head	Continuous	Years	-/+ve
Sex of the household head	Dummy	1 for male and 0 for female	-ve
Educational level of the household head	Continuous	Year of education	+ve
Farm size/land holding/	Continuous	Hectare	+ve
Labor availability/ family size/	Continuous	Number	+ve
Income from off-farm activities	Dummy	Yes or No	+ve
Farming experience	Continuous	Years	+ve
Market distance	Continuous	Kilometers	-ve
Membership of milk collection center	Dummy	Yes or No	+ve
Input access	Dummy	Yes or No	+ve
Access to credit	Continuous	Amount in Birr	+ve
Extension contact	Continuous	Number	+ve
TLU	Continuous	TLU	+ve

# CHAPTER FOUR: RESULTS AND DISCUSSIONS

## Introduction

This chapter presents the main results and discussions of the study. It divided into four sub-sections. The first sub-section describes the socioeconomic and demographic characteristics of the sample respondent household with respect to identified explanatory variables. The second sub-section present the household food security status in terms of food consumption score and dietary diversity of the two group and the constraints of non-adopter household. The third and fourth sub-section describes current level of adoption and intensity of adoption of dairy technologies, factors that influencing adoption of dairy technologies, and Propensity Score Matching (PSM) model for identification of dairy technologies adoption and its impact on household food security. In case of propensity score, estimation of propensity score, common support region, matching algorithms, balancing test, and average treatment effect on treated results (ATT) included. The final section presents the result of Focus Group Discussion (FGD) and Key Informant (KII) Interview.

### 4.1. Demographic and socioeconomic characteristics of respondents

This sub-section has described the household characteristics that explain the information on demographic, and socio-economic characteristics such as age of the household, sex of the household, educational level, family size, farm land size, income from off-farm activities, access to credit, market distance, extension contact, tropical livestock unit, farmer's participation on milk collection center, input access and dairy experience which is assumed that ether positive or negative influence of adoption decision of dairy technology adoption.

As indicated in the Table 3, the mean age of the adopters is 43.74 while, it is 46.12 years for non-adopters. The mean age of the adopters is less than the mean age of the non-adopters in technology adoption. Thus, the mean variation was found to be statistically significant with (p=0.0592) value, this suggest that there is significant difference on the mean age of the household head in the two groups at (p<0.1) level of significant. This suggest that young peoples tend to be more adopters of new technologies than the old aged people.

Table 3: Demographic and socioeconomic characteristics for continuous variables

Name of the variables	Adopters (N=128)	Non-adopters (N=155)	Total Mean	T-value	P-value
	Mean value	Mean value			
Age (year)	43.74 (9.37)	46.12 (11.38)	45.04 (10.56)	1.8944	0.0592*
Education (grade)	1.22 (0.79)	0.79 (0.74)	0.98 (0.79)	-4.7197	0.0000***
Farm size (hectare)	1.98 (0.96)	2.02 (0.91)	2.00 (0.93)	0.3350	0.7379
Number of family engaged in dairy (number)	3.71 (1.80)	3.29 (1.57)	3.48 (1.69)	-2.0595	0.0404 **
TLU (number)	7.51 (2.92)	6.71 (2.54)	7.06 (2.73)	-2.3898	0.0176 **
Market distance (walking distance in minutes)	112.96 (38.74)	125.58 (36.11)	119.87 (37.78)	2.8304	0.0050 ***
Extension contact (number)	2.60 (1.48)	1.44 (1.32)	1.96 (1.50)	-4.9987	0.000***
Dairy experience (year)	17.25 (8.28)	18.21 (8.84)	17.78 (8.59)	0.9367	0.3497
Credit (Birr)	1122.65 (3717.23)	860.64 (2598.31)	979.15 (3150.68)	-0.6957	0.48

**Note:** \*\*\*, \*\*, \*, show significance at  $p < 0.01$ ,  $p < 0.05$ , and  $p < 0.1$  respectively

( ): means standard deviation

Source: Computed from own survey (2019)

The results further revealed that the year of education of the adopters is 1.22 while the figure is 0.79 for the non-adopter households, respectively. In addition, the mean difference was found to be statistically significant with p-value of (0.0000). The calculated probability implies that there is significant mean difference in education status of the adopter and non-adopter households at ( $p < 0.01$ ) significant level. This result shows that as the number of family member who engaged in diary activity increases, the tendency of using dairy technology increases.

The result of the family member who engaged in diary activity result indicated that, there is a significant mean difference between two group. The mean value for adopters and non-adopter found to be 3.71 and 3.29 respectively. Besides, the difference is statistically significant with ( $p=0.0404$ ) level of significant. This implies that the mean difference was found to be statistically significant at ( $p<0.05$ ). This result asserts that as the number of family members engaged in diary activity increases, the tendency of using dairy technology increases.

On the other hand, the effect of livestock ownership was found have a significant effect on adoption of improved dairy technology. The average livestock ownership for adopters and non-adopters was found to be 7.51 and 6.71, respectively. The p-value implies that there is a significant mean difference between two groups at ( $p<0.05$ ) significant level. Accordingly, the adopter household has more livestock owners than non-adopters. This can be the large household with large number of livestock's holding tends to adopt dairy technologies. This finding is conformity with the work of Birhanu, (2002).

The mean treated time market distance of adopter are 112.96 and 125.58 non-adopters were walking distance in minutes, respectively. The calculated probability implies that there is significant mean difference between the market distance of adopter and non-adopter households at ( $p<0.01$ ) level of significant. This result indicated that the household with the nearest distance was more likely to access dairy technologies input than the long-distance households.

Similarly, the average mean of extensions contact of the adopters was 2.60 while the difference for non-adopter respondent was 1.44, and there is a significant difference between two at ( $p<0.01$ ) of significance level. The result is in harmony with (Quddus, 2012) finding, extension contact develop the household knowledge and perception with regard to dairy production technologies and improve their practice and also the household who has contact more with kebele extension agent know more about the use of the service those who cannot access (Berihun, *et al.*, (2014).

Land ownership, and dairy experience and credit amount of the household has found to be statistically insignificant in determining the adoption decision of the households. The mean value of the land holding was found to be 1.98 and 2.02 for adopters and non-adopter household respectively. The average experience of dairy farming of the adopter and non-adopter

smallholder's farmer head is 17.25 and 18.21. In line with this, the mean amount of credit taken by adopters is 1122.65 and 860.64 for adopter and non-adopters.

Table 4: Demographic and socioeconomic characteristics for dummy variables

Name of the variables	Category	Adopters (N=128)		Non-adopters (N=155)		Total Value		Chi <sup>2</sup> -value (probability)
		Count	%	Count	%	Count	%	
Sex	Male	109	85.16	140	90.32	249	87.99	0.183
	Female	19	14.84	15	9.68	34	12.01	
Income from off-farm activities	Yes	120	93.75	152	98.06	272	96.11	0.062*
	No	8	6.25	3	1.94	11	3.89	
Access to input	Yes	124	96.88	21	13.55	145	51.24	0.000***
	No	4	3.13	134	86.45	138	48.76	
Membership of milk collection center	Yes	102	79.69	28	18.06	130	45.94	0.000***
	No	26	20.31	127	81.94	153	54.06	

**Note:** \*\*\*, \*, show significance at  $p < 0.01$ , and  $p < 0.1$  respectively

Source: Computed from own survey (2019)

Among the dummy variables, sex of the household head has no mean difference between adopters and non-adopters. The sex distribution of sample households, from the total sample household, 87.99% of them were male and 12.01% of them were female headed. With regard to the sample respondents improved dairy technology adoption status 85.16% of improved dairy technology practitioners were male household head while the rest 14.84 % was female. From the non-adopter's household side, around 90.32% and 9.68% of the total respondents were male and female respectively.

Similarly, adopter's participation in off-farm activities was found to be 93.75% and 6.25% of the households not engaged in off-farm activities. While from non-adopters 98.06% are engaged in the off-farm activities and 1.94% are not part of it. The chi-square result indicated that there is a variation between adopters and no-adopters at ( $p < 0.1$ ) significant level with ( $\chi^2 = 0.062$ ). This

result might be the household engaged in other off-farm activities increase the household decision of dairy technologies.

Regarding to input access of the respondent households, 51.24% of adopter's households responded availability of input supply for their dairy production while the rest 48.76% didn't. It means that, around 3.13% of adopters group and 86.45% of non-adopters respond that there was no access to technology input supply. In the reverse, 96.88% of adopters and 13.55% non-adopter group was access to dairy input supply. Based on this, the chi-square test result revealed that there is statistically significant association between adopters and non-adopters in input availability and adoption of dairy technologies at ( $p < 0.01$ ) level of significant. This could be the availability of dairy input nearby market is crucial to facilitate the adoption of new or existing technologies.

Similarly, participation of farmers in milk collection center could possibly increase the adoption of dairy technologies. Regarding to this, 79.69% of adopter's households were members of milk collection centers while 20.31% did not part of it. Likewise, about 18.06% of the non-adopters found to be participate in milk collection center and 81.94% was not. Based on this, the chi2 test shows that, there was statistical significance difference between dairy technology adopters and non-adopter households on the participation of milk collection center at ( $p < 0.01$ ) level of significant. Milk collection centers provide dairy technologies like breed and AI, such benefits might to be increases the probability of farmers for adoption. This finding is conformity with focus group discussion.

## **4.2. Milk production status of the respondents**

The average milk productivity of sampled respondent of cross breed and local cow was assessed and the result is indicated in Table 5. The maximum milk yield of sample respondent from local cow was 10 liter/cow/day with 4.31 average yield. But, the maximum milk yield of the household from improved cow was 19 liter/cow/day with 2.93 average yield.

Table 5: Milk production status of the respondent

Milk yield	Mean	Std. Dev.	Maximum	Minimum
Amount from imp (cross breed)	4.310954	5.193639	19	0
Amount from local cow	2.931095	2.445075	10	0

#### 4.2.1. Food Consumption Score (FCS) of the respondents

In practice, food security correlates with food frequency and dietary diversity proxy indicators with regard to access and availability of sufficient quality food (Hoddinott & Yohannes, 2002). Food security as developed by the WFP covered food frequency and dietary diversity in the food consumption analysis. FCS analysis examine the household consumption through using Food Frequency questionnaires and a given food group weight (WFP, 2016). Therefore, applying food consumption score is used to assess food security of the household. The highest weight was attached to the household with food relatively high energy, good quality protein, and micronutrient.

Food consumption score data obtained from food consumption score analysis of the households and categorized in to three food consumption groups (FCG) to determine the food security level of the households. FCS categorized in to (1) “poor” if the household food consumption group falls below 21; (2) “borderline” if the household food consumption group ranges from 21 to 35, and (3) “acceptable” if the FCG is above 35. Based on the FCG, the FS level was divided into two groups: (1) “food insecure” if the FCG is categorized in the borderline or poor groups and (2) “food secure” if the FCG is categorized in the acceptable group (WFP, 2016).

The result indicated that, from the total sampled household, 21.20% of the household food consumption found to be acceptable, for 53% of the household frequency of food group consumption lies in the borderline food consumption categories and the rest of 25.80% of the households are in the poor consumption condition.

Table 6: Food security status of respondents on dairy technology (Using FCS).

Food Consumption Score (FCS)	Adopters (N=128)	Non-adopters (N=155)	Total	Mean of Adopters FCS	Mean of non-adopters FCS	P-value
Acceptable	39 (30.47)	21 (13.55)	60 (21.20)			
Borderline	76 (59.38)	74 (47.74)	150 (53.00)			
Poor	13 (10.16)	60 (38.71)	73 (25.80)			
Total	128 (100)	155 (100)	283 (100.00)	34.05	27.56	0.0000***

( ): Shows percentage

\*\*\* Show significance at  $p < 0.01$

Source: Own computation (2019)

In the other hand, the relationship between food security status and technology adoption of the household result confirmed that from adopter categories the result was found to be 39 (30.47%), 76 (59.38%) and 13 (10.16%) in acceptable, borderline and poor food consumption score respectively. For those households which is not adopt dairy technologies about 21 (13.55%) households are found at acceptable condition and 74 (47.74%) and 60 (38.71%) of the households were borderline and poor consumption condition respectively. Accordingly, the mean food consumption score of the adopter households was 27.56 and 34.05 of non-adopters. The mean variation between the two group was found to be statistically significant at ( $p < 0.01$ ).

#### 4.2.2. Household Dietary Diversity Score (HDDS) of the respondent

As it is depicted in Table 7, food group were consumed by local population in varying percentages. From the total sample respondent 100% of the consumed cereal products like bread and Injera made of Teff, wheat and barley as it was the main staple food in the study area. About 44% and 46% for adopter households and 50% and 49% of non-adopter households consume root crop and vegetable respectively. On the other hand, about 46% and 45% for adopters and 42% and 40% of non-adopters consumed fruit and meat food group respectively.

Table 7: Household dietary diversity of different food groups among adopters and non-adopters

Food group	Adopter (N=128)	Non- adopter (N=155)	T-value	P-value
	Mean value	Mean value		
Cereal or staple food	283 (100.00)	283 (100.00)		
Tubers, roots, yams, cassava	0.72 (0.44)	0.52 (0.50)	-3.4642	0.0006***
Any vegetable	0.68 (0.46)	0.54 (0.49)	-2.4055	0.0168**
Any fruit	0.32 (0.46)	0.23 (0.42)	-1.5301	0.1271
Meat, Poultry and meat- made food	0.29 (0.45)	0.2 (0.40)	-1.8943	0.0592*
Any eggs	0.14 (0.34)	0.09 (0.29)	-1.1426	0.2542
Fish or dried fish	0	0		
Beans, pulses, lentil	0.92 (0.25)	0.87 (0.32)	-1.4661	0.1437
Milk and milk products (cheese, yogurt, butter)	0.67 (0.46)	0.45 (0.49)	-3.8189	0.0002***
Fat, oil	0.91 (0.28)	0.92 (0.26)	0.2601	0.7950
Sugar, honey	0.57 (0.49)	0.41 (0.49)	-2.7959	0.0055***
Coffee, tea, condiments	0.98 (0.12)	0.935 (0.24)	-2.0392	0.0424**

\*\*\*, \*\*, \*, show significance at  $p < 0.01$ ,  $p < 0.05$ , and  $p < 0.1$  respectively

( ): shows percentage

Source: Own computation (2019)

Similarly, the result found from egg and fish food group 11.7% and 0.0% respectively. Low consumption appeared in the egg and fish group. Whereas, 90.1% and 55.8% of the consumption of the household fall in the pulses and milk, milk product respectively. Table 7 result shows that, about 91.9% of the household consumed fat and oil and 48.8% and 95.8% of the sample household food distribution were sugar and condiment food groups respectively.

Further, the mean difference between two group in tuber and root crop, milk and milk product and sugar consumption found to be a significant mean difference between the two group. Thus, the mean variation was found to be statistically significant at ( $p < 0.01$ ) significant level. The adopter's consumption of this food group is greater than the non-adopters with p- value (0.0006),

(0.0002) and (0.0055) for root crop, milk and milk product and sugar and honey respectively. This suggest that the adopter's household are tend to be more take diversified food than the non-adopters.

In other hand, the mean consumption of vegetable food group of the adopters are 0.68 while 0.54 for non-adopters. In the same result, coffee and tea food group of the adopter households mean consumption found to be 0.98 and 0.935 respectively. This implies that the difference is statistically significant at ( $p < 0.05$ ), for vegetable and ( $p < 0.05$ ) for coffee and tea food group. Accordingly, the result entails that adopter's consumption habit of vegetable and coffee is better than the non-adopters. In addition to this the household consumption of meat found to be significant effect on the household food security in terms of dietary diversity score. The mean consumption of adopters and non-adopters was found to be 0.29 and 0.2 respectively. The p-value implies that there is significant mean difference between two groups, at ( $p < 0.1$ ) significant level.

Food from pulse, fat and oil consumption of the households has found to be statistically insignificant to determine the household's intake of dietary diversity food. The mean value of the pulse food group was found to be 0.92 and 0.87 for adopters and non-adopter households respectively. Similarly, for fat and oil consumption of the adopter and non-adopter households is 0.91 and 0.92 respectively. The result revealed that, there is no significant mean difference between two group in mentioned above food group.

#### **4.2.3. Reason for not adopt dairy technologies**

Table 8 indicated that, some of the constraints were statistically rated during the data analysis. These results were indicated that 45.16% of the respondent households mentioned that factors include cost of technologies, lack of capital and occurrence of disease whereas, 30.97% respondents include both cost and unavailability of the technologies. According to them the service is far from their houses/ village/ this is one of the main constraints raised by them and also the lack of dairy input supply (AI, breed and feed) and their cost makes hamper the households not to adopt the technologies. Furthermore, 3.23% and 2.58% the household responds lack of detail awareness on the technologies, nutritious food intake and food security. The rest of the household were no interested to adopt the technologies respectively.

Table 8: Reason for not adopt dairy technologies

Constraints /reasons/	Count	%
Not aware	5	3.23
Unavailability of technologies	28	18.06
Cost of technologies	70	45.16
Not interested	4	2.58
Unavailable and cost	48	30.97
Total	155	100.00

Source: Computed from own survey (2019)

### 4.3. Statistical analyses

#### 4.3.1. Model diagnosis test results

This study conducted all the necessary model diagnosis test include model specification test for the overall model fit (goodness of fit), multicollinearity problem and test for model specification error test. In this regard, model test carried out before running the logistic regression while model specification error test (linktest) were carried out after running the regression.

The explanatory variables were checked for existence of multicollinearity or association between the dependent variables to identify the determinant factors that affecting adoption of dairy technologies. Multicollinearity was tested using variance inflation factor (VIF). Accordingly, the result revealed that there is no problem of multicollinearity observed because the tolerance greater than 10% among explanatory variable. The result is indicated in Table 9 below.

Table 9: Test estimation

Tests	Test name	Factors of Adoption
estat gof	Pearson>chi2	0.9920
linktest	_hat	0.019
	_hatsq	0.135
VIF	Multicollinearity	1.34

The model fitness test of the logistic equations justified the fact that the models are enough to explain the dependent variables. This evidenced by the fact that the Pseudo R<sup>2</sup> statistics of the

model is 0.9920 which lies between 0 and 1. The result confirmed that the explanatory variables (independent variables) of the model could explain the dependent variable and well fitted (see appendix 3).

The link test identified the model specification error occur when the relevant variables are omitted from the model or one or more irrelevant variables are included in the model. The null hypothesis shows there is no model specification error. In this specific study the p-value of  $\chi^2$  shows is not significant then we fail to reject the null hypothesis and conclude the model is correctly specified. In this regard, for the linkage between technology adoption and factor affecting the decision of households to adopt dairy technologies the p-value is 0.135 (see appendix 2). The p-value implies it is not significant so we fail to reject the null hypothesis and conclude that there is no model specification error.

#### **4.3.2. Determinants of dairy technology adoption**

##### **Factors affecting decision of dairy technology adoption**

The logistic regression model estimation result shows that out of the thirteen factors that determine the dairy technology adoption, six variables were found to have a significant effect on the probability of adoption decision of the farm households. These variables are age of the household head, frequency of extension contact, engaging off-farm activities, input access and membership of milk collection center. Five of the variables were statistically significant at  $p < 0.01$ ,  $p < 0.01$ ,  $p < 0.01$ ,  $p < 0.01$ , and  $p < 0.01$  respectively.

The marginal effect reveals that age of the household head found to be negative and significant relationship between adoption of dairy technology at ( $p < 0.01$ ) level of significant with ( $p = 0.003$ ). Accordingly, as the age of the household head increase by one year, decreases the probability of dairy technology adoption of the household by 1.4%. This may be because of the age of farmer increase, the use of the farmer become inactive for new technologies Beyene *et al.* (2010). This result is also in conformity with the finding of Quddus (2013).

Table 10: Logistic regression for dairy technology adoption

Variables	Odds Ratio	Marginal		Z	P-value
		effect dy/dx	Std. Err.		
AGEHH	.9080646	-.0141965	.0295096	-2.97	0.003***
SEX	1.793243	.0743972	1.549452	0.68	0.499
EDU	.8820844	-.0184696	.3252846	-0.34	0.734
DARIYACT	1.063897	.0091178	.1803954	0.37	0.715
FRMSIZE	1.161827	.02208	.3669405	0.47	0.635
MARKDIS	.9930626	-.0010248	.0083864	-0.82	0.410
EXTFRQ	2.466673	.1329082	.5114695	4.35	0.000***
OFFFARM	14.3842	.575359	14.22335	2.70	0.007***
CREDIT	.9999785	-3.16e-06	.0000808	-0.27	0.791
MILCCOLL	92.99848	.6938408	91.32632	4.62	0.000***
INPUTACCES	262.2152	.7760813	262.7866	5.56	0.000***
TLU	1.13569	.0187305	.1677347	0.86	0.389
EXPDAIRY	1.0431	.0062116	.0520273	0.85	0.398
_cons	.0042061		.0096721	-2.38	0.017

(\*)  $dy/dx$  is for discrete change of dummy variable from 0 to 1

$y = Pr(\text{Adop usage}) (\text{predict}) = .17938539$

**Note:** \*\*\*, show significance at  $p < 0.01$

Source: Computed from own survey (2019)

This result implies access to extension contact found to be positive and significant effect on the adoption decision of dairy technologies at ( $p < 0.01$ ) significant level. Regarding to the frequency of extension agent contact increases, the probability of dairy technology adoption increases by 13.2%. The result suggested that access to extension contact and frequency of visit with developmental agent increases the likelihood of farm household for adoption of improved dairy technologies. The result of this study is in consistency with the finding of Muhammad *et al.* (2011), more access of extension contact with developmental agent helps rural households to understand about the use of dairy technologies and make a decision on whether or not to adopt the technologies.

Engaged in off-farm activities significantly and positively influence the probability of the household's in adoption decision of dairy technology with p-value of (0.001). The odds ratio increases by 14.38 indicate that the probability of adoption and intensity to use of the improved dairy technologies increases by 57.5%. As hypothesized, of source of additional income from off-farm activities increases the purchasing power of the household's different dairy technologies and farm input such as breed, feed and AI which helped to increase production and productivity. This result harmony with the work of (Ahmed *et al*, 2008).

Similarly, being member of milk collection center resulted in an increases the likelihood of the household in the adoption of dairy technology. Milk collection participant households differ in adoption of dairy technologies by 69.3% with non-adopters. Thus, the implication of the result could be participation in milk collection center have a positive effect in the adopter households because it provides dairy input and benefited from selling of the milk products while the non-adopters were in the reverse. Hence, it might be contributed on increments of dairy production.

The higher effect was accounted to input access of the household in the dairy technologies. The marginal effect result shows that access to input for dairy production found to be positive and higher marginal effect on adoption difference between participants and non- participant households. Access to input positively influences the probability of the households in the decision of dairy technologies with the p-value of (0.000). This implies that access to input increase by one unit, the probability of adoption increases by 77.6%. The possible reason for that confirmed by focus group discussion, the household who has access to input for their dairy production are more involved to the adoption process of the technology.

### **4.3.3. Level of dairy technology adoption among adopters' groups**

#### **Adoption of breed component**

Breed technology adoption is one of the major components that used to differentiate the adopters and non-adopter households. Cross breed cow selected because of the major implication for household food security (Mekuria *et al.*, 2017). The recommended level was used as to identify status of adoption. In this regard, the status of dairy technology practice was the household who use each technology practice (AI, feed, housing, vet). In breed technology component, there is no significant difference between adopters' household and also in the adoption index (low, medium, high) categories since, every adopter has at least one cross breed cow which is recommended

technology component. Therefore, the adoption index score value for all breed component is 1 and 0 for non-adopter households. Thus, cross breed heifers were the major breed type that distributed in the study area from different sources, Holstein Frisian was the main types. The current status of dairy breed technology adoption was assessed among adopter's household. The adoption of cross breed were (128) 45.23% from the two kebeles whereas the non-adopters were (155) 54.77%.

Table 11: Current level of adoption of breed technology components (N=283) (n=128)

Dairy technology adoption status of the HH	Count	%
Adopters	128	45.23
Non adopters	155	54.77
Total	283	100.00

Source: Computed from own survey (2019)

### **Adoption of AIS component**

The use of AI and knowledge of genetic improvement and cross breeding on smallholder farmer has led to increase milk production Luthiet, *et al.*, (2006) and Suzuki (2005). In the adoption process artificial insemination service is a crucial input for rural households. Adoption of AIS technology component are positively and significant relation with adoption of improved breed and allover dairy technologies adoption. Table 12 indicates, AIS were positive and strong influence on adoption of dairy breed. the mean value of adoption of AIS were 67.12 mean value with 5.63 of standard deviation. The result indicated that there is significant mean variation (F=28.46, P< 0.0000) Accordingly, the mean value for low 11 (8.59 %), 97 (75.78 %), 20 (15.62 %) of the low, medium, and high adoption distribution of AIS among adopter categories respectively. The result indicated that the majority of AIS adopters group lies on the medium adoption level. Further study confirmed that the use of AI improved the milk production and productivity of rural households (Quddus, 2012).

Table 12: Level of Artificial Insemination (AI) technology adoption of respondents

Adoption categories	Adoption Index	Number of farmers	%	Mean	Std. Dev.	F	Prob>F
No	0	0	0				
Low	> 0 to < 35	11	8.59				
Medium	36 to < 70	97	75.78				
High	70 and above	20	15.62				
Total		128	100	67.12	5.63	28.46***	0.0000

Source: Computed from own survey (2019)

\*\*\* show significance at  $p < 0.01$

### Adoption of feed components

Feeding technologies are one of the important components in dairy production. Main feed source for local breeds were grazing of the pasture land and crop residue. The major recommended feeding for dairy producer farmers includes such as feeding of crop legume, standardize crop and hay supplement were assessed. In this regard, the feeding technologies adoption of the farmers computed for all adopters' categories. Accordingly, the adoption index result indicated that there is significant difference in the use of this recommended feed component among adopters' categories. The average mean value of feeding technologies was 67.12 with standard division 5.63. the finding of this study indicated that there is significant difference ( $F=29.68$ ,  $P < 0.0000$ ) among adoption categories at 1% probability significant level.

The study finding shows that the proportion of the respondent for adoption of recommended feed were 110 (85.94%) of the adopters lies on the medium adoption status 18 (14.06 %) were high feeding of improved dairy cows. According to the finding, the adoption of feed technology of the respondent rate was medium when compared to the recommended rate. This could be the lack of supply of industrial by product and the high price of the improved feed. In addition to this may be the inadequate practice of concentrate mixed feeds and recommended ration feed with insufficient feed quality. An improvement of feeding system is an important prerequisite for increased profitability of dairy production (Negash, 2018).

Table 13: Level of dairy feed technology adoption of respondents

Adoption categories	Adoption Index	Number of farmers	%	Mean	Std. Dev.	F	Prob>F
No	0	0	0				
Low	> 0 to < 35	0	0				
Medium	36 to < 70	110	85.94				
High	70 and above	18	14.06				
Total		128	100	67.12	5.63	29.68***	0.0000

Source: Computed from own survey (2019)

\*\*\* show significance at  $p < 0.01$

### Adoption of housing components

Housing of dairy cows consists of improved housing condition such as adoption of trough, gutter, floor, wall and roofing of the farm households. For this technological component, the adopters categorized based on a given adoption index (0, 0.35, 0.7 and above). The score of the housing condition of the respondents were computed based on the data obtained for specific component, the result of housing recommended technology adoption of each categories indicated that, there is a significant mean difference among the adopter categories. The average mean value of housing technological was 67.12 with standard deviation 5.63. the finding of this study indicated that there is significant variation ( $F=15.67$ ,  $P < 0.0000$ ) between adopter categories at 1% significant level. This finding is in line with results of previous studies that showed factor affecting of dairy technology adoption (fentaw, 2017).

Table 14: Adoption level of housing condition technological components of respondents

Adoption categories	Adoption Index	Number of farmers	%	Mean	Std. Dev.	F	Prob>F
No	0	0	0				
Low	> 0 to < 35	15	11.72				
Medium	36 to < 70	93	72.66				
High	70 and above	20	15.62				
Total		128	100	67.12	5.63	15.67***	0.0000

Source: Computed from own survey (2019)

\*\*\* show significance at  $p < 0.01$

### Adoption of veterinary service components

Regular veterinary service practice is another dairy technology component which determine the production and productivity of households. In this study veterinary service component were includes regular vaccination against the prevention measure before occurrence of different bacterial and viral disease and also include the treatment after the occurrence of the diseases. In line with this the adoption score of the veterinary technologies was computed by the value of responses across the adoption categories. The result of adoption index indicated in Table 15, there is a significant mean difference among adopters' categories.

The mean value of adoption of veterinary service practices was 67.12 with standard deviation 5.63 Accordingly, the result indicated that there is significant mean variation ( $F=17.65$ ,  $P<0.0000$ ) between adopter categories at 1% probability level. the proportion of adopter categories in the adoption of veterinary service revealed that vaccination against prevalence disease were 15 (11.72 %) low, 91 (71.09 %) medium, and 22 (17.19 %) high respectively.

Table 15: Adoption level of regular vaccination technological components of respondents

Adoption categories	Adoption Index	Number of farmers	%	Mean	Std. Dev.	F	Prob>F
No	0	0	0				
Low	> 0 to < 35	15	11.72				
Medium	36 to < 70	91	71.09				
High	70 and above	22	17.19				
Total		128	100	67.12	5.63	17.65***	0.0000

Source: Computed from own survey (2019)

\*\*\* show significance at  $p<0.01$

#### 4.3.4. Determinants of extent of adoption

The study also tried to assess factors related to the intensity (extent) of adoption of improved dairy technology adoption. The intensity show that market distance, frequency of extension contacts, membership of milk collection center and input access have a positive and significant effect except the market distance. Whereas the rest of explanatory variables had insignificant effect on this specific study. The statistical significance of three variables and their intensity on adoption of dairy technologies for the variable of frequency of extension contact, membership of

milk collection center and input access were positive and significant at ( $p < 0.01$ ) level of significant. Whereas, market distance is negative and significant at ( $p < 0.1$ ).

Regarding effect of market distance as indicated in the Table 16, it has effect on the farm household purchase or sale of milk production for the market. The finding shows that distance to market affect dairy technology adoption at ( $p < 0.1$ ) level of significance. Accordingly, when the market distance increase by one minute the extent of the household to adopt dairy technology decrease by (0.002). The reason behind the result is, lack of nearest market in the study area made farmers to not involve in the dairy technology adoption process. The idea was supported by focus group discussion.

Table 16: Estimated results using Tobit model

Variables (Intensity)	Coef.	Std. Err	<i>t</i>	P-value
AGEHH	-.0026779	.0056005	-0.48	0.633
SEX	.2000312	.1421052	1.41	0.160
EDU	-.0188897	.0631699	-0.30	0.765
DARIYACT	.0347679	.0281466	1.24	0.218
FRMSIZE	.0095364	.048596	0.20	0.845
MARKDIS	-.0022653	.0012304	-1.84	0.067*
EXTFRQ	.1245119	.0326491	3.81	0.000***
OFFFARM	.1965761	.2006164	0.98	0.328
CREDIT	4.33e-06	.0000131	0.33	0.742
MILCCOLL	.6704616	.1108652	6.05	0.000***
INPUTACCES	1.585753	.1539325	10.30	0.000***
EXPDAIRY	-.0068299	.0065351	-1.05	0.297
_cons	-.2430002	.340369	-0.71	0.476
/sigma	.5699708	.0377335		

Sample (N)=283, LR chi2(12) = 337.49, Pseudo R<sup>2</sup> =0.5380, Prob > chi2= 0.0000,

Log likelihood = -144.91171, Obs. Summary:155, left-censored observations at intscale\_01<=0, 128 uncensored observations 0 right-censored observations.

**Note:** \*\*\*, \*\*, \*, show significance at  $p < 0.01$ ,  $p < 0.05$ , and  $p < 0.1$  respectively

Source: Computed from own survey (2019)

Similarly, frequency of extension contact of the household head has adopted more improved dairy technology than counterparts with positive coefficient. This means that, the frequency of extension contact increase, the extent of adopting dairy technology increases by (12). Frequency of extension service affect the extent of adoption positively and significantly at ( $p < 0.01$ ). The possible reason could be, as the increases the households frequent contact with extension agents improve the knowledge and more exposed to the new technology. In addition to this, the farmer who has frequent contact are more exposed to information, this could be increases the extent of adoption for dairy technologies. The finding corroborates with the study conducted by Samuel *et al.*, (2016).

On the other hand, the household with the membership of milk collection center adopted more dairy technologies than the household who not participated in the center. The milk collection center membership improved dairy technologies affect the extent of adoption positively and significantly (0.67) which is consistent with the hypothesized sign. It means that farmers will more benefited from the involvements of the center, if they are members. Membership of milk collection center affect the extent of dairy technology adoption positively and significantly at ( $p < 0.01$ ) level of significant. The possible reason could be the household who are a member of milk collection center has access to new technologies and training related to milk production and productivity as well as the new technologies. The further implication behind this, the participant household in the center has better access in the milk market, dairy input and incentives from sell of milk. This idea was supported by FGD and key informant discussants.

Similarly, input access also affects extent of dairy technologies adoption positively and significantly (1.58) which is significant at ( $p < 0.01$ ) level of significant. The expected result could be due to access to input includes (breed, AI) and other dairy related service increases the production of milk. In addition to this, since the production is increases the household satisfy their milk demand and sell to market. This could increase the household income and able to purchase diversified food and at the same time, the household improve their food consumption (Eric, 2017).

#### **4.3.5. Impacts of dairy technology adoption on household food security**

This section describes econometric analysis which was followed to identify the impact of improved dairy production technologies adoption on rural household food security. The section

was analyzed that the estimation of propensity scores, choosing matching algorithm and calculate Average Treatment Effect (ATT) on treated and sensitivity analysis.

Propensity Score Matching (PSM) is used to match adopter and non-adopter in order to create reasonable counterfactual (Rosenbaum and Rubin, 1983). Propensity score construct a statistical comparison between treated individual with control individual based on similarities in all observable characteristics except the treatments in order to compute the difference in the outcome variable. Which means that the average treatment effect of the technology adoption is calculated as the mean difference in outcomes across the two group. (Rosenbaum and Rubin, 1983). According to khandker *et al.*, (2010) the PSM effect validity depends on conditional independence and sizable common support across the adopter and non-adopter sample household.

Table 17: Logit estimation model for estimating propensity scores

Variables	Coef.	Std. Err.	Z	P-value
AGEHH	-.098142	.0402782	-2.44	0.015**
SEX	.5900471	.9590324	0.62	0.538
EDU	-.2141835	.4343176	-0.49	0.622
DARIYACT	.1180851	.1983707	0.60	0.552
FRMSIZE	-.2240464	.2861133	-0.78	0.434
MARKDIS	-.0054058	.00761	-0.71	0.477
EXTFRQ	.9255643	.244037	3.79	0.000***
OFFFARM	2.820787	1.947668	1.45	0.148
CREDIT	-.0000281	.0000761	-0.37	0.712
MILCCOLL	4.30878	.8509251	5.06	0.000***
INPUTACCES	5.761459	.9756375	5.91	0.000***
TLU	.212503	.120482	1.76	0.078**
EXPDAIRY	.0651064	.0508883	1.28	0.201
_cons	-5.988286	2.308024	-2.59	0.009

Sample size (N)=283 Pseudo R2=0.7758 LR chi2(13) =302.37Prob > chi2=0.0000 Log likelihood = -43.687911

**Note:** \*\*\*, \*\*, \*, show significance at  $p < 0.01$ ,  $p < 0.05$ , and  $p < 0.1$  respectively

Source: Computed from own survey (2019)

In the first step, logit model is used to estimate the propensity scores for matching purpose Baker (2000). Accordingly, in this study thirteen explanatory variable were identified and used to fulfill the criteria of the balancing propensity. The next step after balancing the predicted probability values, from the binary estimation, matching was done by using matching algorithm. A matching algorithm is selected based on the data at hand in order to select the control group who are matched with the treated group based on the covariant which need to be controlled.

In general, this section presents the result of logistic regression, in the first step in the propensity score matching to estimate for matching dairy technology adopter household with non-adopters. The logistic regression results in the Table 17 showed that, there are different variable that determine household decision in improved dairy technologies practice at different statistically significant levels.

In this study, thirteen selected explanatory variables were hypothesized that determine household's participation in dairy technologies adoption. Among those variables, five of them were found to be significant variable that determine the adoption of households in the decision of adopting improved dairy technologies practice and use of improved dairy technologies either positively or negatively while the rest of eight variables were not significant in explaining the variation in the dependent variable.

Among the explained variables by logistic regression model that influence the probability of household in the adoption could be age of the household, frequency of extension contact, participation in milk collection center, input access, livestock holding (TLU) were the variables identified by logistic regression model that influence household probability of adoption in improved dairy technologies in the study area.

The output of logistic regression Table 17, indicated that the household frequency of extension contacts, participation households in milk collection center, input access livestock holding (TLU) were affect the household's probability of adoption and use of improved dairy technologies positively and statistically significant at  $p < 0.01$ ,  $p < 0.01$ ,  $p < 0.01$ , and  $p < 0.05$  significant level respectively. While age of the household affects it negatively at  $p < 0.05$  significant level.

In this study the number of extension contact of the household increase by one unit, also an increase the probability of participation in adoption process and use dairy technologies by 92.5% units. The possible reason for this may be, farmers which has strong communication with extension agents were expected to more adopt dairy technologies than less contact. The implication of the result that obtained could be household with more contact has access to know about the new technology and intensity to use.

With regard to farmer participation in milk collection center, the main benefit of these were to provide agricultural input like Artificial insemination (AI) service and veterinary service, market and information to increase the production and productivity to their member. Table 17 indicated, the membership of households in milk center have a positive influence on adoption and intensity of use improved dairy technologies significantly at ( $p < 0.01$ ) significant level. The possible explanation could be the involvements of farmer in such institute motivate households to engaged in dairy technologies. This implies that strengthen the center enhance the adoption of improved dairy technologies adoption for rural households.

Similarly, access to dairy input supply result indicated that, the unit increase the household increase the probability of household adoption and level of adoption for dairy technologies increased. Not only the availability of input in the area, access of input by the households and cost of the technologies also matter the adoption of the households. In this study, the implication could be households who have more income are able to adopt improved dairy technologies in better manner. Table 17 reveals that, access to input have a positive influence on adoption and intensity of use improved dairy technologies significantly at ( $p < 0.01$ ) significant level.

In addition to this, tropical livestock unit affect the household's probability of adoption and practice of improved dairy technologies positively and significantly at ( $p < 0.05$ ) of significant level. The logistic regression results show, tropical livestock unit increase by one unit the probability of adopting dairy technologies is increased by 21.25%. the potential reason for this result could be household who owned large livestock have the capacity to afford to adopt improved dairy technologies as well as the imitation to purchase new increases.

As described in the Table 17, the Pseudo-  $R^2$  value is large and the value is (0.7758) indicated that the adoption of the household is fairly random. According to (Caliendo and copeinig, 2008),

after matching there should be systematic difference in the distribution of covariates between adopters and non-adopter groups.

### Propensity score histogram

The propensity score matching (PSM) is to match each participant based on an identical common characteristic with non-participants. Thus, the distribution helps to identify the impact of dairy technology adoption on household food security based on food consumption score and dietary diversity. In line with this the density distribution of propensity scores for adopters and non-adopters is shown in (Figure 3) below. The bottom half of each graph shows the propensity score distribution of non-treated (non-adopters) while the upper-half refers to treated individuals. The y-axis indicated the frequency of the propensity score distribution

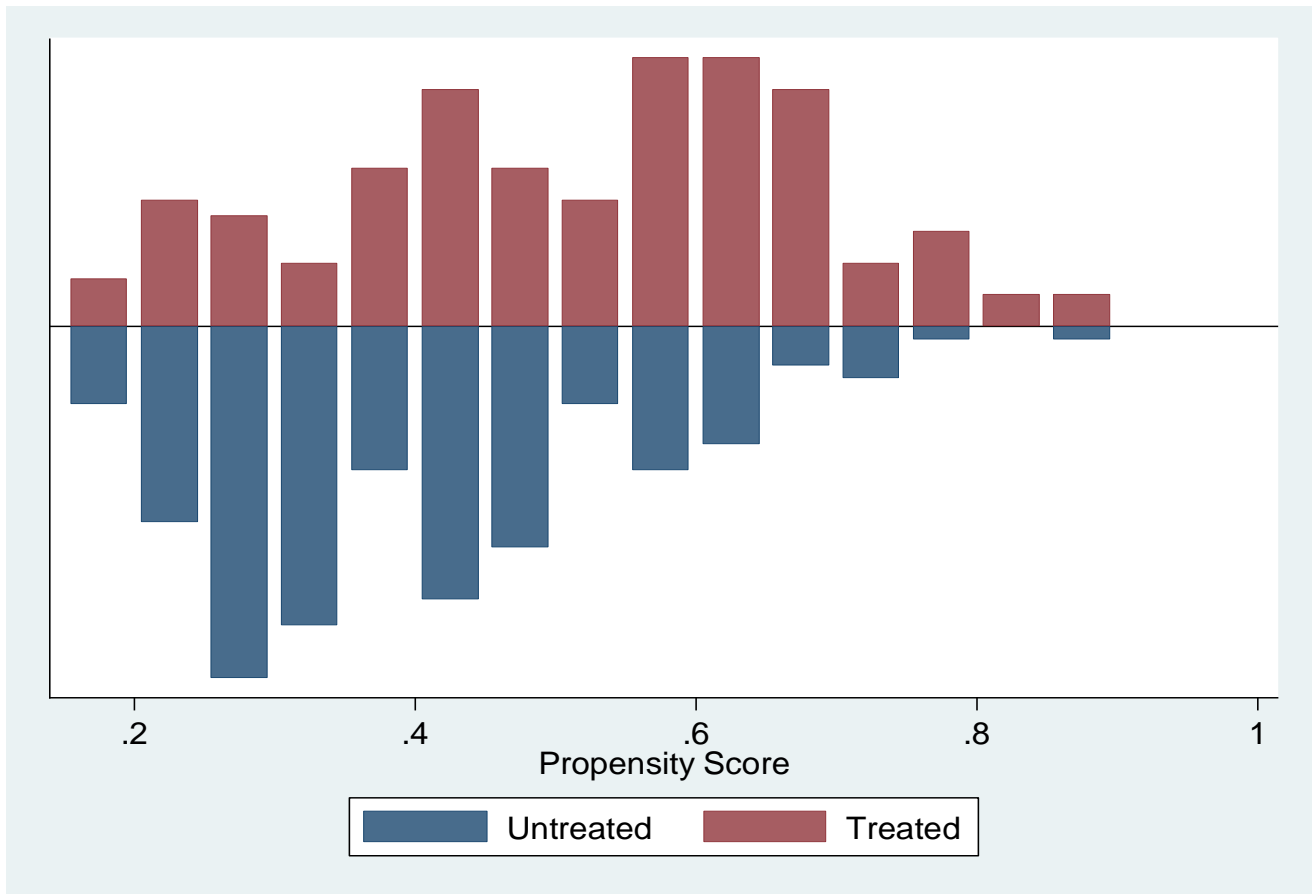


Figure 3: Region of common support between Treated and untreated

**Note:** as shown in the above figure treated on support indicated the farmer in the adoption group who find a suitable match, whereas untreated indicate non-adopters.

Table 18 presents, the result of covariate balancing test to test the hypothesis that both groups have the same distribution in covariates after matching. The result revealed that the covariates means, the percentage bias and the p-value difference in mean before and after matching. Choosing the best performing matching algorithm was to check the balancing of covariate by comparing before and after matching algorithm significance difference using the selected matching algorithm.

Table 18: Testing of covariance balance using propensity score (evaluation of quality of match)

Covariates (variables)	Samples	Mean		%of bias	%reduction bias	P-value
		Treated	Control			
Age HH	Unmatched	43.742	46.123	-22.8		<b>0.059*</b>
	Matched	43.742	42.617	10.8	96.4	0.438
SEX	Unmatched	0.85156	0.90323	-15.7		0.185
	Matched	0.85156	0.84375	2.4	98.2	0.863
EDU	Unmatched	1.2266	0.79355	56.2		<b>0.000***</b>
	Matched	1.2266	1.2891	-8.1	85.6	0.476
Total land	Unmatched	1.9884	2.0258	-4.0		0.738
	Matched	1.9884	2.0293	13.1	-228.4	0.265
MARDIS	Unmatched	112.97	125.59	-33.7		<b>0.005***</b>
	Matched	112.97	111.88	3.8	88.9	0.779
Family size	Unmatched	5.0547	5.2323	-9.9		0.408
	Matched	5.0547	4.9375	6.5	34.0	0.603
OFF-FARM	Unmatched	0.0625	0.01935	21.8		<b>0.062**</b>
	Matched	0.0625	.04688	7.9	63.8	0.584

(Figures in bold shows significant covariates)

*Note: \*\*\*, \*\*, \*, show significance at  $p < 0.01$ ,  $p < 0.05$ , and  $p < 0.1$  respectively*

*(Source: Computed from own survey (2019)).*

The above Table and figure results revealed that the mean standardized bias difference in before matching is in range of 4% - 56.29% in absolute value and P-value in same table shows 73% of chosen variables exhibited statistically significant difference at before matching. Whereas, after matching the standardize bias/standard error difference of explanatory variables lied between

3.8%-10.8%. if the value of this statistics exceeds 20 the covariate is considered to be unbalanced (Rosenbaum & Rubin, 1985). Accordingly, in all cases, it was evident that sample differences in the unmatched data significantly exceeded those in the samples of matched cases. Hence, the process of matching created a high degree of covariate balance between the treatment and control samples that were ready to be used in the estimation procedure.

The below figure indicated that the standardized % bias across covariates (unmatched with matched covariates).

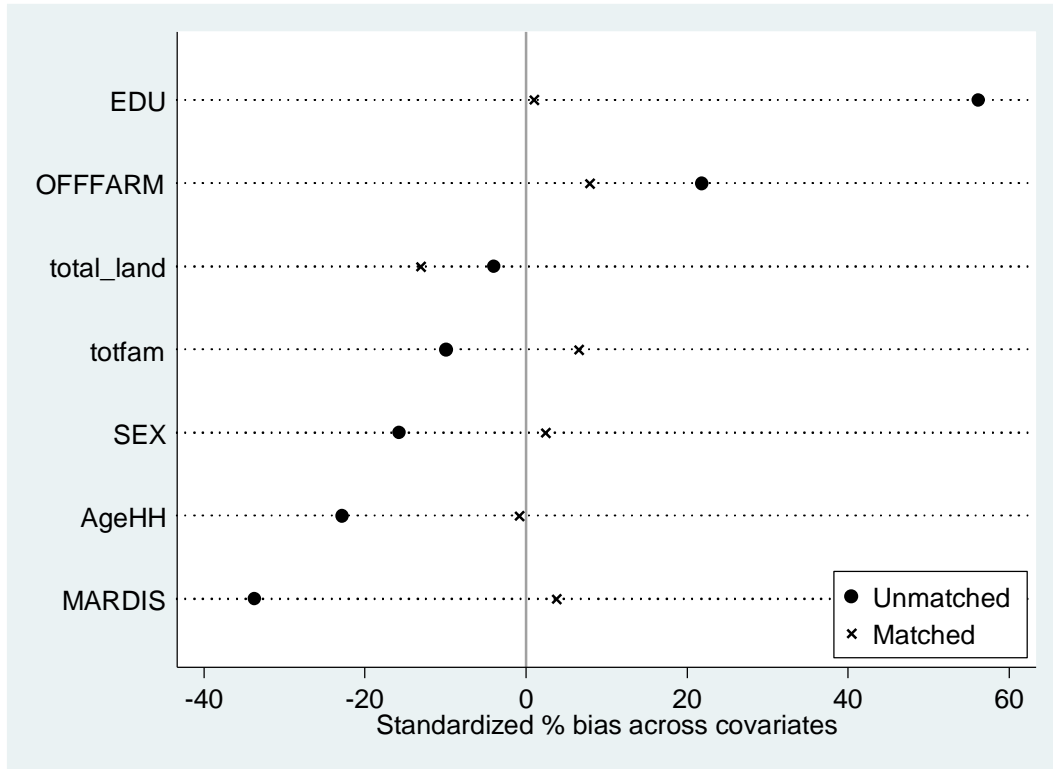


Figure 4: Unmatched and Matched standardized % bias across covariates (Source: Computed own survey result 2019)

As indicated in Table 19, the value of Pseudo R2 was very low it was minimized to 0.006 and the low value of Pseudo R2 indicated that the dairy technology adopter and non-adopter households had same distribution in the covariates after matching. The mean bias is also minimized from 23.5 to 5.1. Beta is also minimized to 18.3 which is less than 25 so, this all indicates the matching was good. Hence, these is used to assess the impact of dairy technology adoption among group of households having similar observed characteristics.

Table 19: Post estimation of PSM

Sample	Ps R2	LR chi2	p>chi2	Mean Bias	B
Unmatched	0.085	33.08	0.000	23.5	70.9
Matched	0.006	2.16	0.950	5.1	18.3

Source: Computed own survey result (2019)

#### 4.3.6. The treatment effect (Impact)

The impact of dairy technologies adoption on household food security computed using the three matching algorithms namely, kernel-based matching (KBM), nearest neighbor matching (NNM) and radius matching (RM) are show below in Table 20 the outcome variable was the household food consumption score and intake of diversified food in the household. The impact of the adoption is shown by the difference in ATT.

Table 20: Performance criteria of matching algorithms

Outcome variable	Match algorithms (kind of matching)	Matched samples		ATT (Impact)	Std. Err.	t-test
		Adopters	Non-adopters			
FCS	Kernel-based matching (KBM)	128	155	6.490	1.359	4.777***
	Nearest neighbor matching (NNM)	128	155	6.490	1.238	5.243***
	Radius matching (RM)	128	155	6.521	1.238	5.267***
HDDS	Kernel-based matching (KBM)	128	155	1.038	0.248	4.192***
	Nearest neighbor matching (NNM)	128	155	1.038	0.244	4.253***
	Radius matching (RM)	128	155	1.055	0.244	4.318***

Source: Computed from own survey (2019)

NB: \*\*\* statistically significant at  $p < 0.01$

Table 20 presents the estimated effect of dairy technology adoption on household food security status based on food consumption score and household dietary diversity by kernel-based matching (KBM), nearest neighbor (NNM), and radius or caliper (RM) methods. The post matching result from KBM reveals that dairy technology adoption tend to positively and significantly affect household food consumption score and dietary diversity of the households. The difference is statistically significant at ( $p < 0.01$ ) level. The estimates of NNM shows that adoption of dairy technologies improves household food security by 6.490 and 1.038 frequency of consumption of households per week and dietary diversity of the household respectively. The difference is significant at ( $p < 0.01$ ) level.

Similarly, the RM result reveals that adopting of dairy technologies also guarantee favorable effect on food security. This means that when we compared to matched households that did not adopt any of the dairy technologies, households that did not adopt experienced a 6.521 and 1.055 frequency of consumption score and dietary diversity respectively. Based on radius, the difference between two groups was still significant at ( $p < 0.01$ ) level.

Based on the study result, all of the above result suggested that the matching algorithm chosen relatively for this study. Therefore, it can possible to proceed to estimate the average treatment effect on the treated (ATT) for the sample households.

#### **4.3.7. The impact of dairy technology adoption on household food security (FCS)**

The final step in PSM process is to estimate treatment effects on the outcome variable in the matched sample through a t-stat result. It has been found that, on average, dairy technology adopter households have increased the food consumption score 7.88 in terms of frequency of eating diversified food per a week. This means that dairy technology adoption has increased the household food consumption score by 23.19%.

Table 21: ATT Estimation results of household Food Consumption Score (FCS)

Variable Sample	Treated	Controls	Difference	S.E.	t-stat
FCS Unmatched	34.0546875	27.5645161	6.49017137	1.2209734	5.32
ATT	34.0546875	26.15625	7.8984375	1.74639659	4.52

#### 4.3.8. The impact of dairy technology adoption on household food security (HDDS)

The average household dietary diversity score result of the sample households indicated that dairy technology adopter household have decreased the intake of diversified food 1 in terms of access and utilization of diversified food in 24 hour recall. This means that dairy technology adoption has increase the household dairtery daiversity by 13.7%. This result shows positive effect is estimated for the adopter households who are more taking diversified food than the non-adopter households. Accordingly to the preferred estimates, the dairy technology adoption has significantly and positive impact on dairty diversity of the adopter households.

Table 22: ATT Estimation results of Household Dietary Diversity Score (HDDS)

Variable Sample	Treated	Controls	Difference	S.E.	T-stat
HDDS Unmatched	7.2578125	6.21935484	1.03845766	.246914672	4.21
ATT	7.2578125	6.2578125	1	.356177762	2.81

# CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

## 5.1. Conclusion

This study has been conducted in Basona worena *woreda*, North Shewa Zone of Amhara National Regional State (ANRS). The study assessed and analyzed adoption of dairy technologies and their impact on the farm household's food security status. Adoption of dairy technologies (breed, Artificial Insemination, feed, housing and vaccination) and their impacts on food security in the study area were not methodologically studied so far. This study is therefore to fill the information, literature a methodology gaps to be used by academia, the government, local practitioners, and the people. A cross-sectional survey design and multi stage sampling procedure was employed. The sample selection method carried out for the study was the probability sampling proportional to size of the respondents. The data was mainly collected from 283 farm households living in two randomly selected kebeles. The sample were 128 dairy technology adopters and 155 non-adopter households. A structured questionnaire, focus group discussion and key informant interview were key data collection tools. From the total sampled households 12.01 % (34) were female and 87.99 % (249) male respondents.

Discriptive and econometrics data analysis model were employed to analyze quantitative data using STATA version 14 software. A binary logestic regression to identify the factor influenceing the dairy technology adoption. Factore affecting and intensity were analysed using Tobit regression model to analyze the current use of technologies. Where as impact of technology on household food security was analyzed by using Propensity Score Matching (PSM) model. In addition to this, the charactrestics of the households' were analyzed by using *t*-test and chi-square test for continous and dummy variables respectively. Model specification tests include goodness of fit, collinarity problem and matching quality test such as matching algorithms have been conducted.

The first analysis was comparing the respondents' food security status at ahousehold level. About 21.20% of households were in acceptable food consumption condition. About 53% and 25.80% of households were in boarderline and poor food consumption condition, respectively. The food consumption score mean value of the household is 34.05 adopters and 27.56 for non-adopters with significant mean difference beteween two groups with ( $p < 0.01$ ). Similarly, according to daietry diversity status of the household, there is significant mean difference

between the two groups in root crop, vegetable, meat, milk, sugar and coffee consumption. But they are similar consumption habit in cereals, pulses, fruits, fat and oil. On the other hand, both groups have poor consumption in egg and fish food groups.

The econometric analysis was carried out to examine the level of dairy technology adoption among the adopter groups. The one-way ANOVA result revealed that in the four dairy technological components (breed, AIS, feeding, housing and veterinary), the adopter households found in the medium adoption condition. From the adopters' group 75.78%, 85.94%, 72.66% and 71.09% of the adopters were in medium condition of Artificial Insemination Service, feeding, housing and veterinary service respectively.

The result of Tobit model revealed that three out of thirteen variables were found to have significant effect on the extent of dairy technology adoption. The variables are that frequency of extension service, membership of milk collection center and input access are found to be affect the extent of dairy technology positively and significantly at 1% significant level. In the same result, the rest of other variables were not found to be statistically significant effect on the extents of dairy technology adoption.

The binary logistic regression model was used to analyzed to identify factors affecting the dairy technology adoption. The result indicated that frequency of extension contact, engaging of off-farm activities, membership of milk collection center, access to dairy input, and total livestock unit have positively and statistically significant effect to determine the household dairy technology adoption status. Whereas, age of the household head had negative relationship with the household dairy technology adoption.

The result of Propensity Score Matching (PSM) by using the three matching algorithms indicated that the dairy technology adoption has positive impact on household food security. Finally, the ATT effect generalized, dairy technologies have positive and significant impact on household food security status in terms of food consumption and dietary diversity in the study area.

As discussed in detail in the theory of diffusion in adoption states, adoption is a choice made by farm household interest. Also, the expected utility theory of adoption stated that, adoption is a process that influenced by social, economic, physiological and physical factors. This theory relates with this study in which the process of adoption of dairy technology also affected by

socioeconomic factor such as frequency of extension contact, input access, and membership of milk collection. These factors have a positive implication in adoption decision of dairy technology of a study area.

Further, diffusion theory shows the application of different models on adoption of agricultural technology. Such models are Heckman two stage, double hurdle and Tobit model. The study employed to quantify the intensity of adoption by using Tobit model. In line with this theory this result indicated that socioeconomic factors of household such as extension contact, milk collection center and input access affect in grate extent of adoption decision of dairy technology.

Various literature on adoption and household food security indicate that, adoption of dairy technology has as significant impact on household food security status. The finding of the study, is the same for this research in which adoption of cross breed has significant effect on household food consumption level and dietary diversity. Other literatures also indicated that, adoption of dairy technology contributes the household asset and income increment. Nevertheless, the result of this research shows that household who adopt dairy technology were better in milk production, food security and dietary diversity.

Generally, food security implies that access, availability, utilization and stability of food by a household in sufficient and safe manner where dietary diversity and food consumption score are proxy indicator of household food security. Therefore, adoption of dairy technology has a positive and significant impact on household food security.

## 5.2. Recommendations

Based on the finding of the study, the following recommendation have been suggested for critical consideration in light of the discussion drawn hereinbefore and conclude above. The recommendations are assumed to give insight for the future policy formulation regarding to technology adoption and food security and also helps to input for further investigation in the country. Moreover, this policy recommendation possibilities to mitigate issues related to socio-economic and demographic problems of people living in the Basona Worena *woreda* and the people who live in the same characteristics in other area of the country.

Based on that the following recommendation is forwarded:

- The research finding indicates that adoption of dairy technology resulted in increment in milk production and food security of the households. This implies that introducing and disseminating of appropriate dairy technologies to smallholder farmers could improve the supply of milk production and narrow the milk demand-supply gap in rural household and improve the household food consumption. Both national and regional agricultural research institutes should introduce diversified breed varieties in affordable cost and quality and disseminate for the rural households
- According to the study, dairy technology adoption was positively and significantly related with extension contact, input access and membership of milk collection center. Thus, the *woreda* extension and developmental agents as well regional and national agricultural bureaus should give more attention in changing the attitude of farmers towards the technology adoption through demonstration, training and frequent field visit (continuous follow up) at *woreda* and zonal level.
- The study finding indicates that milk collection center is one of the rural institutes that provides dairy input for the rural households. The center creates services such as, market linkage for their milk product, advice, training, and information. This will increase the household's income and improve the purchasing power of nutritious and diversified food. Therefore, *woreda* level agricultural institutions should support center to strengthening their capacity in order to provide enough input and financial support for the smallholders.

- Farmers who use dairy technologies have better access to dairy inputs (incentive, veterinary service and Artificial Insemination) and market access for their milk product. Access to dairy input helps the farm households to adopt the dairy package in sustainable manner. Therefore, *woreda* agricultural office should improve research and training linkage with research institute to fill the demand of farm household. Similarly, regional agricultural office should work in collaboration with non-governmental institutes to provide improved breed and concentrated feed with low cost.
- Similarly, the study result indicated that the current dairy technologies adoption status of the households was found to be in medium level in dairy technologies components. Consequently, in order to improve adoption practice and food security status of the households, the responsible bodies like regional and national food security offices should work together in development and awareness creation.
- Other finding also shows that, livestock ownership was contributes to households' economic and social status in a positive and significant manner. Hence, the household with large number of livestock's, have a capacity to adopt dairy technology and improve food security. Accordingly, regional and *woreda* agriculture office in particular livestock sub-sector should have to health care in continuous manner for the households through providing regular vaccination.
- The adoption of dairy technology has a positive and significant impacts on household food consumption and dietary diversity intake of adopter household than non-adopters. In order to improve the food security status sustainably, regional livestock sub sector and food security offices should work in collaboration to create awareness, giving training on food security and nutrition issue of the households in the *woreda*. In spite of this, different governmental and NGO's should participate in the intervention and dissemination process.
- Another study finding indicated, the reason of non-adopt to delay in dairy technologies are cost of technologies, lack of capital, occurrence of disease, lack of dairy input (AI and breed varieties). Therefore, in order to overcome those constraints this research recommend that region agricultural office should provide the dairy input in needed rate and give financial support for households in order to adopt dairy technology.

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# Appendixes

## Appendixes 1: Variables and descriptions

Name of the variables	Description
AGEHH	Age of the household head
SEX	Sex of the household head
EDU	Education level of the household head
DARIYACT	Engage in dairy activity
FRMSIZE	Farm size
MARKDIS	Market distance
EXTFRQ	Frequency of extension contact
OFFFARM	Off-farm activity
CREDIT	credit amount
MILCCOLL	Milk collection center
INPUTACCES	Input access
TLU	Total Livestock Unit
EXPDAIRY	Experience in dairy farming

## Appendixes 2: Logistic model test (goodness of fit, linktest and VIF)

```
. estat gof
```

### Logistic model for Adop usage, goodness-of-fit test

```
number of observations =      283
number of covariate patterns =    283
    Pearson chi2(271) =    218.11
        Prob > chi2 =      0.9920
```

. linktest

Source	SS	df	MS	Number of obs	=	283
Model	49.7005231	2	24.8502615	F(2, 280)	=	340.99
Residual	20.405484	280	.072876729	Prob > F	=	0.0000
				R-squared	=	0.7089
				Adj R-squared	=	0.7069
Total	70.1060071	282	.248602862	Root MSE	=	.26996

Adop_usage	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
_hat	.6130288	.26067	2.35	0.019	.099907 1.12615
_hatsq	.4341487	.2892662	1.50	0.135	-.1352639 1.003561
_cons	.0102176	.0245932	0.42	0.678	-.0381934 .0586285

### Appendix 3: Multicollinearity test (VIF)

. estat vif

Variable	VIF	1/VIF
inpu_access	1.93	0.517226
AgeHH	1.81	0.551074
exp_dairy	1.68	0.596655
ifyes_memb	1.58	0.631402
EDU	1.35	0.739246
ifyes_ext	1.26	0.793393
dary_activ	1.17	0.856521
cred_amount	1.16	0.861589
total_land	1.16	0.864821
SEX	1.14	0.880678
MARDIS	1.09	0.920636
tlu2	1.06	0.941628
OFFFARM	1.04	0.960285
Mean VIF	1.34	

## Appendix 4: Regression estimation result for dairy technology adoption (marginal effect)

```
. xi: logistic i.Adop_usage i.SEX i.OFFFARM i.inpu_access i.ifyes_memb AgeHH EDU total_land dary_activ tlu2 MARDIS cred_ammoun
> t ifyes_ext exp_dairy ,r
i.Adop_usage      _IAdop_usag_0-1      (naturally coded; _IAdop_usag_0 omitted)
i.SEX              _ISEX_0-1            (naturally coded; _ISEX_0 omitted)
i.OFFFARM          _IOFFFARM_0-1        (naturally coded; _IOFFFARM_0 omitted)
i.inpu_access      _Iinpu_acce_0-1      (naturally coded; _Iinpu_acce_0 omitted)
i.ifyes_memb       _Iifyes_mem_0-1      (naturally coded; _Iifyes_mem_0 omitted)
```

```
Logistic regression                Number of obs   =       268
                                   Wald chi2(13)    =       57.46
                                   Prob > chi2       =       0.0000
Log pseudolikelihood = -41.90413    Pseudo R2     =       0.7714
```

_IAdop_usag_1	Robust					
	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	
_ISEX_1	1.793243	1.549452	0.68	0.499	.3297298	9.752589
_IOFFFARM_1	14.3842	14.22335	2.70	0.007	2.071106	99.90079
_Iinpu_acce_1	262.2152	262.7866	5.56	0.000	36.77915	1869.451
_Iifyes_mem_1	92.99848	91.32632	4.62	0.000	13.56999	637.3417
AgeHH	.9080646	.0295096	-2.97	0.003	.8520303	.9677841
EDU	.8820844	.3252846	-0.34	0.734	.4281679	1.817214
total_land	1.161827	.3669405	0.47	0.635	.6256133	2.15763
dary_activ	1.063897	.1803954	0.37	0.715	.7630786	1.483304
tlu2	1.13569	.1677347	0.86	0.389	.8502413	1.516971
MARDIS	.9930626	.0083864	-0.82	0.410	.9767609	1.009636
cred_ammoun	.9999785	.0000808	-0.27	0.791	.9998202	1.000137
ifyes_ext	2.466673	.5114695	4.35	0.000	1.642908	3.703479
exp_dairy	1.0431	.0520273	0.85	0.398	.9459536	1.150222
_cons	.0042061	.0096721	-2.38	0.017	.0000464	.3812844

```
. mfx
```

```
Marginal effects after logistic
y = Pr(_IAdop_usag_1) (predict)
= .17938539
```

variable	dy/dx	Std. Err.	z	P> z	[	95% C.I.	]	X
_ISEX_1*	.0743972	.0952	0.78	0.435	-.112193	.260988	.876866	
_IOFFF~1*	.575359	.17621	3.27	0.001	.229998	.92072	.033582	
_Iinpu~1*	.7760813	.05788	13.41	0.000	.662645	.889517	.488806	
_Iifye~1*	.6938408	.06066	11.44	0.000	.574942	.81274	.455224	
AgeHH	-.0141965	.00678	-2.09	0.036	-.027485	-.000908	45.1679	
EDU	-.0184696	.05598	-0.33	0.741	-.128185	.091246	.996269	
total~nd	.022208	.04377	0.50	0.614	-.063705	.107865	2.03455	
dary_a~v	.0091178	.02545	0.36	0.720	-.040757	.058993	3.3806	
tlu2	.0187305	.02352	0.80	0.426	-.027371	.064832	7.06343	
MARDIS	-.0010248	.00108	-0.95	0.344	-.003147	.001098	119.302	
cred_a~t	-3.16e-06	.00001	-0.26	0.797	-.000027	.000021	1033.96	
ifyes~xt	.1329082	.05072	2.62	0.009	.033496	.23232	1.93284	
exp_da~y	.0062116	.00847	0.73	0.464	-.010396	.022819	17.5075	

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

## Appendix 5: Regression estimation result for determinant factor for extent of dairy technology adoption (Tobit)

```
. tobit intscale_01 AgeHH SEX EDU dary_activ total_land MARDIS ifyes_ext OFFFARM cred_amount ifyes_memb inpu_access exp
> _dairy, ll
```

```
Tobit regression                Number of obs    =          283
                                LR chi2(12)         =          337.49
                                Prob > chi2         =           0.0000
                                Pseudo R2          =           0.5380
Log likelihood = -144.91171
```

intscale_01	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
AgeHH	-.0026779	.0056005	-0.48	0.633	-.0137038	.0083481
SEX	.2000312	.1421052	1.41	0.160	-.0797394	.4798018
EDU	-.0188897	.0631699	-0.30	0.765	-.1432559	.1054765
dary_activ	.0347679	.0281466	1.24	0.218	-.0206458	.0901816
total_land	.0095364	.048596	0.20	0.845	-.0861374	.1052102
MARDIS	-.0022653	.0012304	-1.84	0.067	-.0046877	.0001572
ifyes_ext	.1245119	.0326491	3.81	0.000	.0602337	.1887901
OFFFARM	.1965761	.2006164	0.98	0.328	-.1983887	.591541
cred_amount	4.33e-06	.0000131	0.33	0.742	-.0000215	.0000302
ifyes_memb	.6704616	.1108652	6.05	0.000	.452195	.8887281
inpu_access	1.585753	.1539325	10.30	0.000	1.282697	1.888808
exp_dairy	-.0068299	.0065351	-1.05	0.297	-.0196959	.0060361
_cons	-.2430002	.340369	-0.71	0.476	-.9131038	.4271033
/sigma	.5699708	.0377335			.4956828	.6442588

```
155 left-censored observations at intscale_01 <= 1
128 uncensored observations
0 right-censored observations
```

## Appendix 6: Propensity score matching (PSM) for outcome variable (FCS)

```
. psmatch2 Adop_usage AgeHH EDU total_land MARDIS totfam SEX OFFFARM ,outcome( FCS )
```

```

Probit regression                Number of obs   =       283
                                LR chi2(7)      =       33.08
                                Prob > chi2       =       0.0000
Log likelihood = -178.33064      Pseudo R2    =       0.0849

```

Adop_usage	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
AgeHH	-.0050432	.0081385	-0.62	0.535	-.0209945	.010908
EDU	.4288565	.1039034	4.13	0.000	.2252096	.6325034
total_land	.0161421	.0859752	0.19	0.851	-.1523662	.1846505
MARDIS	-.005109	.0020914	-2.44	0.015	-.009208	-.00101
totfam	.0157862	.046129	0.34	0.732	-.074625	.1061974
SEX	-.4151346	.2560259	-1.62	0.105	-.916936	.0866669
OFFFARM	.5230295	.4171254	1.25	0.210	-.2945213	1.34058
_cons	.520118	.5349298	0.97	0.331	-.528325	1.568561

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
FCS	Unmatched	34.0546875	27.5645161	6.49017137	1.2209734	5.32
	ATT	34.0546875	26.15625	7.8984375	1.74639659	4.52

Note: S.E. does not take into account that the propensity score is estimated.

## Appendix 7: Testing covariates

. pstest,graph both

Variable	Unmatched Matched	Mean		%reduct		t-test		V(T)/ V(C)
		Treated	Control	%bias	bias	t	p> t	
AgeHH	U	43.742	46.123	-22.8		-1.89	0.059	0.68*
	M	43.742	43.828	-0.8	96.4	-0.07	0.945	0.81
EDU	U	1.2266	.79355	56.2		4.72	0.000	1.14
	M	1.2266	1.2188	1.0	98.2	0.08	0.936	1.12
total_land	U	1.9884	2.0258	-4.0		-0.34	0.738	1.10
	M	1.9884	2.1113	-13.1	-228.4	-1.12	0.265	1.46*
MARDIS	U	112.97	125.59	-33.7		-2.83	0.005	1.15
	M	112.97	111.56	3.8	88.9	0.28	0.779	0.88
totfam	U	5.0547	5.2323	-9.9		-0.83	0.408	0.92
	M	5.0547	4.9375	6.5	34.0	0.52	0.603	0.90
SEX	U	.85156	.90323	-15.7		-1.33	0.185	.
	M	.85156	.84375	2.4	84.9	0.17	0.863	.
OFFFARM	U	.0625	.01935	21.8		1.87	0.062	.
	M	.0625	.04688	7.9	63.8	0.55	0.584	.

\* if variance ratio outside [0.71; 1.42] for U and [0.71; 1.42] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.085	33.08	0.000	23.5	21.8	70.9*	1.30	20
Matched	0.006	2.16	0.950	5.1	3.8	18.3	1.75	20

\* if B>25%, R outside [0.5; 2]

## Appendix 8: Propensity score matching (PSM) for outcome variable (HDDS)

```
. psmatch2 Adop_usage AgeHH EDU total_land MARDIS totfam SEX OFFFARM ,outcome( HDDS )
```

```
Probit regression                               Number of obs   =       283
                                                LR chi2(7)       =       33.08
                                                Prob > chi2      =       0.0000
Log likelihood = -178.33064                    Pseudo R2       =       0.0849
```

Adop_usage	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
AgeHH	-.0050432	.0081385	-0.62	0.535	-.0209945	.010908
EDU	.4288565	.1039034	4.13	0.000	.2252096	.6325034
total_land	.0161421	.0859752	0.19	0.851	-.1523662	.1846505
MARDIS	-.005109	.0020914	-2.44	0.015	-.009208	-.00101
totfam	.0157862	.046129	0.34	0.732	-.074625	.1061974
SEX	-.4151346	.2560259	-1.62	0.105	-.916936	.0866669
OFFFARM	.5230295	.4171254	1.25	0.210	-.2945213	1.34058
_cons	.520118	.5349298	0.97	0.331	-.528325	1.568561

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
HDDS	Unmatched	7.2578125	6.21935484	1.03845766	.246914672	4.21
	ATT	7.2578125	6.2578125	1	.356177762	2.81

Note: S.E. does not take into account that the propensity score is estimated.

## Appendix 9: Matching algorithm for outcome variable (FCS)

### Kernel matching (KM)

```
. attk FCS Adop_usage,comsup boot reps(50) dots logit
```

The program is searching for matches of each treated unit.  
This operation may take a while.

ATT estimation with the Kernel Matching method

n. treat.	n. contr.	ATT	Std. Err.	t
128	155	6.490	.	.

Note: Analytical standard errors cannot be computed. Use the bootstrap option to get bootstrapped standard errors.

Bootstrapping of standard errors

```
command:      attk FCS Adop_usage , pscore() logit comsup bwidth(.06)
statistic:    attk      = r(attack)
.....
```

```
Bootstrap statistics          Number of obs =      283
                             Replications =      50
```

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]
attack	50	6.490171	.0452703	1.358684	3.759794 9.220548 (N)
					4.588951 9.400279 (P)
					4.588951 9.79458 (BC)

Note: N = normal  
P = percentile  
BC = bias-corrected

ATT estimation with the Kernel Matching method

Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
128	155	6.490	1.359	4.777

## Nearest neighborhood matching (NNM)

```
. attnd FCS Adop_usage
```

The program is searching the nearest neighbor of each treated unit.  
This operation may take a while.

ATT estimation with Nearest Neighbor Matching method  
(random draw version)  
Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
128	155	6.490	1.238	5.243

Note: the numbers of treated and controls refer to actual  
nearest neighbour matches



## Appendix 10: Matching algorithm for outcome variable (HDDS)

### Kernel matching

```
. attk HDDS Adop_usage,comsup boot reps(50) dots logit
```

The program is searching for matches of each treated unit.  
This operation may take a while.

ATT estimation with the Kernel Matching method

n. treat.	n. contr.	ATT	Std. Err.	t
128	155	1.038	.	.

Note: Analytical standard errors cannot be computed. Use the bootstrap option to get bootstrapped standard errors.

Bootstrapping of standard errors

```
command:      attk HDDS Adop_usage , pscore() logit comsup bwidth(.06)
statistic:    attk      = r(attack)
.....
```

```
Bootstrap statistics      Number of obs   =   283
                          Replications     =    50
```

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]
attack	50	1.038458	.0137024	.2477301	.5406256 1.53629 (N)
					.6081951 1.57514 (P)
					.5239596 1.57514 (BC)

Note: N = normal  
P = percentile  
BC = bias-corrected

ATT estimation with the Kernel Matching method  
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
128	155	1.038	0.248	4.192

## Nearest neighborhood matching (NNM)

```
. attnd HDDS Adop_usage
```

```
The program is searching the nearest neighbor of each treated unit.  
This operation may take a while.
```

```
ATT estimation with Nearest Neighbor Matching method  
(random draw version)  
Analytical standard errors
```

---

n. treat.	n. contr.	ATT	Std. Err.	t
128	155	1.038	0.244	4.253

---

```
Note: the numbers of treated and controls refer to actual  
nearest neighbour matches
```



#### Appendixes 11: Conversion factors used to estimate Tropical Livestock Unit (TLU)

Livestock	Conversion factor
Cow	1
Ox	1
Bull	0.60
Heifer	0.75
Calves	0.20
Donkey/Mule	0.70
Horses	1.10
Shoats	0.13
Poultry	0.013

Source: Stock, et al., 1991

#### Appendixes 12: Food Consumption Score group and weight

Food Group	Weight
Main staples	2
Pulses	3
Vegetables	1
Fruit	1
Meat/Fish	4
Milk	4
Sugar	0.5
Oil	0.5

Source: INDDEX Project (2018)

### Appendix 13: Household Dietary Diversity Score (HDDS)

---

A	Any bread, rice noodles, biscuits, or any other foods made from millet, sorghum, maize, rice, wheat, or any other locally available grain?	A	-----
B	Any potatoes, yams, manioc, cassava or any other foods made from roots or tubers?	B	-----
C	Any vegetables?	C	-----
D	Any fruits?	D	-----
E	Any beef, pork, lamb, goat, rabbit wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ meats?	E	-----
F	Any eggs?	F	-----
G	Any fresh or dried fish or shellfish?	G	-----
H	Any foods made from beans, peas, lentils, or nuts?	H	-----
I	Any cheese, yogurt, milk or other milk products?	I	-----
J	Any foods made with oil, fat, or butter?	J	-----
K	Any sugar or honey?	K	-----
L	Any other foods, such as condiments, coffee, tea?	L	-----

---

Source: FANTA, (2006)

**Household ID-----**

A QUESTIONNAIRE FOR THE SELECTED FARM HOUSEHOLDS IN *KEBELES*

**Dear respondent,**

The main objective of this questionnaire is to collect primary data to undertake an assessment on adoption dairy technologies and its impact on rural household food security. Your responses to the questions are valuable and will be held in utmost confidentiality to be used only for the analysis of this research. You will not be identified by name in any case.

Date of the interview -----(DD/MM/YYYY)
Interviewer name -----
Supervisor name -----
Checked on----- (DD/MM/YYYY)
District -----Kebele-----Village-----

Thank you in advance for your cooperation.

**Part one: Information on socio demographic characteristics of the household**

1.	Sex of the household head	1= Male headed    0= Female headed
2.	Age of the household head	-----
3.	Education level of the household head	0=Not read and Write 1=Informal education 2=Formal education
	If yes, Q3 is formal, enter grade completed	-----
4.	Education level of the partner of the household head	0= not read and Write 1= informal education 2=Formal education
	If yes, Q4 is formal, enter grade completed	-----
	Maximum education level in the household	-----
5.	Marital status of the household head	1=Married            2=Divorced 3=Widow/widower    4=Never married 5. Other, specify.....

	Age category	Number of persons	Number of household members engaged in dairy activity
1.	<7		----- per household
2.	7-14		
3.	15-64		
4.	>64		

**Part two: Information on socioeconomic characteristics of the household**

**Q1- Information on experience of dairy farming**

1.	Experience of household in dairy farming	-----in years	Remark
2.	Experience of household in improved dairy farming technologies	----- in years	
	1=Cross breed cow	----- in years	
	2=Artificial insemination (AI)	----- in years	
	3=Improved forage varieties	----- in years	
	4=Management (housing)	----- in years	
	5=Health service	----- in years	

**Q2- Information on land ownership and land size holding**

		In Timad (ጥግድ)	In ha
1.	Total land holding of household in last cropping season (2011/11)	-----	-----ha
	1.1 Total crop land	-----	-----ha
	1.2 Total forage land	-----	-----ha
	1.3 Total grazing land	-----	-----ha
	1.4 Total pasture land	-----	-----ha

**Q3- Off-farm activity of the household members**

1.	Are you engaged in off-farm activity? <b>1=Yes</b> <b>0=No</b>	
	<b>1.1</b> If yes, how much did you get from off-farm activity (income amount in month)	-----Birr

**Q4- Information on current Livestock ownership of the household**

		Do you own <b>1=Yes</b> <b>0=No</b>	<b>Improved</b> (Number per Household)	<b>Local</b> (Number per Household)	Remark
1.	Milking cows				
2.	Non-Milking cow (mature)				
3.	Heifers				
4.	Calves				
5.	Bull				
6.	Oxen				
7.	Chicken				
8.	Fatten oxen				

**Q5- Information on adoption**

1.	Are you aware about adoption? <b>1=Yes</b> <b>0=No</b>	
	If yes, since when did you know about technologies?	-----
	If no go to part three question	
2.	Are you using improved dairy farming? <b>1=Yes</b> <b>0=No</b>	
	If yes, since when did you start using improved dairy technologies (cross breed, improved forage, health service and AI)	
	If you are not using why? ( <b>multiple answer possible</b> ) <b>1=Not aware</b> <b>2=Unavailability of technologies</b> <b>3=Cost of technologies</b> <b>4=Not interested</b> <b>5=Other specify.....</b>	

**Q6- Information on adoption and level of intensity on dairy technology**

1.	<b>Adoption of breeds</b>	
	Which livestock breed do you practice now?	0=Local breed 1=Cross breed
2.	Do you use AI for breed improvement?	1 =Yes 0= No
	Level of use of breed improvement with AIS (synchronization, bull service, regular AIS)	0 =Very low 1= Low 2=Medium 3= High 4 = Very high
3.	<b>Adoption of feeding</b>	
	Did you feeding your livestock recommended feed? (concentrates, improved forage and standardize crop and hay supplements).	1 =Yes 0= No

	What kind of fodder you have been feeding your livestock's	1=Forage legume 2=Standardize crop 3=Hay supplement
	Current level of use recommended feeding practice (forage legume, standard crop, hay supplement)	0 =Very low 1= Low 2=Medium 3= High 4 = Very high
4.	<b>Adoption of housing condition</b>	
	Feeding trough (width, depth, smoothness)	0= No 1=Poor 2= Moderate 3= Good
	Floor (slope)	0= No 1=Poor 2= Moderate 3= Good
	Roof and side wall (ventilation)	0= No 1=Poor 2= Moderate 3= Good
	How do you rate current condition of housing (feeding trough, gutter, floor, side walls and roofing)	0= No 1=Poor 2= Moderate 3= Good
5.	<b>Adoption of veterinary service</b>	
	Access to regular vaccination	1 =Yes 0= No
	Access to vaccination against disease prevalence	1= Disease prevention 2= Disease curring 3= For productivity
	How do you rate your current use of vaccination against disease prevalence	0= No 1=Poor 2= Moderate 3= Good

**Part three: Information on factor determining the adoption of dairy technology / institutional determinants of adoption/**

**Q1- Access to infrastructure and distance**

1.	Do you sale milk, Butter, yogurt and cheese? <b>1=Yes</b> <b>0=No</b>	
		In minutes of Walking distance <b>(minutes)</b>
2.	<b>If yes, how far is the village market from your residence?</b>	-----
3.	How far is the Woreda market place from your residence?	-----
4.	How far is the nearest farmer milk collection center from your residence?	-----
5.	How far is the nearest agricultural extension office from your residence?	-----

**Q2- Social capital and Networking (multiple answer possible)**

1.	Are you participate in any social institution in your village? <b>1=Yes</b> <b>0=No</b>	
	<b>If yes, in which institution currently participated?</b> <b>1= Agricultural cooperative</b> <b>2= Water association</b> <b>3= Equb</b>	

	4= Edir 5=Other specify.....	
--	---------------------------------	--

**Q3- Cooperative or milk collection center (multiple answer possible)**

1.	Is there any milk cooperative in your area? 1=Yes 0=No	
2.	If yes, are you a member of milk cooperative 1=Yes 0=No	
	2.1 If yes, what is the benefit from engaging in cooperative 1=Market access for dairy product 2=Less cost for dairy technologies 3=Access to dairy technologies (breed, feed) 4=Credit 5=Other specify.....	

**Q4- Access to credit (multiple answer possible)**

1.	Have you ever taken credit in the last 2years? 1=Yes 0=No	
	If yes, amount of credit that you taken	-----Birr
2.	For what purpose you take the credit? 1=To purchase cross breed cow 2=To purchase improved forage/pasture/ 3=For household consumption 4=Other specify....	

**Q5- Access to input**

1.	Do you have access to dairy technology input supply? 1=Yes 0=No	
	If yes, for which dairy technologies 1=Improved breed cow 2=Artificial Insemination 3=Improved feed 4=Standardize housing 5=Regular vaccination	

**Q6- Extension contacts**

	Does an extension agent visit you for cases related to dairy management? 1=Yes 0=No	
--	---	--

1.	If yes, how often the extension worker visits you in one month	-----times
2.	How much training did you get in one month	-----times

**Part four: Information on dairy production, Product and estimated value/ per household/**

**Q1- Information on milk production and currently estimated value**

	Number of milking cow	Amount of milk produced per cow (liter per day)	Consumption (liter per day)	Sold (litter)	Current price (In birr)
Local cow					
Cross breed cow					

**Q2- Information on milk product production and currently estimated value**

	Amount of produced (In Kg per month)	Consumption (In Kg per month)	Sold (In Kg)	Current price (In birr)
Cheese				
Yogurt (litter)				
Butter				

**Q3- Information on household source of income in year (multiple answer possible)**

	Source of income	Amount the household got	Estimated price brought (Birr)
1.	Crop production		
2.	Livestock and their product sell		
3.	Working on others farm (labor)		
4.	Lease and land		
5.	Sale of wood and charcoal		
6.	Remittance		-----
7.	Other specify.....		
Total income			

**Q4- Information on employment opportunity**

1.	Is there any opportunity in the locality if you don't engage in dairy farming? <b>1= Yes</b> <b>0= No</b>	
	<b>1.1</b> If yes, how much are you going to earn	

**Part five: Dietary Diversity Status (HDDS) and Food Consumption Score of the household**

**Information on household food security (consumption and dietary diversity)**

Asking about 12 food groups they consumed during the day or night prior to the survey, whether consumed within the household or prepared within the household.

- “Normal”, “usual” or **average** condition of the household
- Put “**0**” if the household did not eat and put “**1**” if the household ate the food group in the **last 7 days**.
- The frequency of the food group eaten will be collected for the **past 7 days only**.

Please tell me what the household member consumed over the last seven days for **breakfast, lunch, and dinner**.

<b>Food group</b>	<b>HDDS 0 or 1</b>	day 1	day 2	day 3	day 4	day 5	day 6	day 7
Any <b>cereal</b> crops? bread, wheat, teff, or any other foods made from millet, sorghum, maize, rice								
Any <b>root and tuber</b> crops? potatoes, sweet potato, yams, beat root, cassava or any other foods made from roots or tubers								
Any <b>vegetables</b> ? Spinach, carrot, cabbage, pumpkin, beet root...								
Any <b>fruits</b> ? Orange, apple, mango, pineapple, avocado, banana, lemon, strawberry.								
Any <b>beef</b> ? sheep and goat, chicken, or other organ meats?								
Any <b>eggs</b> ?								
Any <b>fresh or dried fish</b> ?								
Any foods made from beans, peas, lentils, chickpea, grass pea or nuts?								
Any cheese, yogurt, milk or other milk products?								
Any foods made with oil, fat, or butter?								
Any sugar or honey?								
Any other foods, such as condiments, coffee, tea?								

## Checklists for Key Informants Interview (KII)

Please note that your insightful answers are crucial to our efforts in understanding overall assessment of impacts of dairy technology adaptation and factors that determine the adoption and level of intensity on rural household food security.

1. Do many people participate in the agricultural extension services?
2. Do farmers participate in dairy technology?
  - 2.1. If yes, in what kinds of technologies? /improved breed, improved feed, better housing, AIS services, vet. Services
3. What are the constraints for the adoption of dairy technologies?
4. What the community members involved in dairy extension (the rich/poor, female /male HHs, the literate/ illiterate, or other?)
5. What are the roles of women in dairy management?
6. Do you farmers get sufficient extension service and training from GO & NGO?
  - 6.1. Is the dairy technology profitable to farmers after participating in the technology?
7. What are the changes/ improvements/ you observed the impacts on household's food security status (households' dietary diversity and consumption patten)?
8. What intervention must be used for better implementation of dairy technologies in the future to increase the level of adoption in the area?
9. Please mention all problems associated with dairy production in the area?
10. Describe any social, economic and environmental problems in the district associated with dairy technology adoption?
11. What potentials are there for dairy technology extension in your area?

## **Check list for Focusing Group Discussion (FGD)**

### **For extension agent**

1. Did you know about food security concept?
2. What are the main constraints or challenges faced in the area during dairy technology transfer?
3. How is the food security Status of the household in the study area?
4. Which method you prefer to transfer dairy technologies in the area?
5. Did you get on food security and nutrition related training?

### **For sample households**

1. What is your perception on the dairy technologies?
2. How do you express the nature of dairy technologies?
3. Which dairy technology are difficult to adopt (breed, forage, AI)?
4. What kind of problem faced time of adopting dairy technologies?

**THANK YOU SO MUCH!!!**