JIMMA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

IMPACTS OF CROSSBREED DAIRY COWS ADOPTION ON SMALLHOLLDER FARMERS LIVELHOOD: THE CASE STUDY OF GIBE WOREDA, HADIYA ZONE, SNNPRS, ETHIOPIA

A THESIS SUBMITTED TO SCHOOL GRADUATE STUDIES OF JIMMA UNIVERSITY AS A PARTIAL FULFILLMENT FOR THE AWARD OF MASTER OF SCIENCE (MSc) DEGREE IN DEVELOPMENTAL ECONOMICS

BY:

SHIFERAW MISHEBO OTOCHO

JULY, 2020

JIMMA, ETHIOPIA.

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UNDER THE GUIDANCE OF

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DECLARATION

I hereby declare that this thesis entitled ‘‘The impact of crossbreed dairy Cows adoption on smallholder farmers’ livelihood: The case study of Gibe Woreda, Hadiya Zone, SNNPRS, Ethiopia ’’, has been carried out by me under the guidance and supervision of Mr. Hailemariam Legesse (PhD candidate) and Mrs. Mekdes Tamiru (MSc).

The thesis is original and has not been submitted for the award of any degree or diploma at any university or institutions.

Researchers’ Name	Date	signature
Shiferaw Mishebo	----------	----------

APPROVED BY BOARD OF EXAMINERS

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Co-Advisor	signature	Date
_____	_____	_____
Examiner (External)	signature	Date
_____	_____	_____
Examiner (Internal)	signature	Date

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ACRONYMS

AADDP	Addis Ababa Dairy Development Project
AADI	Addis Ababa Dairy Industry
AI	Artificial Insemination
AKLDP	Agricultural Knowledge Learning Documentation and Policy
CBDC	Cross Breed Dairy Cows
CSA	Central Statistics Agency
CYMMIT	International Maize and Wheat Improvement Center
DDA	Dairy Development Agency
DDE	Dairy Development Enterprise
ET	Embryo Transplant
EDHS	Ethiopian Demographic Health survey
FAO	Food and Agricultural Organization
FMoH	Federal Ministry of Health
GDP	Gross Domestic Product
KA	Kebele Administration
GWFEDO	Gibe Woreda Finance and Economic Development Office
GWLFRO	Gibe Woreda Livestock and Fishery Resource Office
GDANRO	Gibe development agriculture natural resource office
MoA	Ministry of Agriculture
MoFEC	Ministry of Finance and Economic Cooperation
SNNPR	Southern Nations, Nationalities and Peoples Region
UNICEF	United Nations International Children's Emergency Fund
UNRRA	United Nations Relief and Rehabilitation Administration

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Abstract

The main objective of this study was to identifying the determinants of Crossbreed Dairy Cows technology adoption and explores the impact of adoption in terms of income and assets on small households' livelihood in Gibe woreda, Hadiya zone, SNNPRS, Ethiopia. The woreda has 21rural kebeles and 4 municipal cities with one urban center. Of these kebeles, only six kebeles were potential according to participating on the dairy technologies. By using multistage steps procedure three kebeles were randomly selected for the study and 328 sample households from those kebeles. These selected households were grouped two parts that contain 154 adopters and 174 non-adopters. Primary data were collected from the sample households and key informants by using questionnaire. Secondary data were collected from different source such as related literatures, different relevant sector annual reports and research result documents. Descriptions of the sampled population and test of the existence of association between the dependent and explanatory variables to identify factors affecting adoption of dairy technologies were discussed. Logistic regression results revealed that, education level, family size, farming land size, off-farm income activates, distance to market, credit access, extension contact and input access were significant and positively affect adoption decision of improved Crossbreed dairy Cows adoption and sex of household headed affect negatively. In this study Tobit model used to assess factors related to the intensity of improved Crossbreed dairy Cows adoption and PSM method used to estimate the impact of improved crossbreed Cows adoption in income and physical assets on small farmers' livelihood of rural household. The result from PSM indicated that crossbreed dairy technology adoption has positive and significant impact on small farmers livelihood interims of adopters' annual incomes increased in average by 46.1% and the physical estimated assets increased in average 100%. In conclusion, diary technology has powerful capacity effect on small farmers in terms of income and assets producing. Therefore, based on the finding of this study, focus should be given to major factors that affect crossbreed dairy Cows technology adoption and improving awareness and perception through training, strengthen developmental agents capacity, introducing and disseminating to explore the impact of crossbreed dairy cows adoption on smallholder households' livelihood by applicable government and non-governmental organizations to increase production and productivity of sector.

Keywords*: Impact of crossbreed dairy Cows adoption, small households' income, asset, Gibe woreda*

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

Agriculture, especially in Sub-Saharan Africa, has proved its ability as a leading sector for initiating rapid economic development and, in doing so, has the potential to reduce poverty more than other sectors (FAO, IFAD and WFP,215). It is core sector in terms of overall economic growth of the country. The agricultural sector remains a dominant sector in the Ethiopian economy and an important source of economic growth. This means that the economic development the country is highly dependent on this sector's performance. According to (CSA, 2018) the agriculture contributes 42% of GDP, 85% labor force and around 90% of the total export earnings of the country. The sector is dominated by over 15 million smallholders producing about 95 percent of the national agricultural production. This shows that the overall economy of the country and the food security of the majority of the population depend on small holder agriculture. Ethiopia has a long-term goal to make Ethiopia a lower middle-income country by 2025. The agricultural sector includes both crops and livestock production. From those two sectors, livestock productions have a capacity to play rolls in country economy to arrive the goal. The dairy sector contributes about 16.5 % of the national Gross domestic product and 35.6% of the Agricultural gross domestic product (Metaferia,et al.,2011) .In spite of the large livestock population, the contribution of the Ethiopian livestock sector in general and the dairy sector in particular is below its potential at both the national and household level (Behnkle,2010). The study of (CSA, 2018),estimation implies that the total population of annual cow milk production is about 3.31 billion in liter, and this converts to an average dairy milk production per Cow of 1.371 liters per day. However, the average per capita supply of whole milk and meat were 16 and 8 kg, respectively (FAO Stat, 2013).

One of the reason for this less contribution, about 98.24% of the total cattle in the country are indigenous/local breeds and the remaining are hybrid and exotic breeds that accounted for about 1.54% and 0.22 %, respectively (CSA, 2018).This contributing considerable portion to the economy of the country and, still promising to rally round the economic development of the country. According to (Mihret et al.,2017) Livestock sector and dairy products have a maximum

benefit to small householders as livelihood base, job creation, draft power and income source and similarly the dairy sector can contribute immensely to poverty reduction and household food and nutrition security in the country. According to (AKLDP,2018) report implies that, in Ethiopia number of people living below the poverty line fall from 38% in 2005 to 23.5% in 2016, but the country still records some of the highest level of child malnutrition in the world with 38% of children stunted. Particularly, the people living with poverty accounts at small farm area because, more than 80 percent of whom live in rural areas (World Bank, 2018). The revised global nutrition target for 2025 implies 40% reduction in the number of children under five who are stunted. To break this recorded highest level of child malnutrition caused by less productivity, the livestock sector has been contributing a considerable portion to the economy of the country. It is eminent that livestock products and by-products in the form of meat, milk, honey, eggs, cheese and butter provide the needed animal proteins that contribute to the improvement of the nutritional status of people (Central Statistical Agency, 2012).

The aims of the Ethiopia livestock sector current status and future prospective at increasing milk and meat production, source of house hold income and use of dairy cows for improved milk consumption and nutritional status of house hold members but, One persistent gap has been the absence of technology adoption to make it modern and neither the farmers nor the concerned body are aware of the importance of the technology to update the livestock sector. About this, the study was very important to promote the improved breed and to increase awareness of the impact of adoption technologies on small holder farmers' that would help to come up with workable recommendations in order to improve the performance of the sector. Therefore, as a potential area this study is focused to explore the impact of cross bread dairy cows adoption on small household livelihood in terms of income and physical asset holdings as well as identify factors that affects small households technology adoption in the study area.

1.2 Statement of the problem

The Southern Nations, Nationalities and Peoples Region is the third highest potential region of the country in livestock production having 11.88 million cattle population next to Amhara and Oromia which owns about 16.14 million and 24.43million cattle population respectively . In spite of such a substantial potential, the dairy sector is not developed to the expected level. The cattle population in this region consists 98% indigenous, 1.91% cross breed and 0.09% exotic breeds with the total population Cow milk in the region estimated 0.72 billion liters with an average 1.36 liter per day per Cow (CSA, 2018). This implies that, almost all dairy production in the region depends mainly on indigenous livestock genetic resources. Because of this, production and productivity of livestock in region is low due to poor breeding and husbandry practices. The per capita consumption of milk and its product estimated about 17kg (Alemneh, 2019). Low-level of management, lack of proper breeding management, disease prevalence and feed shortage (both in terms of quality and quantity) were reported to low productive and reproductive performance of crossbred dairy cows (Belay, 2012).This indicates that, the productivity of the livestock resources and the benefits obtained from the sector do not commensurate with the high livestock population (Bereda et al., 2014).

According to National Planning Commission and MOFEC Poverty Reports, Prevalence of Absolute Poverty of SNNPR is 20.7% and the Food Poverty is 24.5% in 2016. From this in rural area obtains 26.1% and in urban area 15.3% which implies that, rural poverty is nearly two times higher than urban poverty. Similarly when we returned to the area where the study was conducted Gibe woreda of Hadiya zone Southern Ethiopia, there was high prevalence of low income small farmers are the most prevalent and most of the livelihoods have not improved and they have become accustomed to living without changes every year. As a result, the livelihoods of many small household farmers live on hand because they do not have the useful resources of modern agricultural machinery, dairy farming technologies and so on. This study is based on the changing nature of these farmers life. According to (GWLFRO, 2019), on the fact that, only 40% of the 243,198 cattle population in the woreda has benefited from the breeding services while the rest are not service users. One of the reasons mentioned this is the lack of awareness about the impacts of adoption technology among the small household farmers and the problem of not realizing the impact of technology is mentioned.

The adoption and extensive use of improved agricultural technologies is vital for poverty reduction and improved food and nutritional security in developing countries *(Barrett, 2010).* Hence, an alternative approach to achieve higher production levels is the introducing of cross bred animals. Cross breeding of local, adapted cattle with high-yielding breeds from the temperate zone enhances productivity and improves livelihoods of resource-poor farmers in a relatively short period of time (Tegegne et al., 2014). Several studies on the impacts of improved varieties (Abdulai and Huffman, 2014) and (Khonje et.al, 2015) have assumed that the characteristics and resources of adopters and non-adopters have the same impact on outcome variables (i.e., homogenous returns to their characteristics and resources). Most of these previous studies used single econometric models in estimating adoption impacts. Though various studies have been done on the impact of dairy cattle on farmers' livelihood, , but the impact vary from one place to another depending on how farmers were motivated to adopt the innovation, performance of the introduced animals and how supporting sectors like extension services, market and marketing are functioning (Muganyizi, 2011).

In this study area, there is a potential for changing the livelihood of smallholder farmers depending on the number of livestock in the area under study. But many farmers are still trapped in the local farming system alone. This is why there is a lack of information about the crossbreed cows adoption technology, which is one of the major problems that farmers face from modern technology and without a clear understanding of how much impact a service user can have; it can be seen as a major obstacle. In addition, the actors involved in promoting modern adoption technology in low income households, especially in rural areas, have limited awareness of the impact of technology on farmers' income growth, physical assets creation and consumption. This is important to do research in a way that solves the above problem because no research has been done on this area in terms of changing the lives of farmers in this area. Therefore, this study helps to address the challenges and small holder farmers by using crossbreed dairy Cows technology adoption improvements in productivity could have a substantial impact on farmer incomes, physical assets and consumption. Furthermore, the study results add up information to the little existing one, on which dairy development plans may be based for effective poverty reduction in the study area.

1.3 Research questions.

1. What are factors that determine crossbred dairy cows' technology adoption in the study area?
2. How is the rate and extent of crossbreed dairy technology in the study area?
3. What are the possible impacts of adoption of high yielding dairy cows on smallholder households' livelihood in terms of income and asset creating?

1.4. Objectives of the study

1.4.1 General Objective

The major objective of this study to explore the impact of crossbreed dairy cows adoption on smallholder households' livelihood: The case of Gibe Woreda, Hadiya Zone, SNNPRS, Ethiopia.

1.4.2 Specific Objectives

1. To identify determinants of crossbred dairy cows technology adoption in the study area.
2. To assess the rate and extent of crossbreed dairy cows technology adoption in the study area
3. To assess the impacts of adopting crossbred dairy cows on the livelihoods of smallholder farmers in terms of on household income and physical asset holding.

1.5. Significance of the Study

The study has a contribution for the gap existed in the literature on the impacts of improved crossbreed dairy cows adoption on household income and asset holdings. The findings of the study are helpful to encourage local farming people to improve dairy technology adoption by providing information for scale up best practices obtained in the study area. Moreover, the results of the study can also be used in guiding policy makers and development planners on agricultural technologies introducing and dissemination on the study area. Likewise, the findings may also provide future research directions for those who may be interested in conducting further research in related area. 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

This study was delimited to the adoption of crossbred dairy cows (high yielding dairy cows) and its effects on smallholder farmers' livelihood in the study area. The study employed cross-sectional data. The study focused only on smallholder farmers that of adopters and non-adopters of high yielding crossbred dairy cows. In addition, the study used data collected only from to be three Kebeles of Gibe woreda in terms of area coverage and it focused on dairy cattle rearing households only at the time of data collecting.

1.7. Operational definition of terms and concepts

Productivity**:** This refers to the ability of a farmer to increase milk yield in his dairy cattle. This is influenced by socioeconomic factors and availability of extension information.

Small Dairy Holder**:** This refers to a farmer who has a small parcel of land to practice dairy farming.

Adopter**:** A small household farmer who has participated in in improved dairy technology adoption.

Non adopter: A small household farmer who hasn't participated in improved dairy technology adoption.

Technology**:** An idea, practice or object perceived as new by an individual.

Technology Adoption**:** Continue full use of an idea as distinct from decision merely to try it, because of the benefits / advantages accruing from the technology.

1.8 Organization of the paper

This paper is organized in to five chapters. The first chapter depicts background of the study, statement of the problem, objectives, research questions, significance, scope and operational definition of terms and concepts of the study. The second chapter deals with literature review including theoretical review, empirical review and conceptual frame work. The third chapter presents research methodology including the background of the study area and, data types, source and methods of data collection, and methods of data analysis. The fourth chapter presents the result of the study and discussion. The last fifth chapter deals with conclusion and recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

The objective of this chapter is to review some related studies in connection with the present study. Some of those studies may not directly relate to the present study but their findings, methodology of analysis and suggestions have a great influence on the present study. Review of some research works relevant to the present study.

2.1 Theoretical Review

The study reviewed two sociological theories in an attempt to understand adoption of dairy farming technologies among small dairy farmers.

2.1.1 Diffusion of Innovations Theory

Everett Rogers (1968) is the main proponent of this theory. He describes innovations as an idea perceived as new by an individual, and which spreads by the process of diffusion through the essence of human interactions. The diffusion of innovation has four elements of analysis. (1) The innovation as perception of the new idea. (2) Idea communication/ diffusion as an element that spreads from its invention or creation to its ultimate users or adopters. This element consists of a new idea, an individual who knows about the idea and those individuals who do not know about the innovation yet. The relationships (interactions) between those who know and those who do not know have a great role in spreading the idea. (3) A social system element defined as population of individuals who are functionally differentiated and engaged in collective problem solving behavior.

All of them embers cooperate at least to the extent of having some common problems which they are seeking to solve. Rogers (1968) explains that in social systems, there is a continuum of types of adoption decisions that ranges from individual to group decision. Most of the innovation is by individual decisions. However, at intermediate point on the continuum from individual choice to group decision is the type innovation requiring prior acceptance by the majority of the social systems' members in making decision of technologies adoption. That is, an individual may wish to adopt an innovation but he/she cannot do so until others join or accept the idea. Some ideas are adopted by a group decision that forces the acceptance, even up on those who are unwilling. Once the community decision is made, the individual has little choice.

In some cases individuals with the influence in the social system are professional persons representing organizations external to the system, referred as change agents. (4) Adoption element of analysis refers to decisions to continue use of innovation, implying that the adopter is satisfied with the innovation. He also elaborated on innovation adoption as a process that involves both learning and decision making, and which under goes five stages; awareness, interest, evaluation, trial and adoption. In support of Rogers, Mbogo (1987) concurs with the view that awareness is created for trial and adoption of technology through the provision of extension services that enable farmers to improve their dairy farming management and adopt high levels of breeding dairy cows. Moreover, (Mugivn 1999) supported the view further that the adoption of farming technology can be described as a behavior that occurs in three ways: (1) Adoption behavior as willingness to change and try new ideas. (2) Farmers focus in increasing profit. (3) Adoption of technological innovations as a consequence of change to ward farming.

The study done by (Chitere 1994) described the extension officers as professionals' change agents who bring about change, and who act as encouragers or enablers, guides, advisers or consultants who facilitate the process of change. Rogers (1968) argues that the adopters of the innovations are vehicles of technological transfer in the spread of technologies. However the characteristics of innovation/ technologies do matter. The technologies that are simple are more rapidly adopted than those that are complex. Those that are easily and quickly adopted tend to be those whose relative advantage is immediate, obvious and a source of clear gain to the adopter. He readily adopted innovations are also compatible with existing values and past experiences.

For Samuel et al.,(2016), however , 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. Immediate and uniform adoption in agriculture is rare with rate usually differing across socioeconomic groups and over time (Khanal et al., 2010). This shows that 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.

2.1.2 Exchange Theory

Social exchange theory began with roots in behavior is min psychological and sociological perspectives that explain social change. The behavioral sociologists are concerned with the relationship between effects of actors' behavior on the environment and their impact on the actors' later behavior positively, neutrally or negatively (Blau,1964).

According to Marx Karl (1998), social exchange, together with value, use of value (utility) and price are the four attributes of a commodity. Marx indicates that the exchange value of a commodity is not identical to its price but represents what quantity of the commodities will be exchanged if traded.

According to Homans(1991), social exchange theory envisages social behavior as an exchange of activity tangible or in tangible and more or less reward or costly between at least two persons. The cost is incurred in engagement (actions) and there ward is what the person gets. He urges that if the action that brings more reward (success), the person is more likely to perform that action. If the response is positive, actors are more likely to repeat the behavior, and when the response is negative they will be less likely to repeat the behavior. People modify their behaviors in an attempt to maximize positive reactions and minimize negative reactions. The study based on (Dona 1991)**,** believes that for social change to occur, a community must possess certain characteristics. These include, knowledge of an issue, changing attitudes about the issue, beliefs forming the issue and developing behaviors to deal with issue.

Blau(1964) views the social exchange explicitly from an economic frame work, that the social interaction has value to the people. He emphasizes action value and actions work effectively for actors seeking to achieve interests or social change. He argues that the provision of something from one person to person, when accepted by another, creates an obligation to reciprocate with provision of something of high value. This shows that, contends that people are attached to each other for a variety of reasons that induce them to establish social associations. The associations remain strongly bonded if they provide rewards, and weaken if the reward is not insufficient. Reward could be income, physical labor, respect and many more.

The adoption of dairy farming technology is a behavior that has both psychological and sociological dimensions. Farmers as actors of this behavior change attitudes and embrace new technology in attempts to improve their livelihood through increased farm productivity. The behavior (adoption of dairy farming technology) engagement incurs variation cost, and the

reward consequences could have positive, neutral or negative impacts. According to (Staal, Baltenweck, Waithaka, DeWolff, & Njoroge, 2002) notes that dairy farming is a practice that involves high capital in acquiring and maintaining dairy cattle for optimal or maximum production. However**,** Stoz (1980) argues that farmers bear short term costs in investing in dairy technologies for resulting in ambiguous long and beneficial productivity. According to (Mugivn 1999)**,** previous traditional communal practices such as community grazing and use natural method in breeding, must change to be compatible with dairy farming practices (that the farmer become aware of the need of technology). Dona (1991) **,** indicates that it is personal and socio-economic characteristics such as formal education, awareness, and experience in farming, afford ability and suitability that influence the adoption of dairy farming technology. Chamberlin (1997) argues that, it is the individual farmer who must decide to adopt a new technology for his/her own operation and that the village is the basic work unit for change agents.

Formation of group associations such as farmers' cooperatives greatly enhance utilization of individual resources for better gain and power bargaining that influence the price to pay. Exchange theory assumes that people have access to information on interactions that they consider for alternatives or, for more profitable situations, relative to their present conditions. However, adoption of technology in developing countries is slow, restricted by various resource constraints and limited search for information (Philipsson & Rege, 2003). Farm technologies are introduced by one party and adopted by another. Therefore this theory helps to explain the exchange relationship between those who introduce the technology and the adopters.

2.1.3 Theoretical Perspectives of Adoption

The adoption of an innovation within a social system takes place through its adoption by individuals or group. According to Feder et al., (1985) adoption may be defined as the integration of an innovation into farmers' normal farming activities over an extended period of time. This implies that an individual may decide to discontinue the use of an innovation for variety of personal, institutional and social reasons one of which might be the availability of another practice that is better in satisfying farmer's needs. He classified adoption as individual (farm level) adoption and aggregate adoption. Adoption at the individual level is defined as the degree of use of new technologies and its potential. In the context of aggregate adoption behavior they define the diffusion process as the spread of new technologies within a region. This implies

that aggregate adoption is measured by the aggregate level of use of specific new technologies with a given geographical area or within a given population. Rogers (1983), defines the adoption process as the mental process through which individual passes from knowledge of the innovation (first hearing about an innovation) to final decision to adopt or reject the technologies. This indicates that adoption is not a sudden event but a process. Farmers don't accept technology immediately; they need time to think over things before reaching a decision.

2.1.4. 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 populations in Ethiopia are indigenous and the rest is improved. Most of the local indigenous cattle belong to Zebu type (Tadess and Abebew.,2016).

According to Tegegne et al., (2010), 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. 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.

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 Zeleke 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.

2.1.5. Dairy production systems in Ethiopia

Livestock are kept in all of the production systems of Ethiopia by pastoralists, agro pastoralists, and crop/ livestock farmers (Ahamed ,2003). Dairying is practiced almost all over Ethiopia involving a huge number of small, medium or large-sized subsistence or market-oriented farms. Based on climate, land holdings and integration with crop as criterion, dairy production systems are grouped in to rural, per-urban and urban dairy systems (Redda, 2002).

2.1.5.1. Rural household dairy production system

Rural dairy system is part of the subsistence farming system that contribute up to 98% of the total milk production in Ethiopia, and includes pastoralists, agro-pastoralists, and mixed crop–livestock producers (Ketema ,2000). The system is not market oriented and most of the milk produced in this system is retained for home consumption (Shahin, 2004). The level of milk surplus is determined by the demand for milk by the house hold and its neighbors, the potential to produce milk in terms of herd size and production season, and access to a nearby market. The surplus is mainly processed using traditional technologies and the processed milk products such as butter, ghee, cheese and sour milk are usually marketed through the informal market after the households satisfy their needs (Tsehay,.2002). Small-holder producers sell their milk and milk

products to urban areas (primarily through informal market) when transport is available and affordable. At some distances, the cost to transport raw milk prohibits selling to distant markets or any market for more rural producers (O'Lakes, 2010).

2.1.5.2. Per-urban or small scale dairy production system

Per-urban milk production is developed in areas where the population density is high and agricultural land is shrinking due to urbanization around big cities like Addis Ababa and other regional towns. It possesses animal types ranging from 50% crosses to high grade Friesian in small to large sized farms, and contributed only 2% of the total milk production of Ethiopia. The main source of feed is both home produced and purchased hay and the primary objective is to get additional cash income from milk sale. This production system is now expanding in the high lands among mixed crop–livestock farmers, and serves as the major milk supplier to the urban market (Gebre wold et.al,2000).

2.1.5.3. Urban or commercial dairy production system

Urban dairy farming is a system involving highly specialized, state or business men owned farms, which are mainly concentrated in around major cities of the country. There are about 40,000 crossbred and pure exotic cows in urban and per urban areas of the country. In Addis Ababa alone, there are about 5200 dairy farms with some 58,500 cattle (almost 50 percent crossbred). Total annual milk production from 5200 dairy farms is estimated at 44 million liters in which 83% is marketed, while the difference is used for household consumption (Azege,2004). In terms of marketing71% of the producers sell milk directly to consumers. Moreover, price is high even when quality is low. No standardize quality control mechanisms or dairy policy exists to safe guard consumers (Tsehay,2002).

They have no access to grazing and currently, a number of smallholder and commercial dairy farms are emerging mainly in the urban and per-urban areas of the capital and most regional towns and districts. Urban dairy systems in general are located in cities and/ or towns and focuses on production and sale of fluid milk, with little or no land resources, using the available human and capital resources mostly for specialized dairy production under stall feeding conditions (Feleke,et.al,2001)

As compared to other systems they have relatively better access to inputs (e.g. feeds) and services (e.g. artificial insemination) provided by the public and private sectors, and use

intensive management. The urban system of Hawassa, Shashemene, Yirgalem and Dilla is mainly based on cattle, both improved dairy cattle genotypes (crossbreds or high-grade) and indigenous cattle. Marketing of fluid milk in these towns is arranged through direct contact between producers and consumers, and/ or involves whole sellers/ processors, cooperatives, and retailers (Tegegne et al., 2013).

2.1.5.4 Constraints of dairy technology in Ethiopia

Feed shortage was more severe problem in Chencha and disease took the high rank in Kuncha. 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 (Minale and Yilikal,2015). Citing findings of the study of (Tegegne et al.,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. 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 (Jiregna,2013).

2.1.6 Determinants of adoption of dairy technologies

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, et al., 2014).

2.1.7 Nutrition requirement of dairy cattle

Nutrition has a profound influence on productivity and production performance of dairy cattle. Because of high metabolic rate and requirement for milk secretion, lactating, cows have special demand for nutrient supplement (Indentent, 2009). In practice milk yield and composition are influenced mainly by the dietary supplies of energy and protein (Tadesse.,2003). Energy and protein, of feeds are central in determining nutritional adequacy and feeding levels for different classes of livestock *(Streeter, 2006).* 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 (Quudus ,2012).

2.1.8 Impact assessment concept

Different authors interpret the term impact assessment differently. In this context, impact assessment is a measure of the direct out-put on the ultimate beneficiaries; it provides a measure of contribution of a program (crossbred dairy technology) in a broader development goal referred to as a goal of the project. It is also referred to the analysis or evaluation of the potential result of a particular program; which provides an approximate order of magnitude to be used by stakeholders. It is important to note that impact begins to occur when there is behavioral change. For instance, if farmers start using crop and livestock production techniques as a result of the intensive training on improved production techniques, then the introduced technology will have led to an impact of crossbred dairy technology adoption (Mwaseba et al.,2004). Impact assessment can be carried out before project inception (Ex-ante) or after a project work has been completed. Impact assessment is meant for planning, studying likely impact, and setting frame work for ex-post impact assessment. The ex-post is meant to provide feedback to implementers, planners, policy makers and other stakeholders. The impact can be assessed by using the following procedures for comparison, these are “before and after”, “with and without” and the target versus achievement realized (Kisusu,2003).

2.1.8.1 Impact of dairy technologies on smallholder farmers' livelihood

The impact of specific improved technologies on the livelihood of the farmer is measured in different indicators. Few of those indicators are impact on income and income diversity of the farmers, cash needs of the family, asset availability, new house construction and rehabilitation of the old, school fees and purchase of educational material of children, medical fees, clothing fees, seed purchase and purchase of livestock and crop for the family size. On other hands, household food diversity and food availability are the criterion for the nutritional effects of adoption (Samuel et al., 2016).

Sources of household Income: In developing countries, livestock production is a major source of income. For many mixed, smallholder farming systems, livestock is an important source of income (Sansoucy et al.,2016). Similarly, (Mohamed et al., 2004) reported that the significant raise in the household income of smallholder dairy farmers in the rural Ethiopia is due to the adoption of market-oriented dairy production using crossbred cows and improved dairy technologies.

Increased purchasing power: The small scale industry contributes significantly to poverty reduction particularly in rural and per-urban areas. In Tanzania, farmers consider this industry as one of their main source of income. Resource poor farmers derive their income from livestock and use them to purchase agricultural inputs such as fertilizer, herbicides and pesticides. (Mode et al.,1989) reported that livestock keeping as a banking strategy and that it plays the role of capital (wealth) accumulation. (Abdi and Delago, 1999) argued that dairy cattle do not only offer capital accumulation which may enable producers to gradually shift to more intensive non-farm activities, but also has spin-off effects from net increase in incomes and spending on assets and services like education and health. In a previous study, reported that in Tanzania, income (financial capital) from milk sales helped the smallholder farmers to acquire addition all and, improve their houses including cattle sheds (physical capital) finance small scale business, send children to secondary schools(human capital)and expanded the dairy enterprises (Bayer et al., 2006).

Milk Consumption: Animal food products such as meat and milk are concentrated sources of high-quality protein, vitamins, minerals, and other micro nutrients vital to human health (Scoones, 2009). When children consume modest amounts of animal proteins, it alleviates poor growth, poor cognitive development, and impaired physical health. Milk is also a good source of

other nutrients such as magnesium, zinc, phosphorus, and calcium which are essential for body growth (Kawonga et al., 2012)

The consumption of milk improve household nutrition as quality foods of animal origin enhance human growth and development, particularly of children in chronically mild to moderately malnourished populations, because they contain amino acids absent in cereals and essential to human health. Dairying with crossbred cows and improved production technologies could have a positive impact on human nutrition, both directly by consumption of increased milk and dairy products and, indirectly via sale of increased output and the purchase of more and better quality food (Tangica et al., 2002).

Household health: It has been well established by nutritionists that consumption of more dairy products results in a better human nutrition and health. So, the family member of the households who consume more dairy products is healthier. Households that used market-oriented dairy production technologies increased their income and animal values significantly. The increased resources led to significantly higher food consumption, calorie intake and marketed surplus. The significantly increased marketed surplus has also the potential to improve diets of non-dairy households (Tangica et al.,2002).

2.2. Empirical literature

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 and better income 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 impede 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 (Beshir et al., 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, (2017), 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. Factors determining technology adoption and productivity differ from one sector to the other and from one region to the other in the same sector. Especially, dealing with agricultural technologies where the sector has its own peculiar characteristics like seasonality of production and its high dependence on the vagaries of natures makes it different from the other sectors. Moreover, there is a significant difference in terms of the characteristics of agriculture in developing and developed countries. In developing countries, the agricultural sector is characterized by its high dependence on natural phenomenon, highly constrained by shortage of resources and undertaken by less educated farmers (Berhanu,2002).

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 (Yenealem2006),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.

According to Dehinene et al.,(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 Iquib 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 improves the farm management skill. According to Dehinene 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, 2012), Furthermore, a number of empirical studies have been conducted by different people and institutions of farmers' adoption behavior both outside and inside Ethiopia using econometric models. The results of various empirical studies confirmed that adoption of a new technology offers opportunities for increasing productivity, output quality, market supply, and income. The empirical studies have witnessed the significant contribution of using improved agricultural technologies to the productivity and welfare (income) of farming communities. The application of each econometric model used for adoption study depends on the objective of the research. Some authors such as Shiferaw and Tesfaye(2006) and (Assefa and Gezahegn (2010) employed Logit and Probit models for estimating status of technology adoption. According to (Beshir, Emana, Kassa, & Haji, 2012) used double hurdle model to analyze the status and intensity of technology adoption. Whereas, Menale et.at.,(2011) and Moti et al.,(2013) used multinomial Tobit model for estimating the status of more than two inter dependent technologies choice option. Logit and Trobit is best suited if the objective of the research is to analyze only status of technology adoption, multinomial model for analyzing the status of more than two independent technologies adoption options and multivariate Logit model for analyzing the status of more than two inter dependent technologies adoption options. To bit and Double-hurdle models estimate both status and intensity of adoption sequentially, but it overlooks the aspect of selectivity bias (Greene,2012).

2.2.2 Literature gap

In light of this review of the theoretical and empirical literature cited above, much of the research that we can help with is focused on the identifying the factors that affect income and assets of small household farmers, either directly or indirectly. However this study focuses primarily on identifying rural barriers to rural farmers' use of cross breed dairy cows adoption technology and evaluating the impact of adoption technology in terms of income and asset holding to improve livelihoods of small household farmers. This review will help farmers to reduce the lack of information adoption technology used by farmers.

2.2.3 Conceptual Framework of the study

The conceptual frame work of this study is explained at the below fig one based on the using dairy adoption technology and its impact on small farmers livelihood. The model shows how the technologies adopted by small dairy farmers in attempts to increase cattle productivity and factors affecting the adoption of dairy farming technologies. The enabling and impeding factors inter relate with each other during the adoption. Increased adoption translates to two things: financial assets and physical assets of small household farmers and possibility of farther adoption.

Conceptual framework model of the study was presented as follows:

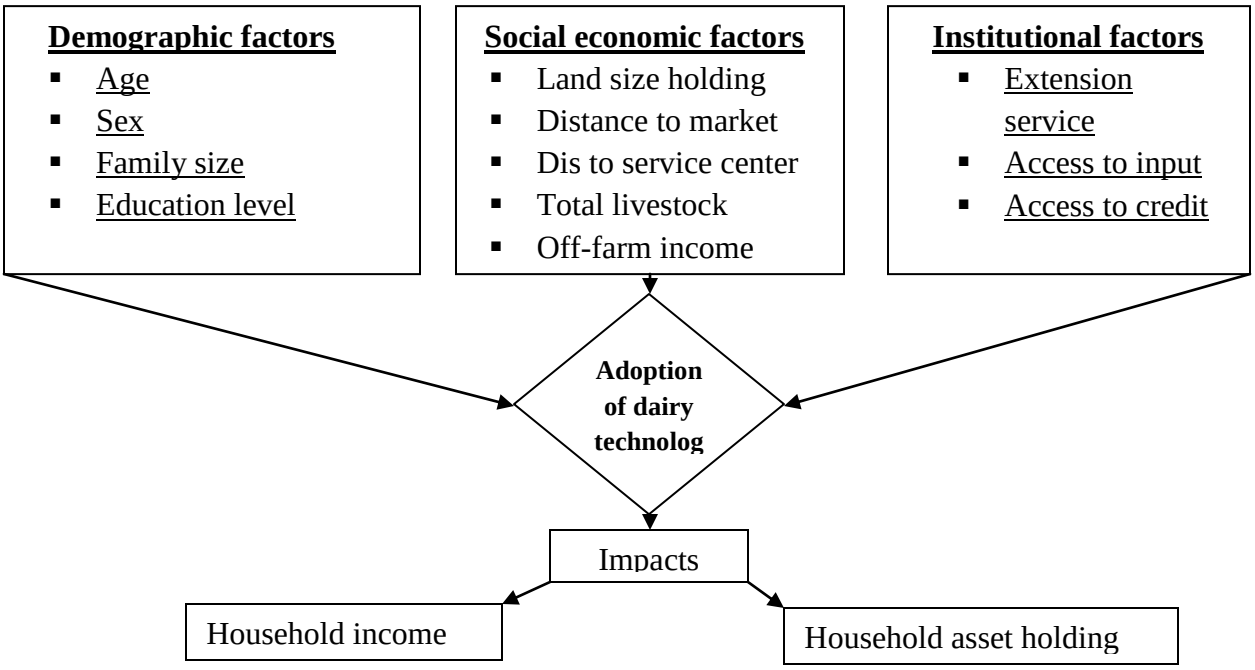

Figure 2.1: Conceptual frame work of crossbreed dairy cows' adoption**:**
Source: Own compilation from the literature (2020).

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Description of the Study Area

Location and Land Use

This study was conducted in Gibe woreda which is located in Hadiya administrative zone in southern Nation Nationalities People Regional State of Ethiopia and is lying between 7^0 37'53"-7^0 42'43''North Latitude and $37^0$37''07''-37^0 44'25'' East Longitudes. The woreda has an altitude that ranges from 1100-2600 meters above sea level. Gibe woreda is located at 260 km from Addis Ababa, 205 from the regional capital Hawassa (capital of SNNPR) and 30 km southwest from capital administrative zone Hosanna. The district is bordered by Gombora district in the North East; Yem special district in the Northwest; Misha and Lemo district in south and southeast; Guraghe in the northwest. The total area of district is 44,783 hectares. With regard to land use pattern of the district, cultivable land comprises the highest (69.8%), pasture (8.4%), forest (14.5%) and remaining (7.3%) is considered as mountainous, swampy and otherwise unusable (GDLFRO, 2016).

Population, Climatic conditions and economic activities

The Gibe woreda consists of 21 rural kebeles and four developing municipality towns with one urban center. The total human population of the district is estimated 142,862 from this 78,465 (54.92%) men and 64,397 (45.08%) female. The total number of households is estimated to be 24,083 from this, male and female accounts 22,280 (92.51%) and 1,803 (7.49%) respectively as reported by (GWFEDO, 2019). Out of the total population, 14 % will be estimated urban residents (CSA, 2013).

The general elevation of the district ranges from 1100-2600 meter above sea level and according to GDANRO report, (2016) the district has three basic agro-climatic conditions, namely Dega (14.2%), Woina-Dega (53.1%) and Kola (32.7%). The mean annual rainfall of 600 to 1200mm and the average temperature is 17.6 ^{0}C to 25 ^{0}C. The common agricultural practice of the district is mixed (crop- livestock) production system. The major growing crops in the district are maize, sorghum; wheat, teff, barley, (coffee and chat) are the major cash crops and vegetable crops currently grown in the area include onion, tomato, green peppers, and some leafy vegetables and

enset. Livestock production systems are generally characterized by low management in terms of nutrition, management, disease control, feeding system and the production system.

The total livestock population in the district is estimated to be 243,198 cattle, 132,204 goat, 79,281 sheep, 12,169 donkey, 2,938 horse; 9,121 mule 450,674 poultry, and 11,600 bee hives are exists in the district (GWLFRO, 2019).

This study was conducted at Homecho G/mehiber, Hamola and Hadaye kebeles as depicted below.

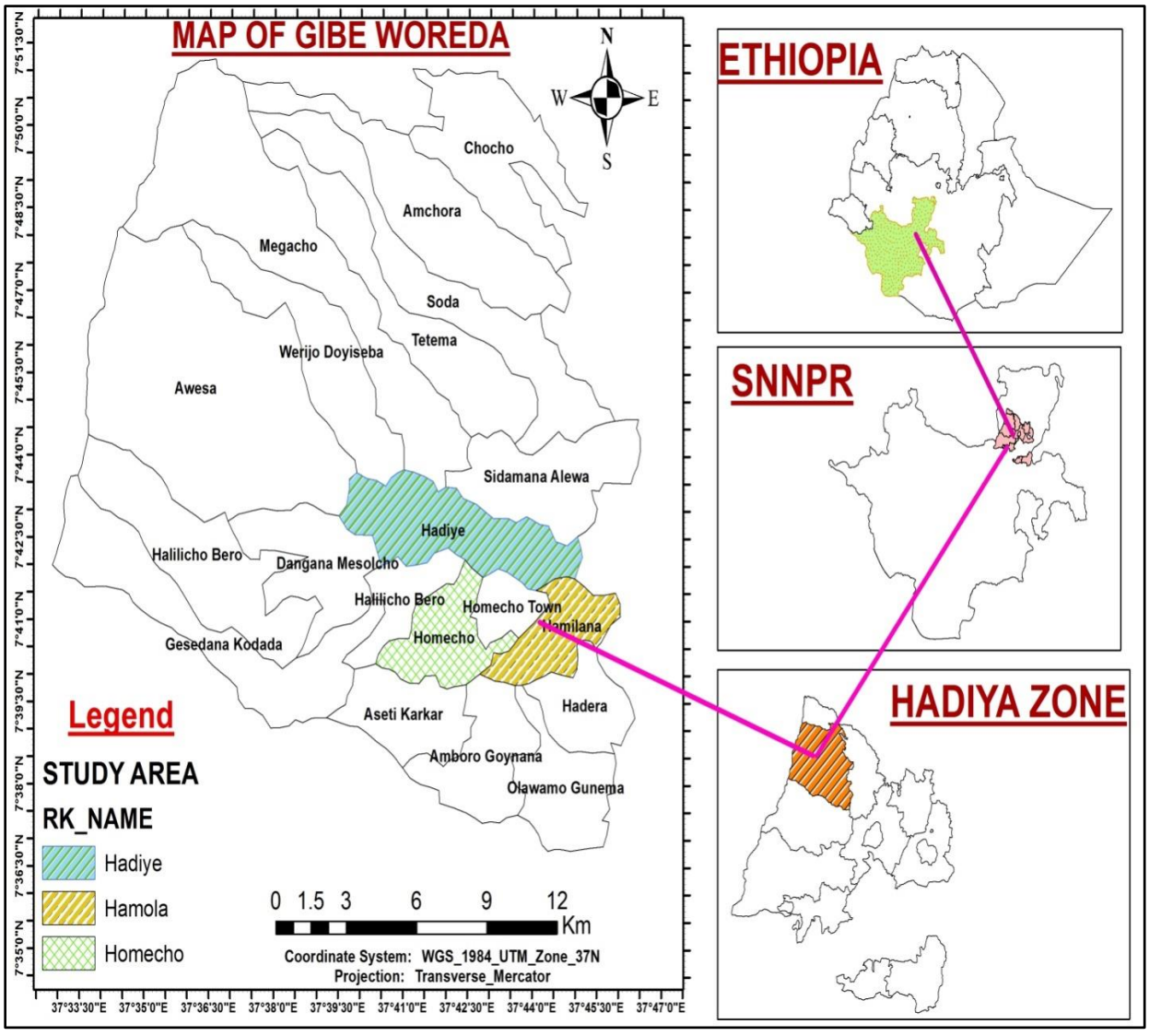

Figure 3.2: Map of Gibe Woreda

Source: Gibe District land administration and land use (2019).

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 techniques and sample size

3.3.1. Sampling techniques

Multistage sampling technique was employed to address the objective of the research in this study. In the first stage, the only six kebeles are selected randomly based on its dairy production potential and number of dairy technologies availability and practiced in the area. At the second stage, three kebeles were randomly selected from the woreda among potential dairy producer kebeles. Thirdly, within the three 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 Homecho K/G/mahiber, Hamola and Hadaye. At the end, simple random sampling was applied to select the sample household farmers. A total of 328 samples were selected and out of which 154 are adopters and 174 non-adopters farm households participated in the process.

3.3.2. Sample Size

Yamane (1967) suggested simplified formula for calculation of sample size from a population. According to him, for a 95% confidence level and p = 0.05, size of the sample should be

$$n_o = \frac{N}{1+Ne^2} = \frac{1837}{1+(1837)(0.0025)} = 328$$

Where,

- N is total number of HHs of the three sample kebeles, i.e. 1837 households.
- Therefore, sample size n=328 households.
- **e** is the level of precision i.e.0.05

Finally, by using population proportion to sample size method the sample size of each kebele would be determined as follows.

$$\text{Sample size of the kebele} = \frac{\text{total sample size} * \text{number of HH of the kebele}}{\text{total number of HH of selected kebeles}}$$

Table 3.1: Distribution of Sample Respondents probability proportional to size by kebeles

Kebel code	Kebeles Name	Total HHs in each kebeles	Non-adopter HHs		Adopter HHs		Total sample size
			Total	Sample	Total	Sample	
01	Homecho K/G/mhber	547	328	52	219	46	98
02	Hamola	769	469	73	300	64	137
03	Hadaye	521	313	49	208	44	93
Total		1837	1110	174	727	154	328

Source: Computed based on data obtained from Gibe woreda administration.

Thus the sample respondents from Homecho ketema Geberemahber, Hamola and Hadaye kebele were selected 98 households, 137 households and 93 households respectively. There for, this study was it holds only 328 households from the whole household population were lived in the study area.

3.4. Methods of data collection

Primary data was collected using questionnaire survey of households, focus group discussion and field observation. Secondary data was also collected from the livestock and fishery resource office of the wereda.

3.4.1. Questionnaire survey

Livestock and fishery resource office experts who were familiar with local language Hadiyisa were recruited and trained on way of handling and administering the questionnaire and questionnaire was prepared by English language and translated into Amharic which interpreted with local language Hadiyisa. Using a semi-structured questionnaire, information about the socio-economic characteristics of households, purpose of keeping dairy cattle, dairy cattle breed and type owned, herd size and composition, source of foundation and replacement stock, herd management labor division, reproductive and productive performance of dairy cattle; breed improvement practices and impacts and adoption of crossbred technologies on household livelihoods, usage of artificial insemination, milking practices, marketing of milk and milk products, consumption of milk and milk products, households income and assets and major constraints and opportunities of dairy cattle production were assessed.

3.4.2. Focus group discussion

A focus group discussion was held with livestock experts, development agents and a group of 1 to 5 farmers having much more experience in each study kebeles so as to get general information regarding small holder dairy cattle production, adoption patterns and the major challenges of dairy cattle production in the study area using a prepared checklist. During focus group discussion the researcher was leaded the discussion based on the checklist.

3.4.3 Field observation

Field observation was undertaken to get more information on the housing system, feeding and watering practices, grazing land, breeding practices, production potential of dairy cattle and veterinary health services, actual status (living standard) of dairy cattle producers in each study kebeles.

3.5 Methods of data analysis

The farm survey data was analyzed using both descriptive and econometric procedures (inferential procedure) of data processing.

3.5.1 Descriptive Statistics.

Descriptive statistics: is concerned with summary calculations, graphs, and tables, like mean, standard deviation (S.D), frequencies, ratios, percentages, and tabular analysis were used to examine and understand the socio economic situations of sample respondents.

3.5.2 Inferential Statistics

Inferential Statistics: is a method used to generalize from a sample to a population. It contains performing estimations and hypothesis tests, determining relationships among variables, and making predictions. The core aim of this investigation was to understand the adoption of crossbred dairy cows' technology on smallholder farmers' livelihoods. The variable representing adoption of the technology is a dummy variable that takes a value of one (1) for adopter or zero (0) for non-adopter depending on whether or not a sample farmer has owned crossbred dairy cow during the survey period. This binary variable was related to several sets of factors (continuous and/ or dummies) that were believed to influence adoption decision of the technology. To determine factors affecting the adoption of improved crossbred dairy cows, binary Logit model

was used. Such model has been widely used in different adoption studies not only to help in assessing the effects of various factors that influence the adoption of a given technology, but also to provide the predicted probabilities of adoption (Asfaw.,1997).

Feder.et.al.,(1985) pointed out that both models have been used inter changeably and give almost the same results. However, the Logit model is simpler in estimation than the Tobit model (Aldrich and Nelson,1984).The Logit model, therefore, was used in this work to identify factors influencing the adoption of cross breed dairy Cows.

Also the main objective of impact evaluation was to estimate the treatment effect of an intervention T on an outcome Y. The evaluator's key question was what happened to the beneficiaries by the intervention of a certain program or project? This was done by comparing individuals those participated in the intervention to those that did not. The effect of a treatment in a population may vary with both observable and unobservable characteristics of farmers. An endogenously switching regression (ESR) model also used to estimate the effect (impact) of improved crossbred dairy cows adoption on households, livelihood. The (ESR) method is discussed below briefly.

3.6. Econometric model specification

3. 6.1. Endogenous switching treatment effect regression analysis

A survey of recent literature shows that many impact assessment studies based on cross-sectional data have moved towards endogenously switching regression model (Abdulai and Huffman,2014). The assumption behind using endogenously switching treatment effect regression is that, in addition to the observed variables, there might be unobservable farm and/ or household characteristics that could potentially influence both the adoption of improved dairy cattle and household livelihood. A farm house hold self-selects in to adopting agricultural technologies due to observable and unobservable variables. Estimating the impact of technology adoption on household livelihood without accounting for this problem might suffer from potential endogeneity bias and thus the estimated results may over- or under-estimate impacts compared to the actual impact. To correct this, endogenous switching regression analysis was used and selectivity is modeled using Logit model. A farmer (i) adopts improved crossbred dairy cows if the expected utility from adoption (U_a) is higher than the corresponding utility from

non-adoption (Una), that means,Ua− Una>0. The fact is that the two utilities are unobservable; they can be expressed as a function of observable components in the latent variable model below.

$Ai = Zi\alpha + \varepsilon i$ Where $Ai = \begin{cases} 1 \text{ if } Zi\,\alpha > 0 \\ 0 \text{ Other wise} \end{cases}$ ---------- (3.1)

Where,

T: is a binary 0 or 1 dummy variable for the use of the new technology;

T= 1 if the technology is adopted and T= 0 otherwise.

α: is a vector of parameters to be estimated,

Z: is a vector that represents household and farm level characteristics, and ε: is the random error

The average treatment effect on the treated (ATT) computes the average difference in outcomes of adopter's category with and without a technology. Most commonly used methods to calculate ATT such as PSM ignore unobservable factors that affect the adoption process, and also assumes there turn (coefficient) to characteristics to be same for adopters and non-adopters, which is not the case in many recent empirical studies (Shiferaw et.al,2014). The ESR frame work proceeds in two stages: the first stage is the decision to adopt a crossbred dairy cows (CBDC), and this is estimated using a Logit model; in the second stage an Ordinary Least Squares (OLS) regression with selectivity correction is used to examine the relationship between the outcome variable and a set of explanatory variables conditional on the adoption decision. The two outcome regression equations, conditional on adoption can be expressed as:

Regime 1 (Adopters): $y_{1i} = x_{1i}\beta_1 + w_{1i}$ if T=1(1a)

Regime 2 (Non-adopters): $y_{2i}=x_{2i}\beta_2+w_{2i}$ if T=0(1b)

The ESR frame work can be used to estimate the average treatment effect of the treated (ATT), and of the untreated (ATU), by comparing the expected values of the outcomes of adopters and non-adopters in actual and counterfactual scenarios.

We calculate the ATT and ATU as follows:

Adopters with adoption (observed in the sample)

$(y_i1|T=1;) = x_{i1}\beta_1+\sigma\varepsilon_1\lambda_{i1}$ ----------(3.2a)

Non-adopters without adoption (observed in the sample)

$(yi_2|T=0;)=x_{i2}\beta_2+\sigma\varepsilon_2\lambda i_2$ ----------(3.2b)

Adopters had they decided not to adopt (counterfactual)

$(yi2|T=1;)=xi1\beta2+\sigma\varepsilon2\lambda i1$ ----------(3.2c)

Non-adopters had they decided to adopt (counterfactual)

$(yi1|T=0;)=xi2\beta1+\sigma\varepsilon1\lambda i2$ ----------(3.2d)

The ATT is computed as the difference between (3.2a) and (3.2c);

$ATT=(yi1|T=1;)-(yi2|T=1;x)=xi1(\beta1-\beta2)+\lambda i1(\sigma\varepsilon1-\sigma\varepsilon2)$----------(3.3)

The average treatment effect on the untreated is given by the difference between (3.2d) and (3.2b);

$ATU=(yi1|T=0;)-(yi2|T=0;x)=xi2(\beta1-\beta2)+\lambda i2(\sigma\varepsilon1-\sigma\varepsilon2)$----------(3.4)

Similarly, the expected change in the livelihood status of a household not adopting CBDC had they adopt, i.e., the average effect on the untreated households (ATU) is given as:

ATU =(d)-(b) =E[Y1i|X, Ai = 0]-E[Y2i|X, Ai = 0] = X2i(β1 − β2) + **λ**2(σ1ε-σ2ε)----------(3.5)

Where, X1, X2 and X_i were set of explanatory variables affecting CBDC adoption in regime 1 and 2, respectively, and β1, β2 ... βi are parameters. It might be the case that households rearing improved dairy cows might have had better livelihood status than households rearing only local breeds, regardless of the fact that these households are rearing improved crossbreed, due to unobservable factors that could potentially affect the status of household livelihood.

3.6.2 Logit model specification

In this research 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).* So, the logistic cumulative probability function for adopters is represented by:

$$Pi= \frac{1}{1+e^{-Zi}} = \frac{e^{Zi}}{1+e^{Zi}} \quad \text{(3.6)}$$

Where,

P_i : is the probability of adopting crossbred dairy cows for the i^{th} farmer

e: represents the base of natural logarithms.

Zi: is a function of n-explanatory variables which is expressed as

$$Zi=\beta0+\sum_{i=1}^{11}\beta iXi= \beta0 + \beta1X1i + \beta2X2i\ldots\ldots \beta11X11i \quad \text{(3.7)}$$

$$Pi=\frac{1}{1+e^{-(\beta0+\beta1X1i+\beta2X2i\ldots\ldots+\beta12X12i)}} \quad \text{(3.8)}$$

If Pi is the probability of adopting a given crossbreed dairy cows adoption then (1-Pi) the probability of not adopting can be written as:

$1\text{-}Pi=\frac{1}{1+e^{Zi}}$……..……..…..…...…… (3.9)

We could use a simple transformation to make the model linear in the Xs and the coefficients.

Taking the ratio of equation (3.6) and (3.9) that means the probability that a farmer is an adopter against the probability that he/she is not, we obtained:

$\frac{Pi}{1-Pi}=\frac{1+e^{Zi}}{1+e^{-Zi}}=e^{Zi}$…….……...…….……..…… (3.10)

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

Now $\frac{Pi}{1-Pi}$ is simply the odds ratio in favor of adopting the ratio of the probability that a person is an adopter to the probability that he or she is not an adopter.

Then the dependent variable was transformed by taking the natural log of equation (3.10) specified:

$Li=Ln(\frac{Pi}{1-Pi})=Zi=\beta Xi+Ui.=\beta 0+\beta 1X1+\beta 2X2+\cdots \beta nXn$……...……..…. (3.11)

Where,

Li is the log of the odds ratio and L is the logit.

Zi: is which the stimulus index, where Pi ranges between 0 and 1.

As indicated, the logit model for this study was identified as follows with variables of the study:

$Y = \alpha + \beta_1 AGE + \beta_2 SEX + \beta_3 EDULEVEL + \beta_4 FMLSZ + \beta_5 FRMLSZ + \beta_6 OFFINC + \beta_7 LIVSZ + \beta_8 MRKDIS + \beta_9 DADC + \beta_{10} CREACC + \beta_{11} EXTCON + \beta_{12} INPUTACC + U_i$

3.6.3. PSM (Propensity Score Matching)/impact model

Propensity score matching (PSM) constructs a statistical comparison group that is based on a model of the probability of participating in the treatment, using observed characteristics. Participants (adopters) are then matched on the basis of this probability, or propensity score, to non-participants (non-adopter).

The average treatment effect of the program was then calculated as the mean difference in outcomes across these two groups. The validity of PSM depends on two conditions: (a) conditional independence (namely, that unobserved factors do not affect participation) and (b) sizable common support or overlap in propensity scores across the participant and non-

participant samples. Its 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 income and physical assets on small farmers' livelihoods. Mach treated (adopters) and untreated (non-adopters) observations on the estimated probability of being treated (propensity score).Most commonly used. Enables matching not just at the mean but balances the distribution of observes 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.

Some steps of propensity Score matching: The need of representatives and comparable data for both adopters and non-adopters members, use a logit to estimate program participations as a function of observable characteristics, use predicted values from logit to generate propensity score probability of independent variables for all treaded and comparison group members, match pairs and once matches are made, we can calculate impact by comparing the means of outcomes across participants and their method pairs. Different approaches were used to match participants (adopters) and nonparticipants (non-adopters) on the basis of the propensity score.

Propensity Score Matching estimates the average impact of adoption of improved crossbreed Cows adoption on adopters by constructing a statistical comparison group on the basis of the probability of adopting in the treatment T conditional on observed characteristics X, given by the propensity score (Rosenbaum and Rubin, 1983).

$P(Xi) = \Pr(Ti = 1/X)$---------- (3.12)

As a result, if the population of units denoted by i and the propensity score P (Xi) is identified, the average effect of Treatment on the Treated (ATT) can be estimated as follows:

$\delta i = Y1\text{i} - Y0i$ ---------- (3.13)

Where, i, the impact of treatment on individual,

δi, is the difference between potential outcomes with and without treatment. States 0 and 1 correspond to non-treatment and treatment, respectively.

To evaluate the impact of a program over the population, we may compute the average treatment effect (ATE

$ATE = E[\delta i] = E[Y1 - Y0]$ ---------- (3.14)

We want to compute the average treatment effect on treated (ATT):

$ATT = E(Y1 - Y0/D = 1)$---------- (3.15)

Where, D = 1 refers to treatment.

The next is the average outcome of treated individuals had they not received the treatment. We cannot observe that, but we do observe a corresponding quality for the untreated, and can compute.

$$\Delta = E(Y1/D = 1 - E(Y0/D = 1) \quad (3.16)$$

The difference between the average treatment effect on treated and average outcome of treated individuals had they not received the treatment as follows:

$$\Delta = ATT + Selection\ bias\ term \quad (3.17)$$

The meaning of Selection bias term is the difference between the counterfactual for treated units and observed outcomes for untreated units. Here it must be zero and Δ must be useful. But, selection bias in a non- experimental context is sizable.

This study focused improved cross breed dairy Cows adoption to small farmers' livelihood was to support households' interims of income and asset holdings. During small farmers these dairy farming technologies was linked by certain constraints for decades and the demands of the product now increasing through time. These constraints were done by different actors and farmers themselves. For those challenges one of the reason as mentioned, the impact of dairy technology were not analyzed on small farmers livelihood as interims of on farm household income and asset holdings in the study area. There for, this study was increase the evidence as the whether or not the crossbreed dairy Cows adoption has brought improved on household income, physical asset and human asset holdings of adopter households with their counterpart. Participant households' annual income, physical assets and human assets such as, children improving and health condition were better than non-participants (non-adopters) of households. In this study impact analysis were analyzed by summering the small farm house holds estimated the whole annual income and asset holdings during the households.

3.7. Definition of variables and working hypothesis

The data was cover information necessary to make household level indices of economic, institutional and social factors that influencing crossbreed dairy technologies adoption in the study area. Both continuous and discrete variables were used on economic theories and findings to answer the research questions of this study. The following variables were constructed.

3.7.1. Dependent Variable

A bundle or packages of technology of different technological elements such as improved cross breed, improve for age feeding, artificial insemination services (AIS), improved housing and regular veterinary vaccination were provided or transferred to smallholder farmers. For the household who participate/ adopts dairy technologies the variable takes the value of one where as it takes the value of zero for the household who does not participate/ adopt (respondent category whether he/she participant or non-participant). However, crossbreed cows adoption will be taken as proxy for this study. The dependent variable for this study is farmers' adoption of crossbreed dairy technologies. This takes the value one for those who participate and zero otherwise.

The Adoption index (AI) as a continuous dependent variable was used to see the proportion or extent of improved dairy technologies adoption. The following dependent variable would be considered as adoption and intensity of adoption of farmer's participation on improved dairy technologies (farmer's adoption behavior of dairy technologies (technical efficiency) was discussed. Intensity of adoption refers to adoption index indicating farmers' level of use of multiple practices from the recommended improved dairy technology components (breed, feed, housing, AIS (including Synchronization) and regular veterinary services) and they benefited from them. Adoption score of farmers on dairy technologies (Adoption index of (the average of 5)= the rank of: very high, high, medium, low, very low= (One farmer has at least one improved dairy cow, current level use of AIS, current level use of recommended feed practice, current level use of improve dairy housing, current level use of regular vaccination activities.

Outcome Variables

It can be a continuous variable that represents the probability of the household whether they that can be benefited from dairy technologies or not. Based on scope of the study, the following hypotheses were made for outcome variables.

Financial Assets: It is defined as the amount of annual income and saving of households. One of the primary objectives of using improved dairy technologies is increasing income and saving of the household. Annual income and saving was considered as indicator of financial assets of the households. Thus, it was hypothesized that, education level, farming land size, off-farm income activities, credit access, extension contact and input access had positive impact on annual income

and saving of participant households while market distance negatively affect the crossbreed dairy technology adoption..

Physical assets: It is defined as the productive and non-productive assets that household owned at appoint of time (data collection). Bothe productive and non-productive assets were valued in birr, where considered as indicator of physical assets of the household. It includes productive, non-productive and durable assets. It was hypothesized that participation in use of improved dairy technologies program would improve physical assets of the participant households.

Human assets: It is about children schooling that enables them to achieve livelihood comes from dairy income. Annual children schooling expenses were considered as indicator of human asset of the household. Improved dairy technology has significant effect in capacitating of this technology users to spend more items for their children as compared to non-technology user. Thus, it was hypothesized that improved dairy technology participants spend more on expenditure on families. In general, the impact (outcome) dependent variable: Impact on income, impact on assets (Total asset holding estimated valued in birr after use of dairy technologies).

3.7.2. Independent Variables

Independent variables are variables that stand alone and are not changed by the other variables but cause change independent variable(s). The independent variables for this study were identified based on review of different literatures and carefully identified only those affects households decision to participate in improved dairy technologies and outcomes considered by the study. To reduce bias, considering relevant variables that would be included in the Logit model are very vital. However, empirical evidences and different theories were used to identify variables that affect improved dairy technologies participation and outcome considered by the study. Based on this, those include household's personal and demographic, economic, institutional and social variables were identified as independent variables for this study.

3.7.2.1 Independent variables and their hypothesized relations with adoption

Household head age (AGE)

Age is an important household characteristic influencing the adoption behavior of subsistence farmers. (Kaaya et.al.,2005) used Logit model to reveal factors influences the extent of adoption of artificial insemination (AI) services and found age of the farmer was positively associated with adoption and use of AI technology. However, in contrary to this, the findings reported by

Quddus(2013) and (Dehinenet et.al.,2014) stated that the probability of adoption decreased with the increase of age of household heads. Young household heads are more likely to apply new technologies because younger household heads are less risk averse than older counterparts (Howley et al.,2012). Therefore, in this study it is hypothesized that age of household head are more likely to affect dairy technologies negatively/positively.

Sex of the household (SEX)

In mixed farming system, both men and women take part in crop production and management practices. Female- headed households are usually less likely to adopt improved agricultural technology adoption since they are usually endowed with less resource and less exposed to new information due to their social position (Assefa and Gezahagn,2010).Therefore, it was hypothesized that being a female headed household had negative influence on adoption of crossbreed dairy technology.

Education level (EDUCLEV)

Education is continuous variable, enables farmers to have access to new information and idea. Formal education of household in the family would increase the farmer's ability to use information relevant to the adoption of improved technologies (Haji,2003). The higher the education level, the better would be the attitude of the farmer towards better methods of production. Education enhances farmers' ability to perceive, interpret and respond to the new events and more likely used high yielding dairy technology (Leake and Adam,2015). Therefore, in this study education was expected to positively influence the adoption decision of crossbreed dairy technology.

Farm land size (FRMLSZ)

It has been noted that adequate size of land holding is the basic requirement for adoption of improved agricultural technologies. It refers to the farm land owned by the household in hectares and is the single most important resource. Farm size was expected to influences households' decision to adopt or reject crossbreed dairy adoption. Land holding size is expected to influence the adoption of crossbreed dairy technology positively as those operating on larger farms tend to have greater financial resources, incentives and more land to allocate to the high yielding wheat varieties of crossbreed dairy (Hassen.et.al.,,2012). Therefore, it was hypothesized that land size would initiate to adopt improved cross breed dairy technologies.

Family size (FMLSZ)

This refers to the number of members who are currently living within the family. Large family size is an indicator for availability of labor provided that the majority of the family members are within the age range of active labor force. Based on this assumption, this variable was hypothesized to have positive relationship with adoption of crossbreed dairy cows. Therefore, farmers' decision of crossbreed dairy cows' adoption becomes dependent on the availability of labor force (labor supply) in the household. Empirical results by (Hassen.et.al.,2012) prove this hypothesis, whereas Berhanu and Moti(2010) found out negative relationship between household.

Market distance (MARKDIS)

This is a continuous variable measured in kilometers; and the longer the distance of farmers' residence to the nearest market, the less would be their adoption decision for dairy products. Proximity to the markets enables farmers to sell dairy products namely milk and milk products. Hence, market distance was hypothesized to have a negative relationship with the adoption of high yielding dairy cows (Leake and Adam,2015). Berhanu and Moti(2010) also found out negative and significant relationship between market supply and distance from the market center. Similar empirical result was indicted by (Hassen.et.al.,(2012).

Input access (INPUACC)

Input availability and potential to use is among the factors influencing adoption. Availability of input for dairy technologies is very important in dairy cows rearing. The inputs such as crossbred cow, artificial insemination service, feed, housing and veterinary services are very crucial for who engaged in the activities. However, required inputs may not be available in accessible local markets. Time lines and availability of input in the market facilitate the adoption rates and intensive use of dairy technologies and hence intensity of adoption would be significantly and positively related with input access. It is measured as a dummy variable as if input is available for a farmer a value of one and zero otherwise. Consequently, input availability is assumed to influence adoption positively. Access to input was, thus hypothesized to be positively related to adoption of dairy technologies.

Extension Contacts (EXTCON)

This variable was measured as a continuous variable taking a value based on the frequency of contact households with the extension agent. It refers to the number of days of contact between

the household head and extension agent within 2018/2019 production year. Frequency of extension service is the major conduit through which new ideas and techniques are transmitted to farmers. Extension agents provide information on the high yielding agricultural varieties and dictate how to adopt it with recommended practices. Empirical results of Hailu,(2008) revealed that frequency of extension contacts has an influence on farm households' adoption of high yielding agricultural technologies. Similar findings also reported by Shiferaw and Tesfaye,(2006). Farmers contact with extension agent was assumed to increase the adoption and extent of use of dairy technologies and hypothesized to influence positively.

Non/off-farm income (OFFINC)

It is a continuous variable that represents an annual income earned (the natural log of off-farm income earned) and measured in ETB from off/non-farm economic activities through external labor supply, rent also fox power, pack animals and land, handicrafts, petty trade, and so on (Hassen.et.al.,2012). The more off/non-farm income the farmer generates, the higher he/she resolves his/her financial constraints, this faster to adopt high yielding production. Hence, availability of non-farm income was hypothesized as one of the factors that influence the likelihood of adoption of high yielding agricultural technology.

Access to credit (CREACC)

This is measured as a dummy variable taking value of 1 if the farmer obtained credit and 0 otherwise. Mpaweni mana(2005) reported that, credit access reduces liquidity problems that household could face while intending to purchase agricultural inputs; and hence paves the way for timely application of inputs thereby increase the overall productivity and farm income. Access to credit affects the ability of a farmer to obtain the necessary improved agricultural technologies at the right time and in suitable quantities (Shiferaw and Tesfaye,2006). This variable was expected to influence the adoption of high yielding production and market supply positively on the assumption that access to credit improves the financial capacity of high yielding production producing farmers to buy modern inputs, thereby increasing production which is reflected in the market supply of livestock production grain. Findings of Alemnewu,(2010) and Muhmmed(2011) also prove this hypothesis with respect to an increase in market supply.

Livestock Size (LIVSZ)

Livestock holding is an important indicator of household's wealth position. Livestock are also an important income sources which enables farmers to invest on adoption of improved agricultural technologies. It influences the adoption of improved technologies differently by different people across different areas. In most cases, it has positive contribution to household's adoption of agricultural technologies (Wongelu,2014).Therefore it was hypothesized that there is positive relationship between the size of livestock holding and adoption of crossbreed dairy technology.

Distance from Agricultural Development Center (DADC):

It is a continuous variable and measured in kilometer. Distance from agricultural development center was expected to affect the dairy technology adoption. The Agricultural Development Center (ADC) is usually strategically located within the farming areas and it is the place where the local extension worker is stationed. As distance from the agricultural development center (DADC) increases, livestock technology adoption decreases because this causes transport cost incurred in obtaining information on technologies and inputs to increase. Farmers were/are less likely to adopt the livestock technologies as the distance increases from the center.

Table 3.2**:** Description of independent variables and expected sign of result

Explanatory variables	Description of variable	Nature of variable	Expected result
Age	Age of household head in years	Continuous	+/-
Family size	Total family member in the household	Continuous	+
Livestock holding of household	Livestock ownership in TLU	Continuous	+
Market distance	Distance of market in kilometer	Continuous	-
Distance from DA	Distance from Agricultural Development	Continuous	-
Farm land size	Land holding (ha)	Continuous	+
Sex of household	1if household head is male 0, for female	Dummy	+/-
Access to credit	if household have access to credit ,1 for Yes and 0 for No	Dummy	+
Extension contact	if household has extension contact1 for Yes and 0 for No	Dummy	+
Input access	if household have access to input ,1 for Yes and 0 for No	Dummy	+
Off-farm income	if household head has off-farm income 1for Yes 0, for NO	Dummy	+
Education level of household head	Illiterate, non –formal and formal education	Categorical	+

Source: Compiled from literature review (2020)

CHAPTER FOUR

4. RESULT AND DISCUSSION

This chapter presents the main results and discussions of the study. It has three sub-sections. The first sub-section describes descriptive and statistical analyses of the demographic and socio-economic characteristics of the sample households are presented. The second sub-section describes econometric model results for factor affecting of adoption and intensity of adoption of cross breed dairy Cows and the final sub-section describes the impact of crossbreed dairy Cows adoption on household income and asset holdings.

4.1. Description of the Socio-economic Characteristics of Sample Household

As already mentioned, this study is based on cross-sectional data collected from 328 sample small farm households, which are selected from Gibe woreda of South Nation Nationality People of Regional state in Ethiopia. Out of the total sampled households, 154 (47%) were adopter of crossbreed dairy Cows while 174(53%) were non-adopter small household farmers. The socio economic characteristics of adopters and non-adopter households are discussed as follow.

4.1.1 Descriptive statistics for continuous variables

AGE: The mean age of the household head adopters in the study area was found 44 years while that of non-adopter is 45 years. This shows that adopters and non-adopters were found almost at the same age level. This indicated that there is no significant mean difference between both age groups of households. The independent t-test (t-value= 0.43 and p=0.565), the result implies that, there was no significant mean difference between two groups in their age. This shows that in this case adoption of crossbreed dairy cows do not affected by age.

Education level: The mean education level of the adopters is grade 2.94 while 2.37 for non-adopters. This shows that the adopters are more educated than the non- adopters of crossbreed dairy cows adoption of small household farmers. The independent t-test (t-value= 4.56 and p=0.074) revealed there is statistically significance difference between adopter and non-adopter households at 10% probability level. Indicates, level of education increases farmers' ability to obtain, process, and use information relevant to the adoption of improved crossbreed dairy Cows of small farmer households.

Family size: According to family size, the mean family size in man equivalent of adopters and non-adopters was 7.86 and 6.98 respectively. The independent t-test (t-value=2.633 and p=0.000) revealed there is statistically significance difference between adopter and non-adopter households at 1% probability level implying that households with large family member who engaged in diary activity are more likely to adopt crossbreed dairy Cows than households with smaller family size who participate in diary activity.

Farm land size: Land is the most important resource that is a base for any economic activity especially in rural and agricultural sector. The average value of the land holding in the study area was for adopter 2.10 hectare and 1.20 hectare for non-adopter small farm households. The t-test statistics (t-value= 2.677 and p=0.000) shows that there is a significant difference in terms of farm land size between adopter and non-adopter household at 1% probability level. This implies that in the study area dairy technology participants were found to have more land holding than non- participants. The possible reason for this could be large land holder farm households considered as more participant of the technologies than counter parts. The study was in line with the study result of (Daniel et.al.,,2017).

Total livestock holding: In the rural area, livestock ownership of the rural farm households is very important for income generation, for food, for traction power, for social security, for organic fertilizer and asset holding. The result of this study indicates the mean livestock holding for adopter and non-adopter household was 5.5 and 4.78 respectively. The independent t-test (t-value=1.187 and p=0.001) revealed there is statistically significance difference between adopter and non-adopter households at 1% probability level implying, a household with large livestock holding can have good access for more draught and it is one of the main cash sources to purchase improved agricultural technology. This finding is conformity with the work of Birhanu,(2002).

Market distance of respondents household: In this study, regarding the distance taken to travel from home to the market place, mean distance to travel to the nearest market center by adopters and non-adopters was 3.16 km and 3.73 km respectively. The independent t-test (t-value= 0.87 and p=0.0293) revealed there is no statistically significance difference between adopter and non-adopter households regarding market distance.

Distance to Agricultural extension office: The average distance taken to travel from home to the nearest Agricultural office for adopters and non-adopters was 4.2 km and 4.66 km

respectively. The independent t-test (t-value = 0.72 and p= 0.107) revealed there is no statistically significance difference between adopter and non-adopter households regarding extension office distance.

Table 4.3: Demographic and socioeconomic characteristics for continuous variables

Variable	Adopter (N=154)		Non-adopter (N=174)		t-value	p-value
	mean	Std.dev	mean	Std.dev		
AGE	44	9.4256	45	11.1036	0.43	0.565
EDULEV	2.94	1.9037	2.37	2.220	4.46	0.074*
FMLSZ	7.86	3.8134	6.98	3.3308	2.633	0.000***
FRMSIZ	2.10	1.0181	1.20	0.5405	2.677	0.000***
LIST	5.5	2.1384	4.78	1.8094	1.187	0.001***
MARDIS	3.16	0.4463	3.73	2.4841	0.87	0.0293**
DADC	4.2	2.7738	4.66	3.1561	0.72	0 .107

***, ** and * = statistically significant at 1%; 5% and 10% probability level respectively.

Source: own survey result 2020

4.1.2 Descriptive statistics for dummy variables

SEX: The respondents were composed of both male and female-headed households. Out of the total sample adopters, the majority of them (87.01%) were male-headed households while 12.99% were female-headed households. The chi-square test ($\chi 2$=1.634 and P = 0.021) the result of chi-square test indicates that there is statistically significant difference between adopters and non-adopters with regard to sex of household in the study area. It implies that adopters are dominated by male household heads.

Income from off-farm activity: Out of the total sample household, respondents who have income from off-farm activity for adopters 80.52% and for non-adopters 51.72% of households. The chi-square test ($\chi 2$=37.142 and P = 0.000) revealed there is statistically significance difference between adopter and non-adopter households at 1% probability level. This result shows might be the household engaged in other off-farm activates increase the household decision of dairy technologies.

Access to credit: Access to credit is source of financing agricultural activities that mean mainly to buy agricultural inputs and it helps farmers to increase productivity. From the total sample

respondents, about 39.94% had use credit while 60.06% small household farmers were not use credit service. The majority (56.49%) of adopters were the user of credit. Farmers who utilize credit can minimize their financial constraints and buy inputs more readily. Thus, it is expected that credit utilization can increase the probability of adopting new agricultural technologies including adoption of cross breed dairy Cows. The result of chi-square (16.675) and (p= 0.000) confirmed that, there is statistically significance difference between two groups at 1% probability level with regard to access and credit utilization.

Extension contacts: The frequency of contact between the extension agent and the farmers is hypothesized to be the facilitator, which accelerates the effective dissemination of adequate agricultural information to the farmers, thereby enhancing farmers' decision to adopt crossbreed dairy Cows during households. Out of the total sample household, respondents about 45.12% had extension contact while 54.88% of households were not having contact with extension agent. Of these, 77.27% of adopters had extension contact. The chi-square test ($\chi 2$=121.2 and P = 0.000) shows that, there is statistically significance difference between adopter and non-adopter households at 1% probability level. Generally adopters of improved crossbreed dairy cows are those more frequently visited by extension workers than the non-adopters. Empirical results revealed that extension contact has a positive influence on farm households' adoption of new technology (Kidane,2001) and (Hailu,2008).

Input access to dairy technology: Availability of input for dairy technologies is very important in dairy cow rearing. The inputs such as crossbred cow, Artificial insemination service, animal feed, housing material and veterinary services are very crucial for who engaged in these activities. Among the total respondents, 49.39% of households were responds availability of input positively while the rest 50.61% didn't. From the adopter group majority, (91.56%) of small household farmers have dairy technology input access in this study area. The chi-square test result revealed that ($\chi 2$=206.5 and p=0.000) there is significant difference between adopters and non-adopters of dairy technology at 1% significant level. The reason could be adopter farmers can afford to purchase input from far places or having chances supported by motivating agencies.

Table 4.4: Demographic and socioeconomic characteristics for dummy variables

Variable		Adopter (N=154)		Non-adopter (N=174)		Total	Chi-square	prob
		Frequency	percent	Frequency	percent			
SEX	Male	134	87.01	159	91.38	89.33	1.634	0.021**
	Female	20	12.99	15	8.62	10.67		
OFFINC	Yes	124	80.52	90	51.72	65.24	37.142	0.000***
	No	30	19.48	84	48.28	34.76		
CREACC	Yes	87	56.49	44	25.29	39.94	16.675	0.000***
	NO	67	43.51	130	74.71	60.06		
EXTCON	Yes	119	77.27	29	16.67	45.12	121.2	0.000***
	No	35	22.73	145	83.33	54.88		
INPUACC	Yes	141	91.56	21	12.07	49.39	206.5	0.000***
	No	13	8.44	153	87.93	50.61		

***, ** and * = statistically significant at 1%; 5% and 10% probability level respectively.

Source: own survey result 2020

4.2 Recently status of dairy technology adoption in study area.

Innovated technologies practices are most of the time depended/recommended/ in a set or at the amount of technological package form to use by farmers. However, at the cause of different reason, farmers usually adopt only certain components of technologies. Moreover, in several cases there is variation in intensity of on given technology or practice. Difference between farmers in their level of technology adoption could be related to many factors such as, economic social, institutional and personal. To make solution to such kind of problems understanding why farmers most of the time adopt only one component of the technology while ignoring the other as well as pay attention reasons for their variation is of a paramount importance.

4.2.1 Current status adoption of breed component in this study

According to level of adoption of dairy technology practices, the small farm household head who take each practice were used to assess the status of adoption. In this study result, the only adopter categories were included. The optimum recommended level was used as a reference to assess

status of adoption. In addition to dairy technology, breed component is the most important component introduced in the area. The current status of the breed level adoption was assessed in each sample kebeles. The result shows that, Table 5 clearly revealed that adoption of crossbred simply in Homecho K/G/mehber, Hamola and Hadaye were 40.04%, 39.01%, and 39.92%, respectively. From the three sampled kebeles 39.57% had gate chance to participate the adoption program while the remaining 60.43% still far from improved cross breed dairy technology by several reasons. This result indicated that the percentage of breed technology participant going on an improvement but still they need high intervention of the nonparticipants or non-adopters groups.

Table 4.5: Current status of adoption of cross breed dairy technology in sampled kebeles

Name of kebeles	Number hhs with dairy Cows	Number of household with			
		Local Cows	percent	Crossbreed Cows	percent
Homecho K/G/mehber	547	328	59.97	219	40.04
Hamola	769	469	60.99	300	39.01
Hadaye	521	313	60.08	208	39.92
Total	1837	1110	60.42	727	39.57

Source: Own field survey result (2020)

4.2.2 Current status of adoption of AIS technological component score of household.

Artificial insemination is one of the vital inputs of availability for cross breed dairy adoption during small farm household. As we understand, for small farm householders, according their capital buying the crossbreed Cows were very expensive to improve their livelihood. Availability of such types of inputs by government or nongovernmental organization for rural household and participate farmers at low cost is the best way to expansion the improved cross breed dairy cows adoption and to made awareness or announced power of technology between small farm livelihoods. In this study Artificial Insemination Services (AIS) were hypothesized to be positively related to adoption of improved dairy breed and overall dairy adoption. The following table 6 implies that, Artificial insemination service were positive and strong influence on adoption of improved dairy breed. The result shows, the average of adoption of AIS input was 0.19 with standard deviation 0.007. The adoption categories of very low, low, medium, high and

very high adopters were 0.07, 0.12, 0.68, 0.12 and 0.006 respectively. The proportion of adoption categories of very low, low, medium, high and very high of adopters were 7.14%, 11.69%, 12.34% and 0.65% respectively. This indicated that access of AIS was at medium level and majority of adopter households used to improve their own improved breed cows. In general the result indicated that there is significant mean variation F=26.74, p<0.000 between adopter categories at 5% probability level.

Table 4.6: Current status of artificial insemination service score

Adoption category	Count	percent	mean	Sta.dev	f	p-value
Very low	11	7.14	0.07	0.0023		
low	18	11.69	0.12	0.0052		
medium	105	68.18	0.68	0.0351		
high	19	12.34	0.12	0.0057		
v. high	1	0.65	0.006	0.000014		
Total	154	100	0.19	0.007	26.74	0.000

Source**:** Own field survey result. The result is significant at the 1% level.

4.2.3 Current status of feeding technological component score of householder

Table 4.7: indicated that the status of feeding in the study area. Feeding is one of the crucial components for dairy technology. As based the result, the mean status of feeding level for no, poor, moderate and good of adoption category was 0, 0.15, 0.39 and 0.86 respectively. The finding of this study indicated that there is significant variation among adoption categories at 5% probability significant level. The proportion of adopters feeding level was 24.03% of poor, 61.69% of moderate and 14.28% of good feeding of improved dairy Cows. This result indicated that majority of the adoption of feed technology component adoption rate was moderate feeding practice when as compare with other rates.

Table 4.7: Distribution of feeding technological component score

Adoption category	Count	percent	mean	Sta.dev	F	p-value
No	0	0	0	0		
Poor	37	24.03	0.15	0.056		
Moderate	95	61.69	0.39	0.031		
Good	22	14.28	0.86	0.533		
Total	154	100			57.7	0.000

Source: Own field survey result. The result is significant at the 1% level.

4.2.4 Current status of regular vaccination technology components score of household.

Regular vaccination is another desired component to prevent the different viral disease. Just like other components the adoption score was explained at some rates.Table8 shows, it revealed that there is significant mean difference among adopter categories. The mean value for poor, moderate and good adopter category was 0.02, 0.28 and 0.33 respectively. The result implies that there is significant mean variation between adopter categories at 5% probability level. The proportion of adoption categories in the adoption of the veterinary service revealed that vaccination against various prevalence diseases was 3.24% of poor, 44.16% of moderate, and 52.6% of good regular vaccination of improved dairy cows.

Table 4.8: Distribution of vaccination technology component score

Adoption category	Count	percent	mean	Sta.de	F	p-value
No	0	0	0	0		
Poor	5	3.24	0.021	0.051		
Moderate	68	44.16	0.285	0.710		
Good	81	52.60	0.337	0.842		
Total	154	100			102.02	0.000

Source: Own field survey result. The result is significant at the 1% level

4.2.5 Milk production status of the respondent

The result of average milk productivity of cross breed dairy cows and local Cow of sample respondent is indicated in table4.9. In the study area, the current productivity of cross bred and local cows was assessed and the level of productivity was described as follows. The maximum milk yield of sample respondent from local cow was 3 liter/cow/day with 2.10 average yields while the maximum milk yield of the household from improved cow was 12 liter/cow/day with 7.55 average yields. As mentioned here, the milk yields of cross breed cows of respondent in average greater than the milk yield of local cow respondent. One the reason for this difference, improvement in milk productivity of crossbred cows depends on use of better feeding and application of all recommended technological components. The result of this study revealed that there was a significant mean difference between local and improved dairy cows in their level of productivity at 1% probability significant level.

Table 4.9: Distribution of milk production

Total milk yield	N	Mean	Sta.dev	min	max	p-value
Amount from local Cows	174	2.10	0.9865	1	3	0.382
Amount from cross breed Cows	154	7.55	3.0746	4	12	0.000

Source: Own field survey result. The result shows significant at the 1% level for cross breed

4.3. Statistical analysis

4.3.1 Factor affecting adoption of cross breed dairy cows

To identify factors that constraining adoption of the improved cross breed dairy Cows in this study, a logit model was estimated. Based on the results of multivariate analysis, a model contained 12 selected predictor interaction terms were included in the multivariate analysis. Using the stepwise (likelihood ratio) method, nine of the twelve predictor variables (Sex, Education status, family size, off-farm income activity, farm land size, input access, market distance, credit access and contact of extension advice) have a significant joint impact in determining household adoption of improved cross breed dairy cows and the remaining variables (age of household head, total livestock and distance from agricultural center) were insignificant in this study area. The overall model is proven, as it is statically significant at a p-value of 0.000. The pseudo R-squared is found about 0.5460, meaning all the explanatory important variables included in the model explain 54.60% of the probability of household's adoption of improved cross breed dairy Cows. The LRCh2 (12) with a P- value (Prob>ch2) 0.000 also tells the logit model as a whole is statically significant. The signs of the regression coefficients of the model (Table 4.10 :) fulfill the underlying assumption and the corresponding p-values imply that the predictor variables included in the multivariate model have a significant joint influence on the outcome variable.

Multicollinerity was tested using variance inflation factor (VIF); this revealed that no problem of multicollinearty observed because tolerance $\frac{1}{1-Ri2}$ greater than 10% among each explanatory variables (the independent variables). The estimation variance inflation factor was done to test whether multi-co linearity problem exist or not. There was no explanatory variable dropped from the estimation model since no series problem of multi-co linearity was detected from the VIF results which are very far less than ten.

Table 4.10: Marginal Effects of predictor variables on improved dairy technology adoption

Variables	Marginal effect (d_x/d_y)	Mean	Std.err	p-value
AGE	0.026849	44.3783	0.02413	0.612
SEX	-0.336152	.92525	0.25396	0.001***
EDULEV	0.032759	0.69237	0.63325	0.005***
FMLSZ	0.468015	0.70000	0.41462	0.062*
FRMLSZ	0.581236	1.00025	0.13061	0.015**
OFFINC	0.171233	0.87952	1.23546	0.0000***
LIST	0.698540	0.24512	0.37235	0.7542
MARDIS	0.615127	0.60230	2.87721	0.0051***
DADC	0.202341	0.3251	2.9653	0.515
CREACC	0.036510	0.3563	22.956	0.070*
EXTCON	0.752537	0.7544	30.9871	0.004***
INPUACC	0.574803	0.6684	0.05960	0.0025***

Sample (N) =328, LR chi2 (12) = 244.74, Pseudo R2=0.5460, Prob> chi2= 0.0000, Log likelihood = -101.74495, ***, ** and * show significance at p<0.01, p<0.05 and P<0.1 respectively. dy/dx is for discrete change of dummy variable from 0 to 1.

SEX: The results computed indicate that sex was found to be negatively and significantly related to the adoption of crossbreed dairy cows at 1% significance level. The negative sign of sex indicates the adverse effect of getting female of household head on the likelihood of adoption of improved varieties. The marginal effect of household sex shows that as sex of household head female, the probability of adoption of crossbreed dairy cows decreases by 33.6 percent. This indicates that as the household head gets female, her ability to engage and manage farm activities goes down and hence the tendency to learn about and adopt new technologies will decline.

Education level: Education of the household head positively influences the adoption of improved technology. The result shows that, it was positive and significant at 1% significance level. The marginal effect of the household education shows that if household heads' increases by one more year, the probability of adopting improved crossbreed dairy cows would increase by 3.27 percent. The implication is that, adoption of improved agricultural technology would increase with attainment of higher levels of education by the farmers. Finally, educated

household headed have better effective to exposes the new adoption technology than non educated household head. The finding was in-line with the study findings of (Beshir et al., 2012) *and* (Hagos and Lemma,2015).

Family size: Household's family size is important variable which in most cases has an effect on household's decision to adopt new technologies. The availability of larger family size in man equivalent for agriculture affects the likelihood of adoption crossbreed dairy cows positively and significantly at 10% significant level, as expected. In rural area, large households provide labour on the farm; as such, it is likely that farmers who have large family size in man equivalent would provide the necessary labour to cultivate improved varieties. The marginal effect of the result implies that if man equivalent ratio increases by one unit, the probability of adopting crossbreed cows would increase by 46.8 percent. In this study, the implication could be households who had more workable labor force imply that they adopt this improved dairy technologies in a better manner. Hence, it was assumed that availability of labor in the household affects adoption of dairy technologies positively.

Farming land size: Households' farm size was hypothesized to increase a farmer's adoption of improved crossbreed dairy cows. It was positively and significantly affected the likelihood of adoption of crossbreed dairy cows at 5% level of probability. The marginal effect of the model shows that, a unit of hectare land increase; it would increases the probability of adopting crossbreed dairy cows by 58.12 percent. This indicates that, small household farmers who have more land size, increase opportunity and positive attitudes to farming that enables them to easily facilitate and be familiar with the benefits of new technology better than who have less land size farmers.

Off-farm income activity: Off-farm income activity of the household head positively influences the adoption of improved technology. As discussed, the result shows that engaged in off-farm activities significantly and positively influences the probability of the household in adoption decision of dairy technology at 1% level of probability. The marginal effect of the result implies that, off-farm income activities of small household farmers would increases the probability of adopting crossbreed dairy cows by 17.12 percent. 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. These finding was in line with the study by (Ahemed et.al,2008), who recorded similar results.

Market distance: The marginal effect of distance to the market on the adoption decision of improved cross breed dairy Cows result shows, as distance to the market become proximate adoption of improved dairy adoption increases by 61.5 percent. Again, it is statically significant at 1% probability level of significance. It has positive and high marginal effect on adoption difference between adopters and non-adopter households. The main reason that accepted by the results and respondents' response were market distance effect has impact on purchasing of inputs. Hence, the implication of this study could be farm households had not been highly suffered by the market distance because the sampled respondents' residences are around the small town and road sides.

Access to credit: As the result implies that, credit utilization is positively and significantly related to adoption of crossbreed dairy Cows of household farmers at 10% significant level. Concerning the availability of credit, in this study indicated that the marginal effect of credit on adoption decision of improved dairy technology, credit user households differ in adoption of dairy technology by 3.7 percent. This result shows, the proportion of adopters who had access to credit is statistically greater than that of non-adopters and households credit users have a positive effect in the adopter households because it provides dairy inputs and increase the purchasing power of like AIS, feeding, improved cows and other desired inputs of dairy technology while the non-credit users were the opposite. Hence, it might be contributed on increments of dairy production.

Extension contact: The result implies access to extension contact found to be positive and significant effect on the adoption decision of dairy technologies at 1% significant level. When the frequency of extension agent contact increases, the probability of dairy technology adoption increased by 75.2 percent. 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.

Access to inputs: The marginal effect result shows that access to input for dairy production is positive and significantly related to adoption of crossbreed dairy cows at 1% significant level. This implies that access to input increase by one unit, the probability of adoption increases by 57.48 percent. 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.

4.3.2 Determinants of extent of crossbreed dairy Cows adoption.

This paper also tried to identify and assess factors familiar to extent of adoption of improved dairy technology adoption. The factors identified that education level of household head, family size, farming land size, off-farm income activity, total livestock, input access and credit access have a positive impact and significant at 5%, 1%, 1%, 5%, 10% 1% an1% level and the other variables age and market distance had a negative impact with 1% and 5% significant level respectively while the rest explanatory variables had insignificant effect on this specific study.

Table 4.11: Estimated regression results using Tobit model.

Variables	Coefficients	Odd ratio	Standard error	p-value
AGE	-.12401	0.976669	.035113	0.000***
SEX	-.17716	1.06872	.6830001	0.795
EDULEV	.32121	0.882251	.447240	0.036**
FMLSZ	.39552	1.10060	.081531	0.000**
FRMLSZ	1.06801	1.039826	.269744	0.000***
OFFINC	.95301	11.4472	.452036	0.035**
LIST	.19620	1.007290	.093312	0.055*
MARDIS	-.71136	-0.48860	.325230	0.029**
DADC	.53803	1.824002	.333051	0.107
CREACC	3.25012	1.78936	1.45236	0.000***
EXTCON	.77904	1.56101	.487282	0.110
INPUACC	2.78620	24.19712	.525031	0.000***
Constant	1.36208	.683147	1.64801	0.408

Sample (N)=328, LR chi2(12) = 244.74, Pseudo R2=0.5460, Prob> chi2= 0.0000, Log likelihood = -101.74495,. ***, ** and * show significance at p<0.01, p<0.05 and P<0.1 respectively.

Age: Household head's age is the one factor that had negative influence on severely improved adoption technology households. It showed negative relationship with using improved cross breed dairy Cows technologies and it is statistically at 1% significant level. The result revealed

that increment in the age of the household head by one year, decreased the probability of the extent of households improved dairy adoption technologies by 0.124.

Education: Education of the household head positively influences the extent of adoption of improved technology. The Tobit model result shows that the estimated coefficient for education was positive and significant at 10% significance level. The result was indicated achieving a good level of education as a household headed increases the extent of household adopt crossbreed dairy cows by 0.321.

Family size: The numbers of household member increases by one unit, the extent of improved adoption of cross breed dairy cows of the household increases by 0.395 units and it is also significant at 1% level of significant. As a result having more labor with in a household would be able to a high possibility of farm management work to increase the extent of adoption technologies.

Farm land size: Farm size has a positive and significant influence on extent of dairy technology adoption. The model result shows as landholding size increases by one unit, the extent of adopting crossbreed dairy cow technology increases by 1.068; it increases the probability of extent of dairy adoption technologies by farm households significantly at 1% level. The reason could be as the landholding size increases, the farm households are more in a position to produce animal feed from crop residue and through forage development.

Off-farm income activates: Off-farm income activates are one of the important variable affecting the extent of improved adoption dairy technologies. From the important finding of this study was that, the small households who have off-farm income activates, increases the extent of using new adoption of crossbreed dairy cows by 0.953 and it is statistically significant at 5% level. This is may be due to the farmers who have more off-farm income may not have challenges to get the inputs of improved dairy technologies.

Total livestock size: The total tropical livestock unit increases, the extent of crossbreed dairy cows adoption increases by 0.19, the probably of use of dairy adoption technologies could be increased significantly at 10% significant level. The positive and significant of total livestock unit on dairy technology adoption is partly through specialization effect and cash generation for reinvestment in the dairy enterprise.

Market distance: 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 5% level

of significance. Accordingly, when the market distance increase by one kilometer the extent of the household to adopt dairy technology decrease by 0.711. 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.

Access to credit: Access to credit has also a positive and significant effect on adoption technologies. The positive coefficient of the variable indicates that householders who had utilized credit were more likely to adopt crossbreed dairy cows than their counterfactuals that did not use credit. It is statistically significant at 1% and increases the extent of households to adopt the cross breed dairy Cows by 3.25. Actually, it reduces the financial difficulties that farmers face at the beginning of the year, thus access to credit enables them to buy farm inputs like AIS, better feeding, housing and better vaccination for better production.

Input access: The result shows that, input access also affects extent of dairy technologies adoption positively and significant at 1% level. This implies that the input access of small household farmers' increases, the opportunity of adopting crossbreed dairy cows by 2.78. 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.

4.3.3 Impacts of dairy technology adoption on household income and asset holding

This part of the analysis was describes to identify the impact of improved crossbreed dairy production technologies adoption on small farm's livelihoods in terms of household income and asset holdings. The propensity scores, matching algorithm and average treatment effect on treated were analyzed in this section of study. In bellow table 4.12, the results of logistic regression indicated that, there are several variables that affect household decision in improved crossbreed dairy cows' technologies practice at different statistically significant levels. In this study, twelve selected independent/predictor variables were analyzed that determine household's cross breed dairy cows participation in dairy technologies adoption. From those variables, seven 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. Among the explained variables by logistic regression model that influence the probability of household in the adoption could be the education level of households, farming

land size, off-farm income activity of households, credit access, extension contact and access to inputs of households were the variables identified by logistic regression model that influence dairy decision of households positively and statistically significant at p<0.01, p<0.05, p<0.1, p<0.1, p<0.1 and p<0.05 significant level respectively. The market distance was affect dairy decision technologies negatively with statistically significant at 1% significant level while the rest of five variables were not significant in explaining the variation in the dependent variable.

Table 4.12: Logit estimation model for estimating propensity scores

Variables	Coefficients	Standard error	Z	p-value
AGE	.0314620	0.161291	0.576	0.565
SEX	-.020131	.1746298	-0.443	0.658
EDULEV	.031227	.1223194	0.042	0.0055***
FMLSZ	.249724	.3936205	0.841	0.401
FRMLSZ	.013622	.1306132	0.234	0.015**
OFFINC	.164810	0.161291	1.878	0.000***
LIST	.015329	.3723522	0.312	0.755
MARDIS	-.615561	2.87754	-1.977	0.005***
DADC	.202144	2.96253	0.653	0.515
CREACC	.026016	22.95247	0.312	0.075*
EXTCON	.070101	30.9876	0.835	0.004***
INPUACC	0.16692	0.55001	0.0598	0.026**
Constant	0.72011	0.89489	1.292	0.0199

***, ** and * show significance at p<0.01, p<0.05 and P<0.1 respectively.

Source: Computed from own survey (2020)

Education level of household headed: As the result indicated, each additional number of years on education status of household head increases the probability of household adoption and use of improved cross breed dairy cows technology by 3.12%. This means when the household headed year of education increases both knowledge and skills also developed. It revealed that many household heads becomes more informed about new technologies and focus on adoption of crossbreed dairy cows to make profits.

Farming land size: The logistic regression output of farm land size indicated that a unit increase in farm land size in hectare, also an increase the probability of household participation and use of improved crossbreed dairy cows by 1.36%. The possible reason for this may be, farmers with less land were expected not to willing to adopt dairy technologies. Hence, there was thinking that the technologies need more land for forage production. This means it was found that a unit increase in land size increases households' probability of adoption of improved dairy technologies. The implication of the result that obtained could be households had with more land size holding were more likely to have capacity in expanding dairy production technologies.

Off-farm income activities of households: The off-farm income activity increases the farm households' participation and using adoption improved cross breed dairy Cows by 0.164 (16.4%). Therefore, by expanding and encouraging the farm households participating for the use of adoption of new technologies program is still important for the labor productivity in rural households of Ethiopia; since the a households who have off-farm income activities user are more productive than who haven't off-farm income activities.

Market distance: Distance of market negatively affected household adoption and use of dairy adoption technology status of the farming by 0.615 (61.5%). It reflecting that those farmers who are close to market centers are technically more efficient than farmers away from nearest market center. This implies that farmers near market center could get more hot and vital market information and may also participate in other income generating activities that could ease resource used in the maintenance of improved dairy adoption and thereby enhance its production. The finding was related with the study findings of Justus (2015).

Access to credit: The result of logit regression indicated that, the use of credit affects positively the level of participation of the rural household in adoption of improved crossbreed dairy cows. This shows that, a use of credit would increase the level of participation of rural households and the use of improved cross breed dairy cows by 2.6 %. This means households who have credit access more advantageous to use dairy technology by minimizing financial cash problems than who haven't credit access opportunity. This result is also similar to those obtained by *Alemayehu (2010).* In other hand this result contrasts to the result obtained by *Paul and Tefer (2009)* on the Impact of Agricultural Extension Services on Farm Household Efficiency in Ethiopia.

Extension contact: In this study the number of extension contact of the household increase by one unit, also an increase the probability of households participation in adoption process and use dairy technologies by 0.07(7%) units. The possible reason for this may be, farmers which have 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.

Access to inputs: Access to dairy input supply result indicated that, the unit of input increases the probability of household adoption and level of adoption for dairy technologies by 0.1669 (16.7%). Not only has the availability of input in the area, access of input by the households and cost of the technologies also mattered 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. Hence, access to input have a positive influence on adoption and intensity of use improved dairy technologies significantly at 5% significant level.

4.3.4 Propensity scores matching estimating of impact.

The study provided evidences as to compare whether or not the adoption of improved crossbreed dairy cows had a significant impact on the households income and physical asset holdings. The logistic regression model was used to estimate propensity score for adopters and non-adopters improved crossbreed dairy cows adoption. The logistic regression shows among twelve explanatory variables, six of them were found to be significant variable that determine households' adoption of crossbreed dairy cows positively and one of the other variable affects negatively, while the rest of five variables were not significant in explaining the variation in the dependent variable. The pseudo-R2 value is 0.5460, this shows that small household farmers in the study area do not have much distinct characteristics overall and as such a good match between adopters and non-adopters of technology becomes easier. The objective of matching procedure is to get similar probability of using or not using the technology under consideration within a given explanatory variables.

4.3.5. Common support condition.

After estimating values of propensity score for treated and its counterfactual group, the next steps in propensity score matching technique is the common support condition. Only observations in the common support region matched with the other group considered and others

should be dropped from consideration. Once the region of common support is identified, sample households that fall outside this region have to be discarded and the treatment effect cannot be estimated for these sample households.

Table 4.13: Distribution of estimated propensity score of households

Group	Observation	Mean	Sta. deviation	Minimum	Maximum
Adopter	154	0.5359	0.2653	0.054378	1
Non-adopter	174	0.47254	0.1254	0.0000025	0.8562
Total households	328	0.6897	0.1325	0.000245	1

Source: own survey result 2020.

Table 4.13: result shows that, distribution of estimated propensity scores vary between 0.054378 and 1 with mean of 0.5359 for adopted sample households and between 0.0000025 and 0.8562 with mean of 0.47254 for non-adopted sample households. Thus, the common support assumption is satisfied in the region of [0.054378 - 0.8562] for sample households. This means that households with estimated propensity scores less than 0.054378 and greater than 0.8562 are not considered in the matching.

The kernel density estimate in figure three and four revealed the distribution of the total sample households, adopters, and non-adopters of sample household with respect to estimated propensity scores

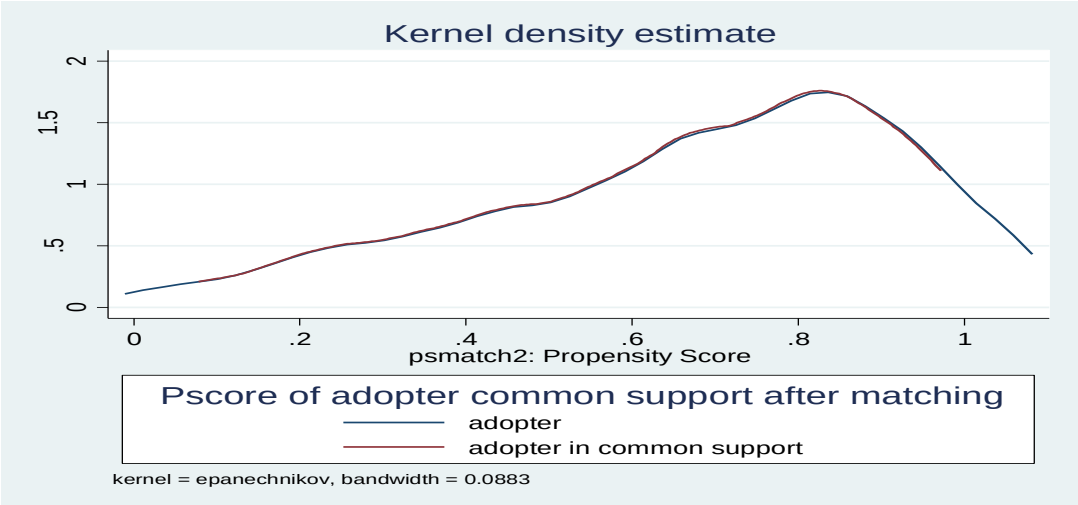

Figure 4.3: Kernel density estimate for adopter

Source: Own survey result 2020

In case of adopter households, most of the observation aligned to the left of the graph. The common support condition obliges to drop down observations with probability of adoption less than 0.054378 and greater than 0.8562.

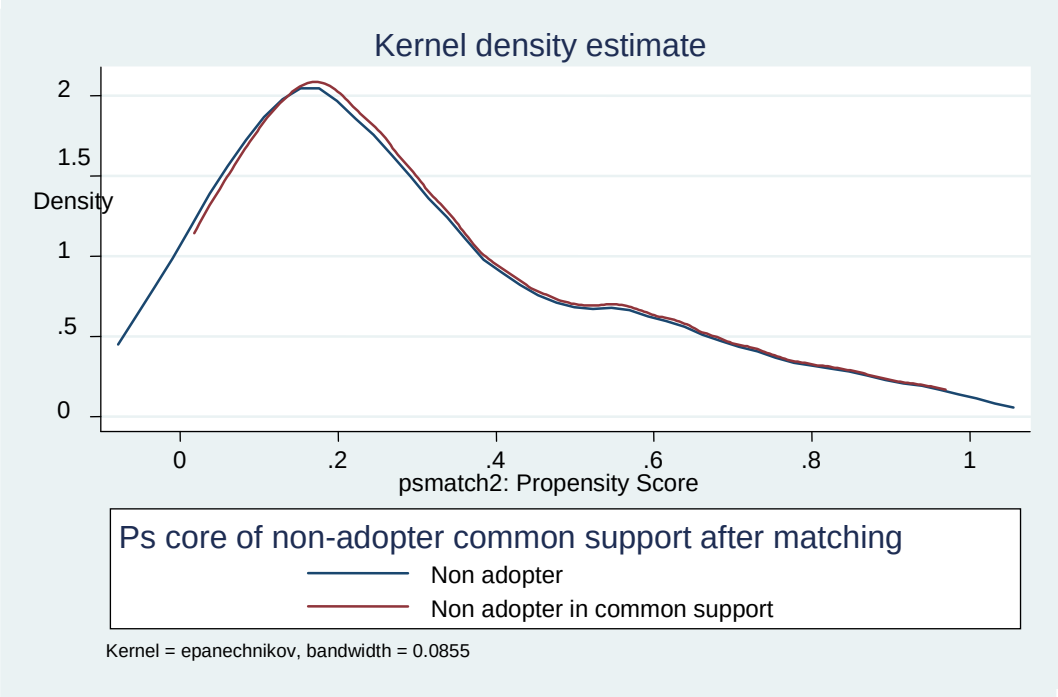

Figure 4.4: Kernel density estimate for non-adopter

Source: Own survey result 2020

In the case of non-adopter households, most of the observations were concentrated to the right of the graph. No observation from the non-adopter households were fall out of the common support region.

4.3.6 Testing of balance of propensity score and covariates (Evaluation of quality of match)

This section of analysis shows that, 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.

Table 4.14: Testing of covariance balance using propensity score

Covariate	sample	Mean		Percent of bias	p-value
		Treated	Control		
AGE	unmatched	44.01	45.0	-1.0	0.45
	Matched	42.32	43.2	-1.2	0.952
SEX	unmatched	0.965	0.9521	2.92	0.685
	Matched	0.729	0.5023	49.2	0.524
EDULEV	unmatched	0.456	0.2658	30.2	0.032*
	Matched	0.4125	0.0089	21.6	0.542
FMLSZ	unmatched	0.9823	0.7521	59.7	0.001***
	Matched	0.8752	0.658	49.8	0.150
FRMLSZ	unmatched	0.6985	0.6213	57.5	0.000***
	Matched	0.8214	0.6523	50.2	0.2635
OFFINC	unmatched	0.9325	0.016	356.2	0.002***
	Matched	0.8523	0.4823	86.5	0.000
MARDIS	unmatched	0.9658	0.2468	472.3	0.000***
	Matched	0.001	0.165	75.9	0.296
EXTCON	unmatched	0.568	0.05234	35.3	0.002***
	Matched	0.5236	0.4569	86.5	0.000
INPUACC	unmatched	0.85455	0.4852	86.7	0.000***
	Matched	0.71426	0.5792	29.9	0.630

Source: Computed from own survey (2020).

The above Table 4.14 results revealed that the mean standardized bias difference in before matching is in range of 1% - 472.3% in absolute value and P-value in same table shows 45% of chosen variables exhibited statistically significant difference at before matching. Whereas, after matching the standardize bias/standard error difference of explanatory variables lied between 1.2% - 86.5%. 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.

4.3.7 Impacts of cross breed dairy technology on households income and asset holdings

The first steps of the request of cross breed dairy technologies objective was to bring better production and productivities of rural small farmers' livelihood in terms to intensive income, asset holding and consumption of households as well as commercializing of productive technologies to interested ones. This reason mentioned, to increase households' income and asset generation for the present and for the future. Here, the cross breed dairy technologies impact on the outcome variables was evaluated. In this technological promotion intervention impact analysis, as total annual income of household indicator revealed that, average treatment effect (ATT) of dairy technology adopter households have got 46.1% more average total annual farm income from dairy technologies and their products per-annum than that of the non-adaptors of dairy adoption technology. This difference was statistically significant.

In table 4.15, the results of assets holding indicated that, the average treatment effect (ATT) of dairy technology adopter households had full of more chances/opportunity/ to earn better asset holdings than non-adaptors households and the difference was statistically significant. This result implies that the households who participating on improved dairy technologies have brought significant and positive impact on annual average income and asset holdings on adopter households than non-adopter. The information obtained from key informant (livestock and fisher resource office expertise, kebele leader and model farmers) interview that was also support this positive and significant finding. Finally, as compared small farm household status in way of improved their livelihoods before adopting and after adopting there were big difference. Accordingly, the small farm households who have after the adopting the improved dairy technology, there was changes in the life of them and productivity in adopting technology and increment at all assets holding. Before participating the program so many small farm households were poor and the life condition was at risk. But after the adopting the improved cross breed dairy cows, their living condition have been improved, better saving behavior, the consumption behavior, purchasing power, children school attend were increased and good health status of households in the study area.

Table 4.15: ATT Estimation results of household annual income and asset holdings

Intervention	variables	Treated	Control	Difference	S.E	t-test
Diary adoption technology	Total annual income	28163	15180	12,983	633	2.32
	Total asset holding after technology use	365423	0	365423	5123	1.68

Source: own felid survey result (2020)

4.3.8. Weights of constraints who the households do not adopt dairy technologies

As below table 4.16 results show that, the factor affects the dairy adoption technologies. Most of the time, the small farms households to far from new improved dairy technology, there was some reasons behind the households not participate the programs. The following results indicated the weight of constraints in all non-adopted households in the study area. These results were indicated that 52.3% of the respondent households mentioned that factors include lack of inputs and 23% grazing land problem because, there was narrow land size for more non adopted households. The reaming constraints like not awarded, disease and lack of capital were 10.92%, 1.72% and12.06% respectively. Those determined here were the main constraints raised by them during group discussion and in individual respondent's data collection time. Finally, those were the serious factors that affect the rural smallholder farmers to participate/adopt dairy technology in the study area.

Table 4.16: Distribution of reason for not adopt dairy technologies

Constraints	Count	Percent
Not awarded	19	10.92%
Grazing land	40	23%
Disease	3	1.72
Lack of input/unavailability	91	52.3
Lack of capital	21	12.06
Total	174	100

Source: result of survey 2020

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDETION

5.1 CONCLUSION

This study was conducted in the *Gibe woreda, Hadiya zone*, in South Nation Nationality People Regional state of Ethiopia. This is one of the potential area considered to be major dairy production could be found in the government extension plan. The study assessed factors that may affect negatively and positively on the adoption of crossbred dairy cows technology and its potential impact on small household farmers income and physical assets holdings. To the farmers living in rural areas where the study was conducted, at different times training has been given to farmers to use better dairy technologies to improve their lives. However, adoption of this technologies and their impact were unknown to fulfill the lack of information for responsible bodies. The sample size needed for the study was identified according to three stage sampling technique. A cross-sectional survey design was employed. The primary data for the study were collected from 154 (47% of adopted) small household farmers who had been in adoption of improved crossbreed dairy Cows at different years and 174 (53% of non-adopted) small households who did not ever accessed this cross breed dairy technology. Of these 89.32% were male-headed households while 10.69% were female-headed households.

The STATA software was used for analyzing the descriptive statistics and the econometric models for both quantitative and qualitative data. In this study, the descriptive statistics results indicated that, the household characteristics were analyzed by using t-test for continuous variables and chi-square test for dummy variables. The binary logistic regression model was used to identify factors that may affect the adoption technologies. Also the Tobit regression model used to analyze the determinants of extents of crossbreed dairy cows adoption while the Propensity score matching (PSM) model used to evaluate the impact of using adoption of improved crossbreed dairy technology in terms on income and assets holding of smallholder farmers. As mentioned above, before processing logit and PSM to assess factors affecting dairy technologies adoption and to calculate the ATT, the characteristics of the households' were analyzed at descriptive parts. Model specification tests include goodness of fit; multicolinearity problem and matching quality test have been conducted.

As the results above, the main challenges that discussed as reason for households who haven't adopt dairy technologies were grazing land, lack of inputs and capital were confirmed by 87.36% sample households while the rest influencing factors such as animal disease and not awarded were confirmed by 12.64% sample respondents.

The current milk production statuses at minimum and maximum level of local cows were 1 and 3 liters of milk yield cow per day respectively while improved cows were 4 and12 liters of milk yield cow per day respectively. There is big difference between them but it is still under their potential.

The econometric model result of logistic regression analyzed shows that, from the total twelve explanatory variables in the descriptive analysis were included in the model, nine of them had shown significant and affecting adoption of crossbreed dairy cows technology. Of these, education level of household headed, family size, farming land size, off-farm income activities, market distance, credit access, extension contact and access to input were found to have positive and statistically significant. However, sex of the household, was found to have negative and significant influence with adoption of dairy technologies.

According to the extent of crossbreed dairy cows adoption, the tobit model results shows that, education level of household, family size, farming land size, off-farm income activities, credit access and input access were affect the extent of household dairy technology adoption positively and significant while the age of household head and market distance were affect negatively or there is negative relationships with household dairy technology adoption.

At the last, comparisons were made between those groups that share common characteristics of independent variables with exception of participating in dairy technologies.

According to this study, ATT results indicated that crossbreed dairy cows adoption technologies had positive and significant impact on adopter households' total annual farm income increment in average 46.1% and estimated asset holdings confirmed by 100% of adopter households in the study area.

As mentioned in theoretical review, in Ethiopia most studies show that credit, input access, extension contact, farm size, labor availability, and human capital, land tenure and education are main factors affecting technological adoption. Similarly, in this study the independent variables identified as having relationship with crossbreed dairy cows adoption are categorized as demographic factors, social economic factors, institutional factors, also this concept draws in

conceptual framework. The probability of household adoption and the use of improved crossbreed dairy cows adoption technology were affected by institutional factors such as credit access, extension contact and input access. These factors have a positive implication in adoption decision of dairy technology of a study area.

Many literatures on adoption of dairy technology have as significant impact on small household farmers' livelihood in terms of household income and physical assets. The finding of the study is the same for this research in which adoption of cross breed dairy cows adoption has significant effect on household income and asset holdings.

Finally, it was concluded that the involvement of dairy technologies had significant impact on participating households' gross annual income and asset holdings after participation on dairy adoption technologies.

5.2 RECOMMENDATIONS

The following recommendations are suggested based on the findings of this study.

- According to the study, institutional factors that affect the dairy technology adoption were positively and significantly related with access to credit, extension contact and input access. Therefore, stakeholders from the *woreda* to the national level need to work within a short period of time to focus on improving the livelihoods' of small households' rural farmers. That is farmers should care of their responsibilities by facilitating low-cost lending, training on the use of crossbreed dairy cows technologies at regular intervals, preparing the input of the necessary dairy technology and making continuous visits.
- The study finding indicates that credit access is one of institutional factor that provides dairy technology for the rural households. This will decrease financial constraints of households and improve the purchasing power of dairy technology inputs (Artificial insemination, feeding, veterinary service and housing). Therefore, *woreda* level agricultural institutions should support by facilitating small credit provision funds like Omo-microfinance to strengthening their capacity and to be beneficiary of dairy adoption technology.
- Another institutional factor was access to dairy input which helps the farm households to adopt the dairy package in sustainable manner. Particularly in this study area, this is known to be major problem for small household farmers. Therefore, woreda to the regional agricultural office should require to lead, in collaboration with government and non-governmental organizations,

disseminate dairy technology input to rural farmers at low cost, provide proper delivery of resources and evaluate the results.

- Extension contact should be taken to address the participation of the rural households in improved crossbreed dairy cows' adoption with regard training on rural dairy technology actives. Rural adoption technology skill training enhances rural household participation in crossbreed dairy cows adoption by reducing skill gap to enter in to new advanced technology. It indicates that the provision of skill training is essential. Therefore, policy makers and different government bodies needs to find ways to improve dairy adoption skill of the rural households
- As indicated in this study, farm land size holding was an important factor to participate on dairy technologies positively in this study. Increase in farmland holding that increases the probability to adopt on dairy technologies. Hence, there was thinking that the technologies needed more land for forage development and attention should be given land is an important for dairy technology participation by all responsible government and practitioners. Therefore, farmers should be aware and advisable to increase the small land productivity through irrigable forage development by irrigation.
- In this study, educational level of the household head is one of the demographic factors that affect adoption of improved dairy technologies positively. It shows the better-educated rural households were actively participating in rural crossbreed dairy cows' technologies more likely than those who have low education or illiterate and they benefited more by using new technology. This implies improving formal education of the rural households increases their access and participation in different rural adoption of dairy technology and it increases the level of household incomes and asset holdings. As a result, any program that aims to improve rural household's participation in crossbreed dairy cows' adoption should focus on improving educational level of the rural household head.
- The study results showed that, distance to the market, which measured by the travelling time from the home of rural household to the nearest major market, has negatively affected their participation (adoption) and their corresponding dairy adoption technology. Hence, in order to overcome this negative effect, the government and stakeholders should improve market accessibility in rural area. This includes different infrastructure like; road, transport service, communication service.

- In this study area the descriptive statistics indicated that 87.36% of households consider it a reason not to use the dairy technology were lack of inputs, capitals and grazing. Therefore, the government, professionals, farmers in the district should be developing sustainable strategy to solve these problems.

Reference:

Abdulai, A., & Huffman, W. (2014). The adoption and impact of soil and water conservation technology: An endogenous switching regression application. *Land Economics*, *90*(1), 26-43.

Abera, M. (2016). *Reproductive and Productive Performances of Crossbred and Indigenous Dairy Cattle under Rural, peri-urban and Urban Dairy Farming Systems in West Shoa Zone, Oromia, Ethiopia*. 43.

Andualem, T. (2016). A review on cattle husbandry practices in Ethiopia. *International Journal of Livestock Production*, *7*(2), 5–11. https://doi.org/10.5897/ijlp2015.0276

Amare, M., Asfaw, S., & Shiferaw, B. (2012). Welfare impacts of maize–pigeonpea intensification in Tanzania. *Agricultural Economics*, *43*(1), 27-43.

Ayalew, H., Chanie, D., Lamesegn, D., & Resources, N. (2018). *INDIGENOUS DAIRY CATTLE BREEDS UNDER FARMER ' S MANAGEMENT REVIEW ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF INDIGENOUS DAIRY CATTLE BREEDS UNDER FARMER ' S*. *November*.

Azage, Tegegni, Gebremedhin, B., Hoekstra, D., Belay, B., & Mekasha, Y. (2013). *Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 31. Nairobi: ILRI. 31*, 78.

Bereda, A., Yilma, Z., & Nurfeta, A. (2014). Dairy production system and constraints in Ezha districts of the Gurage zone, Southern Ethiopia. *Global Veterinaria*, *12*(2), 181-186.

Barrett, C. B. (2010). Measuring food insecurity. *Science*, *327*(5967), 825–828. https://doi.org/10.1126/science.1182768

Bedasa, C., & Getachow, M. (2016). Status of Helminthes Parasites of Cattle in Dairy Farms of Holleta Agricultural Research Center, Central Ethiopia. *Journal of Veterinary Science & Technology*, *7*(5). https://doi.org/10.4172/2157-7579.1000365

Belay, T. (2012). Role of action reseaEthiopia. *Journal of Agricultural Extension and Rural Development*, *4*(15), 417–422. https://doi.org/10.5897/jaerd12.026

Beshir, H., Emana, B., Kassa, B., & Haji, J. (2012). Determinants of chemical fertilizer technology adoption in North eas rch in reducing farmers' livelihood vulnerability: A case of Gotu- Onema, central rift valley, tern highlands of Ethiopia: the double hurdle approach. *Journal of Research in Economics and International Finance*, *1*(2), 39-49.

Braithwaite, D., & Schrodt, P. (2014). Engaging Theories in Interpersonal Communication : Multiple Perspectives Social Exchange Theories : Calculating the Rewards and Costs of Personal Relationships. *Engaging Theories in Interpersonal Communication: Multiple Perspectives*, 377–390. https://doi.org/10.4135/9781483329529.n28

CSA. (2018). *the Federal Democratic Republic of Ethiopia Central Statistical Agency: Key Findings of the 2017/2018 (2010 E.C) Agricultural Sample Surveys*. *2018*, 26.

CSA. (2017). The Federal Democratic Republic of Ethiopia, Central Statistical Agency. *Report on Livestock and Livestock Characteristics, Agricultiral Sample Survey 2017/2018(2010 E.c), Statistical Bulletin 587, volume II*(April).

CSA. (2016). *2016 Ethiopia Demographic and Health Survey (EDHS) Introduction and Methodology*. http://www.ethiodemographyandhealth.org/Measure_DHS_Ethiopia2016.pdf

Central Statistical Agency. (2012). *Ethiopia - Household Consumption Expenditure Survey 2010-2011*. *October*.

Dehinenet, G., Mekonnen, H., Kidoido, M., Ashenafi, M., & Bleich, E. G. (2014). Factors influencing adoption of dairy technology on small holder dairy farmers in selected zones of Amhara and Oromia National Regional States, Ethiopia. *Discourse Journal of Agriculture and Food Sciences, 2*(5), 126-135.

Desta, K. B. (2002). *Analyses of dairy cattle breeding practices in selected areas of Ethiopia*:

Ergano, K. (2017). Interdependencies and sequential patterns in adoption of dairy technologies in Ethiopia. *Journal of Development and Agricultural Economics*, *9*(7), 200–209. https://doi.org/10.5897/JDAE2017.0807

Ergano, K., & Duncan, A. J. (2010). Effective delivery of input services (AI, feed and veterinary services) to livestock development in Ethiopia.

Feder, G., & Umali, D. L. (1993). The adoption of agricultural innovations: a review. *Technological forecasting and social change, 43*(3-4), 215-239.

Felleke, G., & Geda, G. (2001). The Ethiopian Dairy Development Policy: A Draft Document: Ministry of Agriculture/AFRDRD/AFRDT Food and Agricultural Organization/SSFF ….

FAO, IFAD and WFP,215. The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. Food and Agriculture Organization of the united Nations, Rome,Italy.

Galukande, E. G. (2010). *Comparison of production systems with purebred Ankole vs. crossbred Ankole-Friesian animals on-farm using a combined cross-sectional and longitudinal approach (Kiruhura District of Uganda)*: na.

Gebre Wold, A., Alemayehu, M., Demeke, S., Bediye, S., & Tadesse, A. (2000). Status of dairy development. Smallholder Dairy Development Project (SDDP) dairy research in Ethiopia. *The role of village dairy co-operatives in dairy development*.

Gebremedhin, B., Ahmed, M. M., & Ehui, S. K. (2003). *Determinants of adoption of improved forage technologies in crop – livestock mixed systems : evidence from the highlands of Ethiopia*. *37*, 262–273.

Getachew, K., Abebe, B., Tewodros, E., & Almaz, B. (2017). Fattened cattle marketing systems in Moretna Jiru District, North Shoa Zone, Amhara Regional State, Ethiopia. *International Journal of Livestock Production*, *8*(6), 79–86. https://doi.org/10.5897/ijlp2016.0354

Haile-Mariam, M., Banjaw, K., Gebre-Meskel, T., & Ketema, H. (1993). Productivity of Boran cattle and their Friesian crosses at Abernossa Ranch, Rift Valley of Ethiopia. I. Reproductive performance and pre-weaning mortality. *Tropical Animal Health and Production*, *25*(4), 239-248.

Jaleta, M., Gebremedhin, B., Tegegne, A., Jemaneh, S., Lemma, T., & Hoekstra, D. (2013). Evolution of input supply and service hubs in dairy development at Ada'a milk shed in Ethiopia. *Development in Practice*, *23*(2), 249–263. https://doi.org/10.1080/09614524.2013.772119

Kahi, A. (2002). Crossbreeding systems and appropriate levels of exotic blood: Examples from Kilifi Plantations.

Kebede, Y., Gunjal, K., & Coffin, G. (1990). Adoption of new technologies in Ethiopian agriculture: the case of Tegulet-Bulga District, Shoa Province. *Agricultural Economics: The Journal of the International Association of Agricultural Economists*, *4*(968-2016-75386), 27-43.

Ketema, H. (2000). Dairy Development in Ethiopia In: The Role of Village Dairy Cooperatives in Dairy Development. *Smallholder Dairy Development Project (SDDP) Proceeding, Ministry of Agriculture (MOA). Addis Ababa, Ethiopia*.

Khanal, A. R., Gillespie, J., & Macdonald, J. (2010). Adoption of technology , management practices , and production systems in US milk production. *Journal of Dairy Science*, *93*(12), 6012–6022.

https://doi.org/10.3168/jds.2010-3425
Khonje, M., Manda, J., Alene, A. D., & Kassie, M. (2015). Analysis of adoption and impacts of improved maize varieties in eastern Zambia. *World Development, 66*, 695-706.
Metaferia, Cherenet, Gelan, Abnet, Tesfay, Abdi Ali, G. (2011). A Review to Improve Estimation of Livestock Contribution to the National GDP. *IGAD Livestock Policy Initiative*,
Malik, A., Haron, A. W., Yusoff, R., Kasim, A., & Yusoff, S. M. (2012). Pregnancy rate following artificial insemination or natural service in postpartum estrus synchronized beef cattle. *Turkish Journal of Veterinary and Animal Sciences, 36*(4), 451-455.
Manda, J., Gardebroek, C., Khonje, M. G., Alene, A. D., Mutenje, M., & Kassie, M. (2016). Determinants of child nutritional status in the eastern province of Zambia: the role of improved maize varieties. *Food Security*, *8*(1), 239–253. https://doi.org/10.1007/s12571-015-0541-y
Mekasha, Y., Tegegne, A., Yami, A., & Umunna, N. (2002). Evaluation of the general farm characteristics and dairy herd structure in urban and peri-urban dairy production system in the Addis Ababa milk shed. *Challenges and Opportunities of Livestock Marketing in Ethiopia, 139*.
Mekonnen, H., Dehninet, G., & Kelay, B. (2010). Dairy technology adoption in smallholder farms in "Dejen" district, Ethiopia. *Tropical animal health and production*, *42*(2), 209-216.
Mihret, T., Mitku, Fentahun, & Guadu, T. (2017). Dairy Farming and its Economic Importance in Ethiopia: A Review. *World Journal of Dairy & Food Sciences*, *January*. https://doi.org/10.5829/idosi.wjdfs.2017.42.51
Morris et al.,2001 – Gender Affect Adoption Of Agriculture Innovations – Future agricultures.
Muganyizi.,2011, The impact of a dairy cattle project on households livelihoods in kasulu district,Tanznia.
Mwatawala, H., & Kifaro, G. (2009). Reproductive performance of artificially and naturally bred Boran heifers and cows under ranch conditions in Tanzania. *Journal of Animal & Plant Sciences, 4*(1), 267-275.
O'Lakes, L. (2010). The Next Stage in Dairy Development for Ethiopia. Dairy Value Chains, End Markets and Food Security: Cooperative Agreement 663-A-00-05-00431-00. *Addis Ababa, Ethiopia*.
Philipsson, J., & Rege, J. (2003). Sustainable breeding programmes for tropical farming systems.
Quddus, M. (2012). Adoption of dairy farming technologies by small farm holders: practices and constraints. *Bangladesh Journal of Animal Science, 41*(2), 124-135.
Redda, T. (2002). *Small-scale milk marketing and processing in Ethiopia.* Paper presented at the Smallholder dairy production and market opportunity and constraints. Proceeding of a South–South workshop held at NDDB, Anand, India, 13–16 March 2001.
Saadullah, M. (2001). Smallholder dairy production and marketing: Opportunities and constraints. *Proceedings of a South–South Workshop Held at National Dairy Development Board (NDDB) Anand, India, 13–16 March 2001*, *March*, 414–430.
Sahin, I., & Rogers, F. (2006). *Detailed Review of Rogers ' Diffusion of Innovations Theory and Educational Technology-Related Studies Based on Rogers '*. *5*(2), 14–23
Seidel, G. E., & Seidel, S. M. (1991). *Training manual for embryo transfer in cattle* (Vol. 77): FAO.
Shahin, A. S. A. H. (2004). *Adoption of innovations in smallholder buffalo dairy farms in the Menoufia province in Egypt*.
Staal, S. J., Baltenweck, I., Waithaka, M., DeWolff, T., & Njoroge, L. (2002). Location and uptake: integrated household and GIS analysis of technology adoption and land use, with application to smallholder dairy farms in Kenya. *Agricultural Economics, 27*(3), 295-315.

Syrstad, O., & Ruane, J. (1998). Prospects and strategies for genetic improvement of the dairy potential of tropical cattle by selection. *Tropical Animal Health and Production, 30*(4), 257-268.

Tadesse, D., Ayalew, W., & Hegde, B. (2005). Survey of traditional cattle production systems and preferred cattle functions in North and south Wollo zones, Ethiopia. *Ethiopian Veterinary Journal, 9*(1), 91-108.

Tegegne, A. (2003). Financing market-oriented dairy development. The case of Ada'a-Liben Woreda Dairy Association, Ethiopia.

Tegegne, A., Gebremedhin, B., & Hoekstra, D. (2010). Livestock input supply and service provision in Ethiopia: Challenges and opportunities for market-oriented development.

Teodoro, R., Lemos, A., Barbosa, R., & Madalena, F. (1994). Comparative Performance of Six Holstein-Friesian x Guzera Crossbred Groups in Brazil. Health Costs of Calves. *REVISTA BRASILEIRA DE GENETICA, 17*, 439-439.

Thorpe, W., Maloo, S., Muinga, R., Mullins, G., Mureithi, J., Njunie, M., & Ramadhan, A. (1995). Production of marketable milk in the sub-humid tropics: experiences, lessons and technologies from coastal Kenya.

Walshe, M. J., Grindle, J., Nell, A., & Bachmann, M. (1991). Dairy development in sub-Saharan Africa: A study of issues and options.

Wuletaw, Z. (2004). Performance Evaluation of Cattle Crossbreeding Program of Integrated Livestock Development Project: Case study on the contribution of crossbred animals on the livelihood of the rural community. North Gondar, Integrated Livestock Development Project (ILDP), Gondar Ethiopia. *North Gondar, Integrated Livestock Development Project [ILDP]*.

Yigrem, S., Beyene, F., Tegegne, A., & Gebremedhin, B. (2008). Dairy production, processing and marketing systems of Shashemene-Dilla area. *South Ethiopia*.

World Bank. (2018). *World Bank Group Country Partnership Framework*. (11). Retrieved from http://documents.worldbank.org/curated/en/202771504883944180/pdf/119576-revised-Ethiopia-Country-Partnership-Web.pdf

Year, F., & Report, F. (2018). *FIVE YEAR FINAL REPORT JANUARY 2014 – DECEMBER 2018 THE AGRICULTURE KNOWLEDGE , LEARNING , DOCUMENTATION AND POLICY PROJECT FIVE YEAR FINAL REPORT JANUARY 2014 – DECEMBER 2018 THE AGRICULTURE KNOWLEDGE , LEARNING , DOCUMENTATION*. (December).

ZelalemYilma, Guernbableich, E., & Sebsibe, A. (2011). *A Review of the Ethiopian Dairy Sector*.

Zegeye,Y.(2002). *Challenges and opportunities of livestock marketing in Ethiopia.* Paper presented at the Proceedings of the 10th annual conference of Ethiopian society of animal production (ESAP).

Appendixes

Appendixes 1: Variables and descriptions

Names of variables	Description of variables
AGE	Age of respondent
SEX	Sex of respondent
EDULEV	Education level of respondent
FMLSZ	Family size of respondent
FRMLSZ	Farming land size of respondent
OFFINC	Off-farm income activities of respondent
LIST	Total livestock size
MARDIS	Market distance
DADC	Distance of agricultural developmental center
CREACC	Credit access
EXTCON	Extension contact
INPUACC	Input access

Appendex2: Variance Inflation Factor (VIF) of explained variables

Names of variables	VIF	1/VIF
Age	1.597	0.626
Sex	1.052	0.951
Education level	1.536	0.651
Family size	1.225	0.817
Farming land size	1.026	0.974
Off-farm income activity	1.465	0.63
Total livestock size	1.295	0.772
Market distance	1.587	0.63
Distance of agriculture development center	1.492	0.67
Credit access	1.142	0.876
Extension contact	1.751	0.571
Input access	1.763	0.567

Appendex3: House hold interview questions

Part one: over all information

Deer respondent!

The Amis of this questionnaire is to gather information to write a research paper on "**The impacts of cross breed dairy cows adoption on smallholder farmers' livelihood**: in Gibe woreda of hadiya zone, southern Ethiopia". The Specific Objectives of the Study are: to assess the adoption decision of crossbreed dairy cows technology by smallholder farmers, to identify determinants of crossbred dairy cows technology adoption in the study area, to assess the impact of adopting crossbred dairy cows on the livelihoods of smallholder farmers and to assess the impact of dairy technology adoption on household income, milk consumption, better health and Other livelihood activities. The personal responses of the interviewee would be kept confidential, and there should not be any link between status in the program and response. Therefore, you are kindly requested to give accurate information as much as possible.

Thank you for your response!!

1. Respondent code……..…….
2. Kebele name ……
3. Name of village …….
4. Name of enumerator……..…….. Signature ……
5. Date of interviews …….
6. Respondent category

1) User 0) None user

A/ Information on Personal and Demographic back grounds of the respondent,

1. Age of house hold head …… ……. Years
2. Sex of the house hold head: 1) Male headed 0) Female headed
3. Education level of the house hold head year of schooling:

   0) not read and Write 1) Informal education 2) Formal education,

   if it is formal enter grade complete ……
4. Marital status: 1) Single 2) Married 3) Divorced 4) Widow
5. Religion of the hhold head: 1) Orthodox 2) Islam 3) Catholic 4) Protestant 5) Other
6. Family size 1) Male……. 2) Female …… Total…….

7. Marital status of the household head:

1) Married 2) Divorced 3) Widow/widower 4) Never married 5) Other, specify….

Family age categories and participants in dairy activity

	Age category	Number of persons	Number of household members participates in dairy activity
1	Less than 5 years		……
2	Between 5- 14 years		
3	Between 15-64 years		
4	Above 65 years		

Part two: Information on socioeconomic characteristics of the household in district area.

B) Information on experience of dairy farming:

1. Experience of household in dairy farming is ---------- in year

2. Experience of household in improved dairy farming technologies …….. in year

2.1) Crossbreed cow…in year 2.2) Artificial insemination (AI) …… in year

2.3) Improved forage varieties……..In years. 2.4) Management (housing) ---------- in year

C) Information on land ownership and land size holding

		In Timad	In hectar
1	Total land holding of household in last cropping season		
2	Total crop land		
3	Total forage land		
4	Total grazing land		

D) Off-farm activity of the household members

1. Are you engaged in off-farm activity? 1) Yes 0) No

1.1 If yes, how much did you get from off-farm activity (income amount in month**….. Birr**

E) Information on current Livestock ownership of the household

		Do you own 1)Yes 0) No	Improved (Number per Household)	Local(Number per Household)	Remark
1	Milking cows				
2	Non-Milking cow				
3	Calves				

4	Bull				
5	Oxen				
6	Fatten oxen				

F) Information on adoption

1. Are you aware about adoption? 1) Yes 0) No

If yes, since when did you know about technologies? ……..…….

If no go to the next question

2. Are you using improved dairy farming? 1) Yes 0) No

If you are not using,why? **(**Multiple answer possible**)**1) Not aware

2) Unavailability of technologies 3) Cost of technologies 4) Not interested5) other specify

G) Information on adoption and level of intensity on dairy technology

1. 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

If you use, 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. Did you feeding your livestock recommended feed? (Concentrates, improved forage and standardize crop and hay supplements). 1) Yes 0) No

4. Feeding trough (width, depth, smoothness) 0) No 1) Poor 2) Moderate 3) Good

5. Access to regular vaccination 1) Yes 0) No

6. How do you rate your current use of vaccination against disease prevalence?

0) No 1) Poor 2) Moderate 3) Good

H) Access to infrastructure and distance

7. Do you sale milk, Butter, yogurt and cheese? 1) Yes 0) No

8. **If yes,** how far is the village market from your residence? ----------

9. How far is the Woreda market place from your residence? .....

10. How far is the nearest agricultural extension office from your residence? ……

11. 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 housing5) Regular vaccination

12. Are you participate in any social institution in your village? 1) Yes 0) No

If yes, in which institution currently participated? 1) Agricultural cooperative2) Water association3)Equb 4) Edir5)Other specify……

13. Have you ever taken credit in the last 3 years? 1) Yes0) No

If yes, amount of credit that you taken ---------- birr

14. 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….

15. What is your perception about the importance of credit in dairy development?

1) Least important, 2) less important, 3) important, 4) more important, 5) highly important

16. Did you receive extension advice on dairy technologies during the last 3 years? 1) Yes 0) No

If yes, how often the extension worker visits you in one year? ----------times

17. Who provides extension service about improved dairy farming /multiple answers is possible?

1) DA 2) District experts 3) Local leaders 4) woreda council 5) model farmers 6) NGO

18. What are the main serious influencing factors that inhibit use of improved dairy technologies?

1/ Grazing land 2/ disease 3/ lack of inputs 4/ lack of capital 5/ specify other ----

19. What are other major serious challenges for adoption of dairy technologies?

20. How much you saved money? 1) At pocket-------birr, 2) At bank account--------birr

21. How many of your family member attending school? 1) Male 2) Female ……. Total……

22. How do you rate your household health condition in the past three years?

1/ poor 2/ medium 3/Good 4/ very good 5/ excellent

23. Milk production and currently estimated value

catagories	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					

24. 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				

25. Household source of income in year

	Source of income	Amount the household got	Estimated price brought(Birr)
1	Livestock and their product sell		
2	Crop production		
3	others farm (labor)		
4	Sale of wood		
5	Remittance		
6	Other specify……		
	Total income		

26. The impact measurement in the study area

	Impact variables	1) if considerably improved 2) if remain the same, 3) if considerably declined
1	Income	
2	Health status of family members	
3	Productivity	
4	Children schooling	
5	Assets	
6	Household assets	
7	Farm assets	
8	Livestock assets	
9	Farmers social status in the community	

Information about dairy adoption technology impacts on households' income and asset holdings.

1. Household farm income

Sources & amount of annual income of households in the current year

No	Source of income	Produced amount	Total estimated income	
			Before	After
1	Crop production			
2	Livestock & their products sell			
3	labor			
4	Renting			
5	Off farm activities			
6	Sale of wood			
7	Remittances			
	Total income			

2. Livestock ownership, income and asset holdings in the current years

	Source of livestock assets		Quantity		Total estimated birr	
			Before	After	Before	After
1	Oxen	improved				
		local				
2	Dairy cows	improved				
		local				
3	culves	improved				
		local				
4	bulls	improved				
		local				
5	poultry	improved				
		local				
	goat					
6	sheep					
7	mule					
8	donkey					
9	others					
	Productive and non-productive assets					
			before	after	before	after
10	Town house					

11	Farm instruments				
12	Bed				
13	Table				
14	Mat				
15	Cups				
16	Chair				
17	T V				
18	mobile				
19	solar				
20	Radio				
21	Others				
Total estimated in birr					

Appendex4: Key Informants Interview

1. Do many people participate in the agricultural extension services?

2. Do farmers participate in dairy technology?

3. If yes, in what kinds of technologies? Improved breed, improved feed, better housing, AIS services, veterinary Services

4. What are the constraints/ challenges/ for the adoption of dairy technologies?

5. What the community members involved in dairy extension that means the rich/poor, female /male HHs, the literate/ illiterate, or other?

6. Do you farmers get sufficient extension service and training from GO & NGO?

7. Is the dairy technology profitable to farmers after participating in the technology?

8. What are the changes/ improvements/ you observed the impacts on household's on income, consumption, purchasing power (households' dietary diversity and consumption patter)?

9. Please can you tell me all problems associated with dairy production in the area?

10. What potentials are there for dairy technology extension in your area?

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 technologies are difficult to adopt ?
4. What kind of problem faced time of adopting dairy technologies?

THANK YOU VERY MUCH FOR YOU ATTENTION!!

Appendex 5: Hamola kebele farmers group discussion about dairy adoption technology.

Appendex 6: Samples of data collection in Hadaye kebele