Adoption of Crossbred Dairy Cows in Arsi Zone: The Case of Tiyo and Lemu-Bilbilo Woredas

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By

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BIOGRAPHY

The author was born in September 1958 in Koffele woreda, Arsi zone. He learnt his primary education (1968-1974) at Koffele Lutheran Elementary School and completed his junior secondary education (1975-1976) at Koffele Junior Secondary School. Between 1976 and 1980, he attended his secondary school education at Asella and Shashamane compressive schools.

The author joined Addis Abeba University, Alemaya College of Agriculture, in 1981 and graduated in July 1984 with a B.Sc. degree in Agricultural Economics. Soon after his graduation, he was employed by the Ministry of Agriculture in the pervious Wollega administrative region and served for eight years (Sept.1984-1992) as a junior agricultural economist, cooperative expert and head of awuraja agricultural office. The author was then transferred to Oromiya Agricultural Bureau, Arsi zone, and served as Head of the Agricultural Development Department until he joined the School of Graduate Studies at Alemaya University in September 2000.

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AI	-	Artificial insemination
ABRDP	-	Arsi Bale Rural Development Project
AESE	-	Agricultural Economics Society of Ethiopia
AZADD	-	Arsi Zone Agricultural Development Department
CADU	-	Chilalo Agricultural Development Unit
CBDCs	-	Crossbred Dairy Cows
CIMMYT	-	International Maize and Wheat Improvement Center
CSA	-	Central statistical Authority
DA	-	Development Agent
DRDP	-	Dairy Rehabilitation and Development Project
EEA	-	Ethiopian Economic Association
Ha	-	Hectare
HH	-	Household
IAR	-	Institute of Agricultural Research
KM	-	Kilometer
lt	-	Liter
MEDaC	-	Ministry of Economic Development and Cooperation
ML	-	Maximum Likelihood
MOA	-	Ministry of Agriculture
OPEDB	-	Oromiya Planning and Economic Development Bureau
PA	-	Peasant Association
Qt	-	Quintal
SDDP	-	Smallholder Dairy Development Project
SPDPP	-	Selale Peasant Dairy Development Pilot Project
TLU	-	Tropical Livestock Unit

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Adoption of Crossbred Dairy Cows in Arsi Zone:
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ABSTRACT

Ethiopia has the largest number of livestock population in Africa. Contrarily, the productivity of the country's livestock sub-sector is much below the productivity level realized in most countries in Sub-Saharan Africa. Poor genetic performance, feed shortage, and poor veterinary services have characterized the sector. These in turn have resulted in low productivity of the sub-sector.

National research system and different international institutions have been trying to overcome these problems. Through their efforts, considerable number of technologies has been generated. However, the adoption of these technologies by small-scale farmers has been very limited. According to various theoretical and empirical studies, a wide range of economic, social and institutional factors influence adoption of agricultural technologies among farmers. At the same time, the relevance and significance of these factors differ over regions and localities. A better understanding of the role of factors affecting farmers' decision on technology adoption would then help to design relevant policies and procedures that could fasten the development and diffusion of more appropriate technologies.

With the purpose of contributing towards this end and lack of such study in the area, this investigation was undertaken in two selected woredas of Arsi zone of Oromiya National Regional State. It has examined the influence of different factors on farm households' adoption decision of crossbred dairy cows and quantified the relative importance of those factors significantly associated with the adoption of the technology. In the process both secondary and primary data were used to meet the objectives of this study. Secondary data were obtained from various relevant documents, while primary data were collected from farm households. A two-stage *random sampling procedure was used to draw sample farm households. The selection of peasant associations using a simple random sampling method was followed by the selection of 120 farm households employing proportion to size random sampling procedure. The required data were collected through personal interviews, based on a structured questionnaire.*

Descriptive analysis was used to examine and understand the socioeconomic situation of sample farmers. The survey result has revealed that 40% of the sample farmers adopted crossbred dairy cows during study year. T-test and Chi-square test were used to examine statistical differences between adopters and non-adopters for different continuous and dummy variables, respectively. Logistic regression model was estimated to identify factors affecting farm households' adoption decision of crossbred dairy cows. Among twelve explanatory variables included in the estimated logistic model, ten of them were found to be significantly related to farm households' adoption decision of the technology. The estimated model correctly predicted 87% of the sample farmers into adopters and non-adopters.

Formal education, total local livestock holding, the distance between farmers' residence and market, family size, total cultivated area, access to credit, access to artificial insemination, access to bull service, farmer's leadership position in local farmers' organization and extension contact were found to be significant variables in the adoption decision of crossbred dairy cows. The probability of adoption of crossbred dairy cows for an average farmer in the study area was estimated at the sample means of the continuous explanatory variables and at the most frequent values of the dummy variables in the model and was found to be 0.20. Sensitivity analysis has revealed that accesses to artificial insemination and bull services increase the probability of adoption of the technology by 0.72 and 0.65, respectively. Lack of access to credit and extension services decreases the probability of adoption of the technology by about 0.16 and 0.15, respectively. A decrease in market distance by 1km increases the probability by 0.05. The findings of the study imply that strengthening and expanding artificial insemination and bull services, strengthening extension service, provision of credit facility and the development of marketing infrastructure would significantly improve the adoption of crossbred dairy cows.

CHAPTER ONE: INTRODUCTION

1.1 Background

Ethiopia is one of the least developed countries in the world with per capita income of 130 US Dollars (World Bank, 1996). Poverty and food insecurity are, thus, the two major problems in the country. Sixty percent of her populations live below the poverty line (FAO, 1993; World Bank, 1996). As in many developing countries, agriculture is the mainstay of the Ethiopian people, and about 85% of the total population is engaged in the sector. The contributions of the sector to the country's Gross Domestic Product (GDP) and exports average 60% and 90%, respectively (World Bank 1995). The overall economic performance of Ethiopia is highly dependent on the performance of agriculture (EEA, 1999/2000).

Despite its considerable role, Ethiopian agriculture is predominantly characterized by traditional methods of farming and exhibited very little changes over the past few decades. The sector is, thus, characterized by low production and productivity. It is mainly dominated by smallholder farmers who are substantially concentrated in the highlands (Gryseels, 1983). Simeon and Nega (1997) also reported that small-scale farmers' production accounts for about 90% of the total agricultural output and 84% of the marketed surplus in Ethiopia. The sector had been characterized by a very low growth rate estimated at about 1.4% per annum in real term during the last three decades (Teressa and Heidhues, 1998). This growth rate had been meager, when compared with the growth rate of population of 2.49% per annum during the same period.

Among the major factors behind the poor performance of Ethiopian agriculture are diminishing farm size and subsistence farming, soil degradation, inadequate and variable rainfall, land tenure insecurity, weak agricultural research base and extension system, lack of financial services, imperfect agricultural markets and poor infrastructure (EEA, 1999/2000). According to this source, one of the consequences of the poor performance of Ethiopian agriculture is widespread food insecurity as about 50 to 60% of the country's population is food insecure. The major cause of food insecurity is drought, low technological base and resource degradation, which has been the consequence of the ill-advised rural policies of past successive governments.

Consequently, the agricultural sector has failed to meet adequately its primary objectives such as providing food, raw materials, exports, and resources invesitable in itself and other sectors of the economy (FAO, 1993; Assefa, 1995; Getachew, 1996; as cited in Teressa and Heidhues, 1998). Domestic food production has failed to meet the country's basic food requirements. The country has faced structural food deficit, which has resulted in dependency on food imports, particularly food aid, to feed her growing population during 1985-1996 (EEA, 1999/2000).

As many productive sectors, effective agricultural production requires the availability and efficient utilization of factors of production, such as land, labor, capital, and knowledge. The latter two factors, namely capital and knowledge, are certainly in short supply in the Ethiopian agriculture, although utilization of the first two (land and labor) is certainly inefficient (EEA, 1999/2000).

The country has a total land area of about 113 million hectares. Some estimates of land use pattern suggest that about 12.6 million hectares (10.3% of the total area) is intensively cultivated, and 15.3 million hectare (12.5%) is moderately cultivated. Grassland accounts for 30.5% of the total area (EEA, 1999/2000). Smallholder farmers dominate the country's agricultural sector. About 96% of the cropped area, representing 8% (or almost 10 million ha) of the national land area is cultivated by smallholder farmers producing 90 to 94% of all crop production. Land holdings are small and fragmented, and at national level, about 60% of the holdings are less than 2 hectares (CSA, 1996).

The Ethiopian highlands are considered to be suitable for both crop and livestock production (FAO, 1996, as cited in Simeon and Naga, 1999). It constitutes 40% of the total land area, supports about 90% of rural population and more than 60% of the total livestock population (Kamara, 1999).

Mixed farming or crop and livestock is one of the characteristics of the country's agriculture, particularly in the highlands. Although crop production has the dominant role, the livestock sub-sector also plays an important role in the sector. It is not uncommon to find farm households maintaining a few heads of livestock with their other farming practices. About 81% of the farmers are involved in both crop cultivation and livestock rearing (Degene and Adugna, 1997). The two sub-sectors are interdependent and are well integrated through input-output relations. The livestock sub-sector provides traction power, transport services, and manure, which are extremely vital to the crop production sub-sector. Besides draught power and transportation services, livestock provide food (meat and milk) and generates income for smallholder farmers. The crop sub-sector in turn produces crop residues and important by-products for use as animal feed. Therefore, it can be argued that the Ethiopian farm households have made their choice by adopting a mixed farming strategy instead of specializing in either of the sub-sectors. Combining crop cultivation with livestock production can also minimize possible risk of starvation (Degene and Adugna, 1997).

Ethiopian agriculture is also characterized by a low level use of modern technologies and inputs which is manifested by low level of yields of both crop and livestock production (MOA, 1995 as cited in Simeon and Naga, 1999). The authors further stated that agricultural productivity has to be improved significantly if food deficit problem is to be minimized and ultimately eliminated. Intensification of agriculture through a closer integration of livestock into the cropping system and use of modern technologies is an important step to increase farm productivity and tackle poverty and food insecurity.

The country has the largest number of livestock population in Africa. Some estimations indicate that Ethiopia has about 29.82 million cattle, 11.55 million sheep, 9.61 million goats, 1.12 million horses, 2.6 million donkeys 1.04 million camels, 0.22 million mules and 62 million poultry (CSA, 1995). With regard to livestock distribution, peasant farmers living in the highlands keep 70% of the total livestock population. Smallholders and pastoralists in the lowlands own the remaining (MOA, 1985 as cited in Teferawork, 1989).

Cattle contribute about 70% of the total value of livestock output. However, as noted by Teferwork (1989), The Ethiopian cattle breeds are Zebu breeds and their productivity is reported to be very low. The management of livestock is still largely traditional with more emphasis on number than quality of production. Thus, the current contribution of the livestock sub-sector to the Ethiopian economy has not been up to the expected level given the large size of livestock population. Simeon and Naga (1999) also reported that livestock productivity in Ethiopia is below the productivity realized in most countries in sub-Saharan Africa. This indicates the productivity of the livestock sub-sector is very low.

The sub-sector has received insufficient attention in terms of research and extension (Deneke, 1989; Tasfaye, 1995). As noted by Chilot and Mohammed (2000), compared to crops, extension activity on livestock is limited. Lack of efficient extension services, shortage of veterinary services, poor management practices among the stockowners, inadequate capital investment, and low genetic potential of the indigenous stock are among the many reasons that are assumed to contribute to the low level of production and productivity of the livestock sub-sector (Teferi, 1994). Degene and Adunga (1999) reported that milk yield have remained extremely low with national average of 1.09 litters/day/cow. This is mainly because of feed shortage, diseases, and limited attempts at introducing improved breeds.

One of the efforts undertaken to improve the productivity of the sub-sector especially dairy was the crossbreeding program that has been taken up by the country as a means to improve dairy production and productivity under farmers' management. Crossbreeding of temperate dairy breed with Zebu cattle in Ethiopia has been used as a means to combine high milk yield per lactation and early maturity with good adaptation of local breeds (Gashaw, 1994). The latter includes the ability to resist and survive in the face of various diseases, to produce on low quality feeding system and poor management. Gryseel and Anderson (1983) noted that the average annual milk yield from improved crossbred dairy cows is more than ten times that of the local breeds under smallholders' management practices. They further pointed out that dairy production with crossbred cows is a profitable enterprise even at the existing milk price and it is the most efficient means for increasing farm income. However, improved breeds of animals are very few in numbers. According to CSA's (1996) surveys, indigenous breeds account for 99.74 % of the cattle population. This shows that at national level the diffusion of crossbred dairy cows (CBDCs) is very low.

The comprehensive crossbreeding program of the then Institute of Agricultural Research (IAR) has also concluded that Friesian and Jersey crosses with exotic inheritance of 50 to 62.5% blood level are appropriate to smallholder dairy production in Ethiopia (Zinash et al., 2000). It has been with this background and justification that different institutions in different parts of the country have since long started the introduction of exotic breeds and crossing them with the local ones. The first attempt of introducing crossbred cows into the farming system was undertaken by the Chilalo Agricultural Development Unit (CADU) (Zinash et al., 2000). CADU started the popularization of crossbred cattle in Arsi 32 years ago in the early 1970. The introduction was in a package form where the provision of artificial insemination (AI) was accompanied by health services.

According to the information obtained from Arsi Zone Agricultural Development Department (AZADD), CADU established the first liquid nitrogen plant in Asella for storage and handling of frozen semen in 1971. This unit started crossbreeding program through artificial insemination of local heifers with imported semen from purebred Jersey and Friesian bulls. The crossbred dairy cows, offspring with 50% exotic blood level, have been extended to farmers as component of extension packages designed to improve the productivity of dairy cattle. Towards this end, different programs and services were initiated. Accordingly, Dairy Rehabilitation and Development Projects (DRDP), the National Artificial Insemination Center, the Selale Peasant Dairy Development Pilot Project (SPDDPP) and the Smallholder Dairy Development Project (SDDP) contributed to the development of the dairy sector through the dissemination of crossbred dairy cows.

1.2 Statement of the Problem

Since the inception of CADU and ARDU, different crop and livestock production technologies have been released from research centers to improve agricultural production and productivity in Arsi zone. Considerable development efforts have also been made to disseminate these technologies among farmers. In particular, tremendous efforts have been made to produce and disseminate crossbred dairy cows in the zone over the last three decades.

Despite these efforts, there have been no or very few studies that addressed the adoption of crossbred dairy cows among farm households in the zone. Consequently, information on factors affecting adoption of crossbred dairy cows is very scarce in the zone as well as in the country as a whole. Studying the process of adoption, identification, and analysis of factors affecting adoption of crossbred dairy cows would significantly contribute to efforts being made to develop the dairy industry in the country. This study was, therefore, initated to examine factors influencing the adoption of crossbred dairy cows by smallholder farmers in Arsi zone.

1.3 Objectives of the Study

The specific objectives of this study were:

1. To determine rate of adoption of crossbred dairy cows:
2. To identify factors affecting adoption of CBDCs by smallholder farmers in the study area: and
3. To assess the relative importance of key factors in influencing adoption of the technology.

1.4 Significance of the Study

This study has generated information on a diverse set of factors that influence the adoption of CBDCs among farm households. It has also generated information about how widely CBDCs are adopted in the study area. It is hoped that the information generated by this study would help in designing appropriate policy and extension services directed at fostering the adoption of the technology by farm households. It is also expected that the information would considerably improve the planning of development activities. The empirical result of the study would also serve as a springboard for others similar detailed and comprehensive studies in the country.

1.5 Scope of the Study

The scope of this study was restricted to the investigation of various factors conditioning the adoption of crossbred dairy cows among farm households in Arsi Zone. More specifically, the study was undertaken in two woredas, namely Tiyo and Lemu-Bilbilo, on 120 randomly sampled farmers.

1.6 Organization of the Thesis

The thesis is organized in six chapters. Chapter two deals with review of literature. A brief description of the study area is presented in Chapter three, and Chapter four covers the research methodology. Empirical results are discussed in Chapter five. Finally, Chapter six presents summary, conclusions, and policy implications of the study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The Chapter deals with the role of livestock and crossbred dairy technology and adoption of the agricultural technology by smallholder farmers and concludes by examining the empirical adoption studies of these technologies. The purpose is to review studies on agriculture and livestock technology adoption in different areas.

2.2 The Role of Livestock and Crossbred Dairy

Livestock have diverse functions in agricultural production and plays a crucial role in the farming system. Hence, it improves the productivity of farm enterprise and contributes to the intensification of agricultural production in several ways. Food production in the form of meat, milk and other livestock food products constitute the major group of livestock outputs. In the smallholder mixed farming systems, 26% of livestock output is used for food. In pastoral systems, the proportion used for food increases to 61% (EEA, 1999/2000).

The same report reveals that livestock are sources of cash income for smallholder producing mixed farming and pastoral households as 24% and 31% of their livestock outputs are sold for cash, respectively. Over 90% of pastoralists' incomes are generated by cash income from livestock. In the highlands mixed farming systems, about 42% of livestock output is used as on farm inputs in the form of draft power, manure and the transport of farm produce and feed. The livestock sub-sector contributes approximately 12-15% to total Gross Domestic Product (GDP) and 20-30% of agricultural GDP (MEDaC, 1999). Live animals, meat, hides, and skins are a commodity group that constitutes the second most important foreign currency earners next to coffee. In 1987/88, livestock and livestock products contributed 23% and 21% of the value of agricultural and total exports, respectively. Since then these shares have gradually declined as shown in Table 1.

Table 1. Share of Livestock in Agricultural and Total Exports (percent)

Share of Livestock	1987/88	1992/93	1993/94	1994/95	1995/96
In agricultural export	23.4	17.6	15.9	14.8	13.9
In total export	21.3	16.6	15.1	14.2	12.9

Source: EEA, 1999/2000, volume 1, P.174

Animal products not only represent a source of high quality food, but also are important sources of proteins and essential amino acids and calories, when used as a major constituent of human diet (FAO, 1996 cited in Simeon and Nega, 1997). Animals are also used as buffer to risk of crop failure and to variability in crop production. Cash from the sales of livestock and livestock products is used to purchase grains. According to different evidences from research, using animals for traction can increase food production by enabling timely and better soil preparation (Gryseels, 1988; Omiti, 1997).

Thus, animal and animal products are critical sources of income for many smallholders in developing countries. Dairy production in particular served as a dominant income generating means for many of them. For instance, in semiarid areas of Mali, livestock contributes 78% of cash income (Li-pun and Shapiro, 1998). The income is used for the purchase of food as well as agricultural inputs. Gryseels (1988) reported that in the central highlands of Ethiopia, the sale of livestock and livestock products contributed 83% of cash income per household per year. About 52% of cash income was from trade of live animals and the remaining 31% was from the sale of livestock products. Manure alone accounted for 25% of the sale of livestock products and dairy products contributed over 50% of the same. Furthermore, the author has stated that the share of livestock in cash income is higher in those villages where total cash income is higher indicating that increased cash income comes primarily from livestock. This was also supported by a recent study (Omiti et al., 1997) that examined the economic outcomes of introducing livestock to crop farms to increase food production and cash income in the central highlands of Ethiopia, and this improved the agricultural performance of smallholder farmers.

Livestock, and especially dairy, can make unique contributions to the nutrition, and especially the micronutrient, and health status of members of smallholder farms (Li pun and Shapiro, 1998). Livestock production also improves farm household's food security in several ways. The authors further explained that livestock actively contribute to sustainability of agricultural system in many ways, besides acting as reserves to be used in times of need. However, the contribution of the livestock sub-sector towards food supply and other needs of the Ethiopian people are less than what is expected due to low productivity of local cattle.

There is greater potential to increase cash income and labor utilization through rearing of high yielding livestock breeds, better feed, and pasture management and use of improved technology (Omiti et al., 1997). This study further showed the possibilities of assuring long-term food security with the adoption of new technology. In line with this, it was noted that the introduction of crossbred dairy cattle is a promising way to raise the genetic potential of local cattle and to achieve a higher milk production than with the local cattle (Teferi, 1994). The study by Omiti et al. (1997) also supports the above statement and showed the benefit of assuring long-term food security with the adoption of new technology. Compared with keeping a local Zebu cow (under improved pasture), keeping a crossbred cow presents another opportunity for generating farm income in rural areas. With inclusion of crossbred dairy cows in farmers farming system, a farmer would earn 1175 birr as opposed to 954 birr (Omiti et al., 1997).

Livestock husbandry, especially dairy farm, is a labor-intensive activity. As man to land ratio increases due to population growth, it can offer a viable option to absorb the redundant labor and can minimize the rural underemployment and unemployment problem. Omiti et al. (1997) have shown that by keeping crossbred cows on farm instead of local Zebu cows, a farmer will be able to sell more milk (767kg instead of 175 kg) and employs more family labor (807 hours instead of 782 hours). Mengistu (1997) also supported this in his evaluation of the economic returns of using crossbred cows for traction and milk production. This study showed that the introduction of crossbred cows increases labor utilization, on the average, by about 40% compared to the traditional technology. On the other hand, since livestock outputs in the country are from animals that are kept under traditional management system and poor genetic structure, it is crucial to create a meaningful and sustainable dairy development strategy through transferring dairy technologies that have developed by different institutions.

Several organizations, including international and national agricultural research centers and MOA, have developed and promoted the use of improved dairy technologies to help increase smallholders' farm productivity and income (Freeman et al., 1998). Crossbreeding of indigenous cattle with well performing breeds of European origin offers a quick and efficient opportunity for increasing milk production (Bhat et al., 1978). Ramish (1995) concluded that an increase in the productivity of milking cow had resulted in rapid increase in milk production.

Mengistu (1997) also indicated that efforts of researchers directed at the introduction of crossbred cows show that this technology can raise net cash income of adopters. To this end, livestock ownership has a significant impact on overall farm productivity and food production. He pointed out that those farmers with relatively less land holding benefit more from keeping crossbred cows. This is so because as land size decreases, feed resources become more limited and the need arises to keep a smaller number of animals to support the farming system. According to this review, using more productive animals on farm can result in reduced stocking rate and over-grazing. This is quite essential to establish a sustainable farming system in view of the present small and declining land holding due to population pressure.

2.3 Adoption of Agricultural Technology

The adoption of a new technology can be defined in several ways. Rogers (1962) defines the adoption process as the mental process where an individual passes from first hearing about innovation to final adoption and proposes a different set of stages, such as awareness, interest, evaluation, trial and adoption. Adams (1990) who noted that adoption is not a sudden event, but a process also supports this. Van den Ban and Hawkins (1996) define technology adoption as a decision to apply an innovation and to continue to use it. According to this definition, the adoption process refers to changes that take place within the minds of an individual with regard to an innovation from the moment that he/she first becomes aware of the innovation to the final decision to continuously use it or not. Some times adoption is defined as the proportion of farmers using a technology, in other cases; it is the actual proportion of field or crop area under the new technology (CIMMYT, 1993).

Adoption of new technologies in farming activities is becoming crucial for developing countries in order to meet the challenges found in agricultural production and productivity. The spread of improved technologies is the key ingredient in any rural development program (Aregay, 1979). The author also explained that pattern of innovation diffusion within the farming community is also different. Most diffusion studies have shown that not all farmers in a community adopt new ideas at the same time. Some accept readily, the majority accepts slowly and some never get detached from old ideas. When a new technology is introduced, all potential adopters do not usually adopt it instantaneously and uniformly (Mann, 1989). According to both authors, a few people adopt the new technology right away, while others wait and observe before they make decision to adopt it.

In many areas of African countries, technologies are becoming available, but adoption has been slow or has not been sustained (Byerlee and Heisey, 1993 as cited in Kedir, 1998). According to Feder et al. (1985), immediate and uniform adoption of innovations in agriculture is quite rare as adoption behavior differs across socioeconomic groups, over time and geographical location. It was further underlined that some innovations have been well received in one area, while only small groups of farmers have adopted them in another area. Some technologies have been well adopted, while others have been adopted by only very small groups of farmers. Adoption decision is conditioned mainly by perceived profitability of the technology, that is, once a farmer becomes aware of the improved technologies, the most important factor determining adoption appears to be farmers' perceptions that the new technology will be more profitable than their current practice (Chilot, et. al., 1996). In view of the above arguments, Byerlee and Polanco (1986) explained that farmers adopt technologies in step-wise pattern based on criteria of profitability, risk nature, initial capital requirements, complexity, and availability.

2.4 Empirical Adoption Studies

Over the past two-three decades, development programs in Ethiopia have included several new technologies. However, there has not been a wide spread adoption of these technologies in the central highlands of Ethiopia (Yohannes et al., 1990). Different studies conducted on factors influencing the adoption of agricultural technologies have underlined that factors, such as characteristics of household (education, age, and family size) farm characteristics, technology characteristics, wealth (economic) status, contact with extension workers, farmers knowledge of the specific technology, price, access to credit, position of farmers in farmers organization, were important determinants of adoption of new technologies (Legesse, 1992; Teressa and Heidhues, 1996; Lelissa, 1998; Wolday, 1999; Mulgeta, 2000; Regassa et al., 2001). In line with this, Simeon and Nega (1997) also suggested poor linkage between research and extension, high cost, low returns, inappropriateness of technologies, lack of credit facilities, the prevalence of animal diseases, absence of transport and marketing infrastructure as some of the problems affecting diffusion of technologies.

According to Yohannes et al. (1990), various socioeconomic factors and the degree of risk aversion were the causes of low adoption rates. There is a growing evidence that the major factor explaining low adoption of technology in Africa is lack of appropriate institutional and policy support (Eicher, 1985; Sanders, 1989; World Bank, 1990; as cited in Kedir, 1998).

A study undertaken in mid 1970 by CADU provides evidence that contacts with extension agents was vital source from which farmers get information for technology adoption (Aregay, 1979). This shows that farmers require information on new technologies to adopt them. Farmers prefer direct source of information to indirect one. It is also noted that adoption is a long term process. It needs strong extension efforts to both create awareness and convince farmers to adopt it (Mohammed and Kedir, 1997).

Recently, Berhanu (2002) conducted a study on factors affecting the adoption of crossbred dairy cows in Selale area. The investigation has shown that distance from farm to market, bull service, farming experience, total livestock owned; extension contact, animal health problem, farm size, feed shortage, and off-farm income have significant effect on the adoption of crossbred dairy cows in the study area.

As reported by Van den and Hawkins (1996) and Freeman et al. (1996), adoption of improved technologies is strongly influenced by the policy environment, like input supply, markets, credit, price policy and improved support services. Likewise, the effectiveness of extension services and other communication media as well as farmers' educational level influence the use of improved technologies. It was also pointed out that extension effort and input availability are most crucial in influencing technology adoption (Chilot et al., 1996). Farmer's adoption decision can be influenced by many economic, social, and physical factors, which vary from area to area, and their effects on adoption decision are often not uniform. Because of this, the reaction of farmers to new technology is often not precisely the same (Kelvin et al., 1971 as cited in Legesse, 1992).

These variations in the adoption of agricultural technologies by farm households necessitate empirical investigations. In Ethiopia, almost all such empirical studies have mainly been concentrated on the examination of the adoption of crop production technologies (Kebede, 1991; Chilot et al., 1996; Asfaw et al., 1997; Teressa, 1997; Wolday, 1999; Lelisa, 1998; Kedir, 1998). The rural development project started by CADU in late 1960s was an important start of extension work in Arsi. However, major emphasis was given to crops especially wheat (Mohammed and Kedir, 1996). It is also noted that extension activity on livestock is limited as compared to crops (Chilot and Mohammed, 2000).

Very recently, there has been a growing effort in extending the sphere of analysis of technology adoption to natural resources (Mulugeta, 2000, Million, 2001). With regard to livestock and in particular dairy technologies, there are only a few studies that have been done (Freeman et al., 1996; Simeon and Nega, 1997; and Berhanu, 2002) and no such investigation is conducted in the study area.

The main conclusion that can be made from this review of literature is that the available empirical information on the adoption of dairy technology in general, and CBDCs in particular, is extremely scant. This suggests that there is a need to bridge this information gap through further research on the adoption of dairy technologies including CBDCs. This necessitated the study of the adoption of crossbred dairy cows in Arsi zone.

CHAPTER THREE: DESCRIPTION OF STUDY AREAS

3.1 Introduction

In the adoption of crossbred dairy cows, Arsi provides good information. Livestock forms an integral part of nearly all-farming systems in the crop producing areas of Arsi. The large proportions of cattle kept on farm are indigenous Arsi types. There are also around 22,000 heads of crossbred cattle (about 0.8% of the total cattle in the zone), which is more than the national average of 0.26% (Table 2).

Table 2. Proportion of Indigenous and Crossbred Livestock in Ethiopia, 1994/95
(% of Indigenous and Crossbred)

Livestock	Indigenous	Crossbred	Total
Cattle	99.74	0.26	100
Sheep	99.79	0.21	100
Goat	99.99	0.01	100

Sources: Dejene and Adugna, (1999 p. 32)

Generally, livestock extension activities are provided by the public sector and the service is perceived as unsatisfactory in terms of coverage and quality and unable to meet the increasing demand for the service. In the past, several livestock development projects were initiated in Arsi and contributed to the promotion of crossbred dairy cattle. In this zone, Gobe crossbred cattle multiplication center, the Asella Animal Research Section, and the Asella Semen Processing and Liquid Nitrogen Plant has established by development project implemented in 1970s. However, their contribution to the development of the livestock sector has declined with the termination of the respective projects.

Recently, Arsi Zone Agricultural Development Department (AZADD) provides the livestock extension services. The Department promotes packages of dairy production technologies to increase milk production through distribution of crossbred heifers (on the sale base), establishment of bull service stations and provision of artificial insemination (AI) services. The extension service is assisted by different sections in order to accomplish its institutional mandates. The Asella Animal Breeding and Forage Development Center and the Gobe Cattle Multiplication Center also contribute for dairy development through provision of AI services and supply of crossbred cattle.

In Arsi zone, as it is the case elsewhere, livestock productivity is low mainly due to prevalence of animal diseases, poor animal husbandry, shortage of feed both in quantity and quality, and poor genetic potential of Arsi type, limited access to livestock support services and inputs. High cost of inputs and the absence of reliable market outlets for output are further problems on the productivity of the livestock sub-sector.

This chapter is divided into three parts. The first and second parts briefly outline resource base and some features of the Oromiya National Region State and Arsi zone respectively. The third part provides detailed descriptions of the study areas within Arsi zone.

3.2 Background of Oromiya Region

The study was undertaken in Arsi zone of Oromiya National Regional State. Oromiya is the largest of all the nine regional states of Ethiopia. Oromiya region is important in terms of its population and other resource endowments (OBPED, 1996). Based on the 1994 population and housing census, the population of the region is projected to be about 23 million (with sex ratio of 1:1) in 2001 and expected to grow by 3% per year. In Oromiya, the economy is dominated by agriculture. The share of agriculture in the regional domestic product would probably be more significant than its contribution in the GDP of the nation as a whole. The sector provides employment for about 92% of the population of the region (OBPED, 1996). According to OBPED (1996), out of the total land under private peasant holdings, the largest proportion of total holdings (71.2%) used for the production of annual crops followed by grazing land (9.9%). The same source indicates that the average total land holding size per household in Oromiya was 1.36 hectares. The largest and smallest holdings per household were reported to be 2.18 hectare in Arsi and 0.6 hectares in east Hararghe zones (OBPED, 1996).

The major crops that are grown in Oromiya are maize, teff, barley, wheat, sorghum, and oats from cereals; faba bean, field peas, chickpea, lentils, grass peas, and haricot bean from pulses; noug and linseed from oil crops and coffee and chat from major cash crops. However, the distribution of the major crops varies from zones to zones depending on crop suitability factors, cultural practices, food habits, etc.

Livestock plays significant role in the region's economy. In fact, livestock census has not been undertaken in Oromiya. However, according to some sources (Table 3), the livestock population of oromiya is estimated at 15.13 million heads of cattle, 5.18 million heads of sheep, 3.62 million heads of goats, 0.63 million heads of horse, 1.26 million heads of donkey, 0.64 million heads of mules, 0.88 million heads of camels, 33.35 million poultry and 1.68 million beehives under the holding of farm households in 1995/96 (OBPED, 1996; CSA, 1995).

According to this source, about 47.7% of cattle, 40.6% of sheep and 36.3% of goats stock of the country are found in this region. The proportion of horses, donkeys, mules, and camels found in the region are 58.0%, 44.4%, 36.9%, and 35.47%, respectively. The region accounts for one-third and 47.5% of the country's beehives and poultry, respectively. More recent source, EEA (1999/2000) indicates that about 50% of the country's livestock populations are found in Oromiya region.

Table 3. Estimated Livestock Population in Oromiya 1995/96 G.C

Livestock type	Number	TLU	% of the national total
Cattle	15,132,500	12,009,928	47.70
Sheep	5,189,740	518,974	40.60
Goat	3,621,650	362,165	36.30
Horse	631,510	505,208	58.00
Donkey	1,261,340	504,536	44.30
Mule	792,000	636,000	36.90
Camel	879,260	1,143,040	35.47
Poultry	12,334,970	-	37.00
Beehives	1,684,980	-	47.50

Source: OBPED, 2000. P. 36

3.3 Arsi Zone

3.3.1 Physical Characteristics and Population

Arsi zone shares boundaries with East Shewa, West Hararghe, Bale zones and Southern People Nations and Nationalities Regional State (Figure 1). Assela is the zonal capital, located at 175km south east of Addis Ababa. Based on the 1994 census, the total population of Arsi was forecasted to be 2.7 million in 2001 and 90% is rural population (OBED, 2000). Arsi zone has 20 woredas with an area of 23,679.7km^2 and population density of 101 persons per km,^{2} which is more than the regional average of 53 persons per km^2 (OBED, 2000).

The altitude of Arsi zone ranges from 1500 to more than 4000 meters above sea level (OBED, 2000). The average temperature varies from 10 to 24^{o}c. The rainfall of the zone is characterized by bimodal pattern. The average rainfall in the highlands of Arsi ranges from 800 to 1200 mm with a seasonal distribution. The main rainy season, which accounts for approximately 60% of the annual precipitation, covers the period between the beginning of June and end of September, while the short rainy season is during March to May.

3.3.2 Agriculture

In Arsi zone, there are 525 Peasant Associations (PAs) with 302,791 members and 115 service cooperatives with about more than 175,000 members (OBPED, 2000). According to the same source, arable land accounted for 35.4%; pasture land for 18.8%, while forest and shrubs covered 18.0% of the total land area. Degraded land and others constituted 27.8% of the total area of the zone.

The farming system of Arsi zone was characterized by crop-livestock mixed farming system. Crop production is carried out in both meher and belg seasons although the main cropping season is meher. Barley, wheat, teff, maize, sorghum, faba bean, field peas, lentil, and linseed are the major annual crops grown in the zone. Table 4 shows the total cultivated area, production level, area coverage and yield of different crops in the Arsi zone for the year 2000.

Table 4. Area Coverage and Total Production of Major Crops in Arsi Zone, 2000

Crops category	Area (ha)	Production (qt)	% of total Cultivated land
Cereals	522471.40	8282929.50	84.00
Pulses	54683.80	528718.50	8.80
Oil crops	33933.00	217032.90	5.50
Fruits and vegetables	10577.00	127030.00	1.70
Total	621665.20	9155710.90	100.00

Source: AZADD, 2000: p.10

The zone is also known for its livestock production. According to OBED (2000), there are about 2.74 million cattle, 1.33 million sheep and goats, 476,721 equines 1.3 million poultry, and 112,204 traditional and 353 modern beehives in the zone. For example, if we compare livestock population in different zones, Arsi ranks first in cattle and sheep population in the country (Dejene and Adugna, 1997). This indicates that livestock is an important element in the farming systems in the zone. As noted in Section 3.1, livestock play an important role in providing draught power, food and cash income.

In Arsi, as it is the case elsewhere, there is high competition over land use among livestock, crop and forest sub-sectors. Grazing lands, especially in the intensively cultivated areas like Gadab, Hetosa, Tiyo, Lemu-blbilo etc. have shrunken in size, which has adversely influenced livestock production. Because of overstocking, over-grazing has become prevalent. The existing grazing land alone cannot support the existing livestock population. Uses of fallow land for grazing and crop residue are other sources of feed in the area.

3.4 Location of the Study Areas within Arsi Zone

Out of 20 woredas in the Zone, this study was conducted in two purposively selected woredas, namely Tiyo and Lemu-Bilbilo. These woredas were selected because of their large livestock population and livestock extension activities that have been carried out since the advent of CADU and ARDU.

3.4.1 Tiyo Woreda

Tiyo Woreda (576 km^2) is found around Asella town with its administrative center in Asella town (Figure 2). In 2001, the population of Tiyo woreda was forecasted to be 132146 of which about 60% were rural populations. Economically active populations account for about 55.4% (OBPED, 2000). The woreda has 15 PAs with 13,704 members and 9 service cooperatives consisting of 7426 members. The cultivable land accounted for 40% of the total area of the woreda, grazing land was 23.1% and population density of the woreda was estimated at 223 per km^2 (OBPED, 2000). The ethnic composition of the woreda consists of Oromo and Amhara and Oromos are the indigenous majority in the area.

A mixed farming system consisting of crop and livestock production was practiced. Crop production is mainly practiced under rain-fed conditions. According to information obtained from woreda agricultural office, cereals account for 80.1% of the land covered by crops. The major crops grown and average yields per hectare in the woreda are barley 11 quintals, wheat 10 quintals and teff 6 quintals. Farmers in the woreda are familiar with the use of agricultural inputs due to the legacy of CADU and ARDU. In 1996/97, about 15353 qt. of fertilizer and 583.5 qt of seeds and more than 210 liters of herbicides were used. Thus, most of the crops were fertilized. However, the yield levels were low due to low rate of application. The climatic condition of Tiyo woreda was not a limiting factor in crop production. However, in recent years, insufficient and erratic distribution of rainfall has made it difficult to raise crop productivity in the woreda.

The ecology of the woreda varies considerably with respect to climate, soils, natural vegetation, and agricultural potential. The altitude of woreda ranges from 1700 meters to more than 4000 meters above sea level. The rainfall of Tiyo was characterized by a bimodal pattern and on the average; it receives 1224.5 mm of rainfall annually (AZADD, 2000).

According to OBPED (2000), the estimated population of livestock in the woreda was 96,966 cattle, 33,817 sheep, 16,121 goats, 6,913 horses, 1,358 mules, 8,109 donkeys, and 24,439 poultry. According to information obtained from AZADD (2000), there were some 9,600 crossbred cattle (having 50% and/or above exotic blood levels) and this account for 10% of total cattle population in the woreda. This has largely resulted from ARDU's past development activities, particularly AI service that has been in place for a couple of decades.

The concentration of crossbred animals is higher in Asella town and its immediate vicinity. The constraints considered as the most serious by the farming community were shortage of improved cattle at reasonable prices and low conception rates (i.e. too many repeats). The latter problem is important to those farmers using AI services. Average farm size per household is 1.5 hectares and about 5.9% of the farmers are landless (OBPED, 2000).

3.4.2 Lemu-Bilbilo Woreda

Lemu-Bilbilo (1,212.5km^2) is 50 Km southeast of Asella with its administrative center at Bokoji (Figure 2). The woreda has 31 PAs with 22,000 members and 8 service cooperatives with 13,800 members (OBED, 2000). The altitude of the woreda ranges from 1500 meter around Wabe River to 3,800 meters above sea level at Kakar Mountain. Its rainfall is bimodal and on the average it receives 1083 mm of rainfall annually (AZADD, 2000).

A mixed farming system consisting of crop and livestock production is practiced in the woreda. About 48.1% of the total areas of the woreda were cultivable land, of which 88.4% was cultivated. The other land use types are pastureland (29.4%), forest and shrub land (12.7%), degraded and others 9.81% (OBPED, 2000). The major ethnic composition of the woreda consists of Oromo and Amhara of which Oromo are the indigenous majority in the area. According to the same source, the average farm size in the woreda was 2.23, while the average number of oxen per household was 2.4 and 7% of the farmers have no oxen. The most important crops grown in the woreda are barley and wheat. The average crop yields per hectare were 10 Qt. for barley and 12 Qt. for wheat. About 28516 Qt. of fertilizer, 674 Qt. of improved seeds and 487 lt of herbicides were used in 1996/97 cropping season. The most important factor constraining agricultural production according to many farmers was land shortage. This is because of high population growth in rural area. The average family size of the woreda was 8 people. Households with more than 10 persons were not uncommon.

In the woreda, different types of livestock are raised. It is estimated that there were 309,383 cattle, 44,430 small ruminants, 6,167 equines, 61,607 poultry, and 7,229 beehives (OBED. 2000). According to information obtained from AZADD (2000), there were about 4000 crossbred cattle in the woreda in year 2000. The same source indicated that the average livestock holding per household was 10 cattle (with 1 pair of oxen common to most households), 10 sheep, and 3 equines. Livestock rearing is constrained by poor nutrition, low productivity due to poor genetic potential and disease or inadequate health services.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

This Chapter briefly discusses the research methodology used in the study. It provides detailed description of site selection process and how sample respondents were drawn, how the field survey was conducted, and how the individual interviews were conducted. The Chapter also presents the procedures and statistical package used in data analysis to empirically test the hypothesis stated in Chapter one Section 1.4.

4.2 Selection of Study Areas

As explained in Chapter three, the study was undertaken in Arsi zone of Oromiya National Regional State. Out of 20 woredas in the zone, the study was conducted in two purposively selected woredas, namely Tiyo and Lemu-Bilbilo. These woredas were selected because of their large livestock population and livestock extension activities that have been carried out since the advent of CADU and ARDU. The study covered two and five randomly sampled PAs from Tiyo and Lemu-Bilbilo, respectively. The target population of this study consisted of smallholder farmers.

4.3 Sample Selection

A two-stage random sampling procedure was employed to draw the sample PAs and farm households. The first stage was the selection of PAs using a simple random selection method, while the second involved the selection of farm households to be interviewed.

4.3.1 Selection of Peasant Associations

Lists of a total of 15 and 31 PAs in Tiyo and Lemu-Bilbilo woredas, respectively, were obtained from their respective woreda agricultural offices. Samples of 2 and 3 PAs were randomly selected from Tiyo and Lemu-Bilbilo woredas, respectively. The lists of farm HHs in the selected PAs made sampling frames from which sample farm HHs were randomly selected for interview. Table 5 shows sampled PAs from each woredas, total HHs of PAs, and the number of sampled HHs for interview.

Table 5. Woreda, Sampled PAs and Number of HHs Interviewed in each PAs.

Woredas	Sampled PA	Total HHs	Number of HHs interviewed
Tiyo	1. Oda-dawata	1023	32
	2. Shala-Chabeti	817	26
Lemu-Bilbilo	1. Lemu-Burkitu	850	27
	2. Koma-Katar	672	21
	3.Onkolo-Farachu	430	14
Total		3792	120

Source: Woreda agricultural offices

4.3.2 Selection of Sample Farm Households

The second stage of Sampling was selection of farm HHs to be interviewed. The lists of household heads were obtained from the sampled PA offices and they were used as sampling frames. A total of 120 HH heads were drawn using proportion to size random sampling method. In all the five sampled PAs, all elements of the population were smallholder farmers growing wheat, barley, and other crops with integration of livestock.

4.4 Data Collection Procedure

The data upon which this study was based were collected through structured farm HH survey conducted in the five PAs, namely Oda-dawata, Shala-Chabeti, Lemu-Burkitu, Koma-Katar and Onkolo-Farachu, sampled from two woredas (Table 5). The farm survey was conducted from November 2000 to January 2001.

Prior to the household survey, four enumerators (three males and one female) were selected through woreda agricultural offices. Three of the enumerators were 12 grades complete and one was a graduate of junior college. The enumerators had previous experience in conducting farm household surveys with Ethiopian Agricultural Research Organization (EARO) and other agencies. They were familiar with the study woredas. They also speak the local language and know local customs and traditions. In addition, after the selection was done, the enumerators were given intensive three-day training on data collection procedures. The research questionnaire was pre-tested using a pilot sample of 5 farmers who were not part of the study sample.

The majorities of the household heads were interviewed in the presence of their immediate family members like spouses and children. During the interview process, the household members were allowed to discuss among themselves on critical value estimates, such as yield, incomes, and expenditures. The presence of family members helped not only in making the heads comfortable during the interview, but also in enhancing their recall capacity and making them reach consensuses on answering questions related to land holding, area cultivated, income and expenditure. It is believed that this process has played a role in minimizing biases that could have been caused by either overestimation or underestimation of values of sensitive economic variables, mainly holding size, area cultivated, incomes, and expenditures.

4.5 Methods of Data Analysis

The farm survey data were analyzed using both descriptive and econometric procedures of data processing. Descriptive statistics, like mean, standard deviation (S.D), frequencies, ratios, percentages, and tabular analysis were used to examine and understand the socioeconomic situations of sample respondents.

The core aim of this investigation was to understand the adoption of crossbred dairy cows. The variable representing adoption of the technology is a dummy variable that takes a value of one for adopter or zero 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 are believed to influence adoption decision of the technology.

Literature on technology adoption indicates that for such type of dependent variable, the most commonly used qualitative response models are the logit and probit models. The logit model, a logistic distribution function, and the probit model, a normal distribution function, are used in estimating the probability of technology adoption (CIMMYT, 1993; Feder et al., 1985; Greene, 1993; Pindyck and Rubinfeld, 1981). Such models have 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 et al., 1997). Feder et al. (1985) pointed out that both models have been used interchangeably and give almost the same results. However, the logit model is simpler in estimation than the probit model (Aldrich and Nelson, 1984). The logit model was, therefore, used in this work to identify factors influencing the adoption of CBDCs.

4.5.1 Model Specification

Following Gujarati (1988) and Maddala (1992), the logistic distribution for the adoption of crossbred dairy cows can be specified as:

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

Where P_i is the probability of adopting crossbred dairy cows for the i^{th} farmer and ranges from 0 to 1. Z_i is the function of a vector of n explanatory variables and expressed as:

$$Z_i = B_0 + \sum B_i X_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where B_o is the intercept and B_i is a vector of unknown slope coefficients.

The relationship between P_i and X_i, which is non-linear, can be written as follows:

$$P_i = \frac{1}{1+e^{-B_0+B_iXi+\ldots+B_nX_n}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The slopes tell how the log-odds in favor of adopting crossbred dairy cow technology changes as independent variables change. If P_i is the probability of adopting a given crossbred dairy cow, then $1-P_i$ represents the probability of not adopting and can be written as:

$$1-P_i = 1-\frac{1}{1+e^{-Z_i}}$$

$$= \frac{e^{-z_i}}{1+e^{-z_i}}$$

$$1-P_i = \frac{1}{1+e^{Z_i}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Dividing equation (1) by equation (4) and simplifying gives:

$$\frac{P_i}{1-p_i} = \frac{1+e^{Z_i}}{1+e^{-z_i}} = e^{Z_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Equation (5) indicates simply the odd-ratio in favor of adopting crossbred dairy cow. It is the ratio of the probability that the farmer will adopt the technology to the probability that he will not adopt it. Finally, the logit model is obtained by taking the logarithm of equation (5) as follows.

$$L_i = L_n\left(\frac{P_i}{1-P_i}\right) = Z_i = B_o+B_1X_1+B_2X_2+\ldots+B_nX_n \quad \ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where L_i is log of the odds ratio, which is not only linear in X, but also linear in the parameters. Thus, if the stochastic disturbance term U_i is taken into account, the logistic model becomes:

$$Z_i = B_o + B_1 X_1 + B_2 X_2+\ldots+ B_nX_n+ U_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

This econometric model was used in this study, and variables that were assumed to influence the adoption decision of CBDCs technology were tested. The parameters (B_i) of the model were estimated using the iterative Maximum Likelihood Estimation (MLE) procedure due to the non-linearity of the logistic regression model. The MLE procedure yields unbiased, asymptotically efficient, and normally distributed regression coefficients (parameters).

The logistic regression slope coefficient can be interpreted as the change in the log odds associated with a one-unit change in the independent variable (X_i), i.e., it tells how the log odds in favor of adopting CBDCs change as X_i changes by one unit. The B_o is the log odds in favor of adopting CBDCs when all the explanatory variables assume the value of zero.

In the adoption literature, many social and economic factors are considered in influencing farmer's adoption decision (Feder et.al., 1985). It is, thus, hypothesized in this study that a farmer's decision to use crossbred cows is influenced by farmer and farm characteristics (formal education, age, farming experience, family size, resource endowments, like farm size, livestock holding etc.), social and institutional factors (credit provision and extension services). Farm household head is decision-maker and his farming experience and level of education are expected to influence his ability to assess the potential benefits of new technologies. Farmer's resource endowments might influence his access to new technology by affecting his purchasing power. Institutional support, like credit and extension services might affect farmer's decisions to adopt technologies by influencing his level of awareness towards the existence and potential benefits of new technologies.

In reality, not all the explanatory variables have the same level of impact on the adoption decision of farmers. The relative importance of each significant quantitative explanatory variable in adoption decision can be measured by examining variable elasticity, defined as the percentage change in probability as the percentage change in value of these variables. To compute the elasticity, one need to select a variable of interest, compute the associated P_i, and vary the X_i of interest by some amount and re-compute the P_i and then measure the rate of change as dP_i/dX_i, where: dP_i - percentage change of P_i and dX_i - Percentage change of X_i. The impact of each explanatory variable on the probability of adoption is calculated by keeping the continuous variables at their mean values and the dummy variables at their most frequent values (0 or 1).

4.5.2 Definition of Variables and Their Expected Effects

The dependent variable of the model is adoption or non-adoption of CBDCs. It has a dichotomous nature-representing farmer's adoption decision on crossbred dairy cows; taking value of 1 for adoption and 0 for non-adoption of the technology. A number of working hypotheses influenced formation of the model. Based on adoption literature and background of the farming system in the study area, the following explanatory variables were hypothesized to influence the adoption of CBDCs in the area.

Education of farm household heads (FEDGDL): This refers to the grade level of formal schooling a farm HH completed during the survey period. Formal education enhances farmers' ability to perceive, interpret, and respond to new events in the context of risk. Education is, thus, hypothesized to increase the probability of farmers' adoption of CBDCs.

Total family size (FMLSIZE): This refers to a total number of family members. Family labor is the main sources of farm labor. Since technology under discussion is labor intensive, farmers with large family size are expected to adopt CBDCs. Larger family size is expected to increase the probability of CBDCs adoption. It is, therefore, expected to positively affect adoption decision.

Total area of land cultivated (TACULT): This refers to the total area of farmland that a farm HH cultivated in hectares. It is hypothesized that as cultivated land increases, grazing land will decrease, availability of feed resource would not be ensured and the two sub-sectors are competitive unless they are systematically integrated. Size of cultivated land is, thus, expected to negatively influence farmer's adoption decision of CBDCs in the area.

Total local livestock holding (TLLK): This refers to the total number of livestock measured in TLU. The herd size owned by farm household is taken as a proxy indicator of wealth in this study. Those HHs that own larger number of livestock are relatively rich as compared to those who own less number of livestock. Farmers with larger herd size are assumed to have more cash to invest on CBDCs and thus the variable is expected to positively influence adoption of the technology.

Market distance from farmer's residence (MKDST): This refers to the distance in Km from the farm HH's residence to the nearest local market. Proximity to the markets enables farmers to buy the necessary inputs, sell outputs like milk at fair prices, and minimize marketing cost. Hence, market distance is hypothesized to have a negative relationship with the adoption of CBDCs.

Age: This is the age of the HH heads in years. Older farmers are relatively reluctant to new technology than young and middle aged farmers. This variable is thus, hypothesized to be negatively related with the adoption of CBDCs.

Credit: This is a dummy variable, which indicates whether the farmer has access to credit or not. Introduction of CBDCs with complementary practices require considerable amount of capital for purchase of improved cows and inputs (seed, fertilizer, feeds, veterinary services etc.). However, smallholder farmers cannot finance these inputs for adoption of the dairy technology. On the other hand, the availability of farm credit especially from formal sources becomes a vital component of the modernization of agriculture and to improve the wealth ststus of farmers. Hence, credit is hypothesized to influence adoption of CBDCs positively.

Access to artificial insemination service (ATAISR): It is a dummy variable, which shows farm HHs accessibility to this service. It takes the value of 1 if the farmer has access to the service, 0 otherwise. Crossbred cows are expensive to buy for smallholder farmers. Provision of AI service is considered to be the best way of extending CBDCs and expected to determine the success of the technology. Access to AI service is, thus, hypothesized to be positively related with the farmers' adoption decision of CBDCs.

Access to bull services (ATBUSR): Availability of bull service is the best way of extending CBDCs in the rural area where there is no accessibility of road for AI service provision. The availability of this service determines the success of technology under discussion. Thus, in this study, bull service is hypothesized to influence adoption of CBDCs positively.

Position: This is a farm HH's leadership position in the community-based organizations. It is a dummy variable and assumed that those farmers who have some position in PA and service cooperatives are more likely to be aware of new practices as they are easily exposed to information. It is, therefore, hypothesized that those farmers who participated in some social organizational leadership are more likely expected to adopt CBDCs.

Extension Contact (CONDA): This is also a dummy variable indicating HHs contact with development agent (DA) within a month. It takes the value 1 if a farmer has contact with DA one or more days within a month, 0 otherwise. In most adoption literature, agricultural extension has positive correlation with adoption decision. It is believed to be the main source of information, knowledge, and advice to smallholder farmers in the country. Contact with extension agent, thus, gives the farmer access to information and it is hypothesized to increase the probability of farmers' adoption of CBDCs.

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Off-farm Income (OFFIC): Additional income earned from outside agricultural activities increases the farmers' financial capacity and expected to increase the probability of investing on new technologies. The variable is a dummy variable taking the value of 1 if the farmer earned income out of agricultural activities during the last three years, 0 otherwise. Hence, this variable is expected to affect adoption of CBDCs positively.

CHAPTER FIVE: RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents the survey data and describes the findings that originated from the analysis of the data. This was done in two major sections. The second Section (5.2) contains results of descriptive analysis on household's information on crop and livestock production, institutional support, level of adoption, farmer's perceptions, and non-adopters interest to CBDCs and types of dairy technologies adopted by farmers in the study area. The thred section (5.3) presents the econometric results of the study. The section examines the factors affecting adoption of crossbred dairy technologies and their relative importance in the study area.

5.2 Results of Descriptive Analysis

5.2.1 Demographic Characteristics of Farm Households

Attempts were made to collect information on demographic characteristics of the survey HHs to provide information on some of the key variables for the study area. The variables examined in this section are HHs' sex and age structure, ethnic and religion composition of sample HHs, marital status, and family size of sample HHs.

5.2.1.1 Sample Household Heads by Sex

The household heads sex composition is presented in Table 6. Out of the 120 respondents, 106 (88.3%) were male, while only 14 (11.7%) of them were female. The proportion of female-headed households to the total households is consistent with other findings in Arsi zone (see, Alemneh, 1985). Chi-square test was conducted to see the association of sex and adoption of CBDCs and it was found to be insignificant.

Table 6. Distribution of Sample Household Heads by Sex

Sex	Number interviewed		Total	% of total
	Adopter	Non-adopter		
Male	43	63	106	88.30
Female	5	9	14	11.70
Total	48	72	120	100.00

Source; Compiled from survey data

5.2.1.2 Age Distribution of Sample Household

About 57.5% of the respondents were found in the age category of 18-50 years, while the remaining 42.5 % was above 50 years of age (see Table 7). Most of the farmers (92.5%) were found in the age category of 31-60 years. Only 7.5% were below 31 years old. This finding is also consistent with another finding in the zone (Kedir, 1998), which indicated that the proportion of youth was low because of lack of access to land. As the result, most of the youths in the zone look for wage labor and other activities. The average age of the sample farmers was 49.13 years with a standard deviation of 14.33 and the range varies between 21 and 80. Farm experience ranges from 20 to 60 years. It averaged to 28.16 years with a standard deviation of 13.72 years. Average age for adopters and non-adopters were found to be 48.25 and 49.71, respectively. The t-test was found to be insignificant. This leads to the conclusion that there is no significant difference between the age of adopters and non-adopters of CBDCs.

Table 7. Distribution of Sample of Household Heads by Age

Age	Farmers Category		Total	% of total
	Adopters (Number)	Non-adopters (Number)		
18-30	2	7	9	7.50
31-40	13	18	31	25.83
41-50	14	15	29	4.17
51-60	10	13	23	19.17
> 60	9	19	28	23.33
Total	48	72	120	100.00
Average age	48.25	49.71	49.13	

Source: Compiled from survey data

5.2.1.3. Ethnic Composition and Religion of Sample Households

According to the 1994 census, 85% of the people living in the Oromiya region belong to the Oromo ethnic group. This survey also indicates that 83.3% of the respondents were Oromo.

In terms of religion, about 63.3% of the sample farm house holds were Christians while 36.7% were Muslims (Table 8).

Table 8. Sample Household Heads by Ethnic Group and Religion

Ethnicity	Number of Interviewees	% of total interviewees
Oromo	100	83.30
Amhara	20	16.70
Total	120	100.00
Religion		
Orthodox Christian	73	60.80
Muslim	44	36.70
Protestant	3	2.50
Total	120	100.00

Source: Compiled from survey data

5.2.1.4 Marital Status

An overwhelming majority (89.16%) of the respondents were married, while less than 11% were single (1.66%), divorced (2.5%) or widowed 6.66% (Table 9). Of those married, about 28% were polygamous, while the majority (72%) reported having only one wife.

Table 9. Marital Status of Sample Household Heads

Marital status	Number	% of total interviewed
Married	107	89.16
Single	2	1.67
Divorced	3	2.50
Widowed	8	6.67
Total	120	100.00

Source: Compiled from survey data

5.2.1.5 Family size

In terms of the number of household members, the majority of sample farmers (91.6%) had more than four members. Only 8.4% of them had less than five members, and about one third (33.33%) had more than nine members. The average family size was 8.4 for sample farmers. The family size of HHs ranged between 1 to 24 persons with standard deviation of 3.67 (Table 10). This is much higher than the national average of 5.13 for the country and 5.44 for Oromiya (CSA, 1996). According to the 1966, 1980 and 1994 surveys the average family size in Arsi zone was 5, 6.2 and 6, respectively. These changes may be attributed to an increase in the rural population in Arsi. The average family size for adopters and non-adopters of CBDCs were 9.8, and 7.4 respectively. The t-test was significant at less than 1% that indicates that those farmers with large family size adopt CBDCs than with small family size (Appendix 2).

Table 10. Sample Households by Family Size

Family size	Number interviewed			% of total interviewed
	Adopters	Non-adopters	Total	
1-4	1	9	10	8.40
5-9	24	46	70	58.30
10-15	18	15	33	27.60
> 15	5	2	7	5.70
Total	48	72	120	100.00
Average	9.8	7.4	8.4	-

Source: Compiled from survey data

5.2.2 Education Level of the Sample Households

Educational status of the sample household heads is presented in Table 11. Out of 120 household heads, 62 respondents (52%) can read and write. Of these literate farmers, 62.5% were adopters and 37.5% were non-adopters. About 48.33% of the sample household heads were illiterate and out of this 37.5% were adopters and 55.61 were non-adopters. Illiteracy is high in the case of non-adopters; out of literate farmers only 12.5% of the farmers have no formal education. The household heads that attained seven grade and above of education are 18.34%. The finding from this survey, thus, revealed a 52% literacy rate for the area. An independent sample t-test was conducted for mean difference in the education of adopters and non-adopters. The result showed that the mean difference is significant at 1% probability level. This indicates that the level of education of adopters of CBDCs was higher than that of non-adopters.

Table 11. Sample Household Heads by Level of Education

Level of Literacy	Farmers category				Total	% of total
	Adopter		Non-adopters			
	Number	%	Number	%		
Illiterate	18	37.50	40	55.56	58	48.33
Only read and write	4	8.33	11	15.28	15	12.50
Grade 1-6	16	33.33	9	12.50	25	20.83
Grade 7-8	2	4.17	6	8.33	8	6.67
Grade 9-12	8	16.60	6	8.37	14	11.67
Total	48	100.00	72	100.00	120	100.00

Source: Compiled from survey data

5.2.3 Farm Characteristics

5.2.3.1 Land Holdings and Land Use Patterns

The overall average farm size was 3.2 hectares per sample household, while it was 3.85 hectares for adopters and 2.85 hectares for non-adopters (Table 12). The average farm size in the study area is greater than that of the country 1 hectare (EEA, 1999/2000) as well as the region's average of 1.36 hectares. The average farm size for adopters was significantly higher than that of non-adopters at less than 1% probability level (Table 12). This leads to the conclusion that those farmers with large farm size have adopted CBDCs than those with small farm size.

Table 12. Land Use Patterns of Sample Respondents

Use Type	Farmers group		Over all average	t-value	Sig. level
	Adopters	Non-adopters			
Land under cultivation	2.40	2.00	2.10	2.008	0.038**
Grass land	0.30	0.45	0.64	3.282	0.001***
Areas of land under forage and hay production	0.10	0.03	0.03	0.749	0.455
Area of fallow land	0.80	0.02	0.24	2.301	0.046**
Woodland	0.03	0.02	0.03	1.893	0.061*
Home stead	0.22	0.15	0.18	1.695	0.095*
Average size	3.85	2.85	3.20	3.555	0.001***

Source: Compiled from survey data

***, **, * Significant difference between CBDCs adopters and non-adopters at less than 1%, 5%, and 10% probability level, respectively.

According to the information obtained from sample households, the grazing land was decreasing during the last years as much of the grazing land was brought under cultivation. Land scarcity, especially shortage of grazing land, has a negative influence on livestock production particularly on the adoption of CBDCs. This study has revealed that the overall average size of cultivated land per households was 2.10 hectares during the survey year and the average size of fallow land was 0.24 ha. The corresponding figures for adopters and non-adopters of CBDCs were 2.4 and 2.0 for cultivated land, respectively, and 0.80 and 0.02 hectares for fallow land, respectively.

Table 13 shows that 10% of the sample respondents had less than 1.5 hectares and 35% of the respondents had 1.60 to 2.50 hectares, while 8.33% of sample farmers had an average farm size of greater than 5 hectares. About 73% of adopters owned farm size greater than 2.5 hectares and the proportion of non-adopters who owned farm size greater than 2.5 hectares were about 43%. These figures imply that farmers with larger farm size were adopters of CBDCs than those with smaller farm size.

Table 13. Farm Size by Farmers' Groups

Farm size (ha)	Farmers group: Adopters		Non-adopters		Whole sample	
	Number	%	Number	%	Number	%
1.5	5	10.42	7	9.72	12	10.00
1.6-2.5	8	16.67	34	47.22	42	35.00
2.6-3.5	12	25.00	17	23.61	29	24.17
3.6-5	15	31.25	12	16.67	27	22.50
>5	8	16.66	2	2.78	10	8.33
Total	48	100.00	72	100.00	120	100.00

Source: Compiled from survey data

5.2.3.2 Major Occupation of Sample Respondents

Knowledge of livelihood occupation of respondent can assist in designing appropriate strategies for extending technologies and improving the productivity of certain crops and animals, which are important to farmers in the area. In this survey, the term major occupation was explained to farmers as an activity from which they drive a significant portion of their family income.

Out of 120 respondents, an overwhelming majority (85%) of the households had no occupation other than farming. The remaining 15% of the households had secondary occupation as off-farm activities. The primary activity in the study area was crop farming. Crop production was the dominant source of income as it was practiced by 75.8% of the respondents and livestock was the second source of income. About 16.7% of the respondents considered livestock production as their primary source of income, while 7.5% of them reported that both crop and livestock contribute equally to their income (Table 14).

Table 14. Major Occupation of Heads of Sample Households

Major occupation	Number	%
Crop farming	91	75.83
Livestock rearing	20	16.67
Both	9	7.50
Total	120	100.00

Source: Compiled from survey data

5.2.4 Crop Production

Farm household level data on crops grown and land allocations in the 2000/2001 cropping year are presented in Tables15 and 16. The most commonly grown crops by sample farmers were reported to be wheat (98.3%), barley (88.3%), faba bean (52.5%), linseed (26.7%), field pea (23.3%) and teff 16.7% (Table 15). As indicate in the Table, wheat and barley were the two top crops grown by the sample farmers. This can be explained by the fact that wheat and barley have been both staple and cash crops in the Arsi zone. Faba bean, linseed, and field pea were also grown for cash as well as for home consumption. Very few households grew maize, sorghum, rapeseed, oats lentils, and potato.

Table 15. Type and Importance of Crops Grown by Sample Farmers

Type of crops	Number of farmers	% of total interviewed
Wheat	118	98.30
Barley	106	88.33
Faba beans	63	52.50
Field Pea	28	23.33
Linseed	32	26.70
Teff	20	16.70
Maize	12	10.00
Sorghum	6	5.00
Rape seed	3	2.50
Lentils	3	2.50
Oat	2	1.60
Potato	1	0.80

Source: Compiled from survey data

The sample farmers cultivated a total of 274.44 hectares in the 2000/2001 cropping season. Of this, barley accounted for 37.82% (103.78 hectares), followed by wheat, which accounted for 36.42% (100.02 hectares) (Table16). Linseed accounted for 8.11% of the total cultivated land. The area under the remaining crops taken together accounted for 17.64% of the cultivated land. The mean area under all crops during the same season was 2.29 ha. The mean area under barley was 0.86 ha followed by wheat, which was 0.83 ha. The mean area under linseed and beans was 0.19 ha and 0.18 ha, respectively (Table16).

Table.16. Area under Crops Grown by Sample Farmers in 2000/01 Cropping Season (Mehar & Belg).

Crop	Area(ha)	% of total area	Mean/HH
Barley	103.83	37.82	0.86
Wheat	100.00	36.45	0.83
Linseed	22.25	8.11	0.19
Beans	21.73	7.91	0.18
Pea	10.87	3.96	0.09
Teff	7.75	2.82	0.06
Maize	2.88	1.05	0.02
Sorghum	2.40	0.87	0.02
Oats	1.25	0.46	0.01
Lentils	0.75	0.27	0.01
Rape seed	0.52	0.19	0.01
Potato	1.00	0.09	0.01
Total	274.44	100	2.29

Source: Compiled from survey data.

5.2.5 Livestock Production

As noted in Section 3.2, mixed farming characterizes the farming system of the study area. Both crop and livestock production activities were undertaken either as major or secondary occupation in the study area. The type of livestock kept by adopters and non-adopters are presented in Table 17. Cattle are considered the single most important animals kept by all of the adopters and 94.4% of the non-adopters of CBDCs in the area. This is because cattle are essential for ploughing, threshing and milk and milk products (Table 18). Out of the total sample households, 3.3% had no cattle. As shown in Table 17, 67.5%; 13.33%; 63.33%; 47.5%, and 2.5% of the sample farmers had sheep, goats, horses, donkeys and mules, respectively.

Table 17. Ownership of Livestock by Farmer Groups

Types of livestock	Farmers' group: Adopter		Non-adopters		Whole Sample	
	Number	%	Number	%	Number	%
Cattle	48	100.00	68	94.40	116	96.67
Sheep	37	77.10	44	61.11	81	67.50
Goats	7	14.67	9	12.50	16	13.33
Horse	40	83.33	36	50.00	76	63.33
Donkey	26	54.17	31	43.10	57	47.50
Mules	2	4.17	1	1.40	3	2.50

Source: Compiled from survey data

Table18 presents purposes of keeping of livestock in the study area. The data indicate that cattle are the most important animals kept by sample farmers mainly for ploughing, thrashing, and for milk. Out of the total sample households, 86.7% and 24.2% kept local and crossbred cattle for ploughing and threshing, respectively. About 80% and 32.5% kept cross and local cattle for milk, respectively.

Table 18. Purposes of Livestock Keeping in the Study Area

Types of Animal and Purpose	Number	% of total
Cattle for ploughing & treshing		
Local	104	86.70
Cross	29	24.20
Cattle for milk		
Local	96	80.00
Cross	48	32.50
Cattle for cash		
Local	88	73.30
Cross	25	20.80
Sheep and goat for milk	5	4.20
Sheep and goats for meat	63	52.50
Sheep and goat for cash	52	43.33
Equines for transportation	75	62.50
Equines for threshing	82	68.30
Poultry for cash	75	62.50
Poultry for egg	44	36.70
Poultry for meat	66	55.00

Source: compiled from survey data.

The livestock holding size varied between farmer categories: adopters and non-adopters. The average livestock holding size was 14.9 TLU for adopters and 6.9 TLU for non-adopters and the overall average for the sample farmers was 10.13 TLU (Table 19). The average number of livestock was higher for adopters when compared with non-adopters. The mean difference test between adopters and non-adopters in terms of livestock holding was statistically significant at less than 1% probability level. This leads to the conclusion that adopters of CBDCs were in a better position with respect livestock holding than non-adopters.

Table 19. Average Livestock Holdings (TLU) by Farmer Groups

Livestock type	Farmers' Group		Over all mean
	Adopter	Non-adopters	
Cattle			
Local	7.88	5.270	6.310
Cross	3.98	-	1.900
Sheep	0.77	0.404	0.550
Goats	0.03	0.023	0.025
Horses	1.77	0.922	1.260
Donkey	0.51	0.283	0.370
Mules	0.025	0.027	0.026
Total	14.965	6.900	10.130

Source: compiled from survey data

Table 20 presents proportion of sample farmers by oxen ownership. The data indicate that out of 48 respondents under adopters' category 47 (97.9%) owned one ox or more. The corresponding figures for non-adopters were 60 (83.33%). About 85.4% of the adopters and 69.44 of the non-adopters owned at least a pair of oxen and/or more. From the whole sample, 37.5% of the sample households had more than two oxen and 10.83% have no oxen. T-test for mean difference in oxen ownership between adopters of CBDCs and non-adopters was significant at less than 1% probability level.

Table 20. Oxen Ownership by Farmers' Group

Oxen ownership	Farmers' group				Whole Sample	
	Adopters		Non-adopters			
	Number	%	Number	%	Number	%
No ox	1	2.10	12	16.67	13	10.83
1 ox	6	12.50	10	13.89	16	13.33
2 oxen	17	35.40	29	40.27	46	38.33
>2 oxen	24	50.00	21	29.17	45	37.50
Total	48	100.00	72	100.00	120	100.00

Source: Compiled from Survey data.

5.2.5.1 Feed Types and Feeding System

Pasture, hay, crop residues, and concentrates reported to be sources of feed for livestock in the study area. Pasture and crop residues were the predominant sources for 96.6% and 100% of sample farmers, respectively. About 85.8% of the sample farmers reported the problem of feed shortage. However, only 14.2% and 25% of the sample respondents grew tree Lucerne and fodder, respectively. About 53.33% of the sample respondents reported that they use concentrates for oxen and crossbred dairy cows only. About 53.3% of respondents used free grazing only, 43.3% used rotational grazing, and only 3.3% used zero grazing (Table 21).

Table 21. Feeding Systems and Feed Types of Livestock in the Study Area

Feeding type	Number of respondent	% of total
Free grazing	64	53.30
Rotational grazing	52	43.30
Rotational grazing	4	3.30
Feed type		
Crop residues	120	100.00
Pasture	116	96.67
Concentrates	64	53.33
Fodder and other forage crops	30	25.00
Tree Lucerne	17	14.20

Source: Compiled from survey data

5.2.5.2 Livestock Diseases and Health Services

The most common diseases in the study area were anthrax, blackleg, pastorolosis, foot and mouth, faciollosio, and external and internal parasites. About 52.5% of sample respondents reported that crossbred cattle are more susceptible to diseases. There was no effective animal health service in the study area. About 74% of the sample farmers reported that they did not get animal health service during the 2000/01 cropping season. Even though there was no area, where livestock production was completely abandoned due to animal health problems, animal diseases and ineffective health services were the major constraints on animal production in the area. These constraints may influence the adoption of CBDCs in the area.

5.2.6 Institutional Support

5.2.6.1 Agricultural Extension Services

Agricultural extension service is one of the services provided by the public institution (ZADD) in the area in order to promote agricultural technologies to the farmers. In the area, agricultural offices under different level provided this service. The institution has the structure up to PA level and all sample PAs have one development agent (DA) each. However, DAs are under pressure to work with as many farmers as possible, since the DA to farmers' ratio was found to be 1: 940 and even more than that in some PAs. The survey farmers were asked to identify how many days per month did the DA visit them. About 35.83% of respondents have reported that they were visited once by DAs with in a month. Only 11% reported that they were visited more than one day and 53.33% were not visited at all (Table 22). Chi-square is significant at less than 1% suggesting that the number of extension contacts were higher for adopters of CBDCs than that of non-adopters of the technology.

Table 22. Contact with DAs by Farmer Groups (days per month)

Number of days	Adopters		Non-adopters		Total sample	
	Number	%	Number	%	Number	%
0 days	8	16.67	56	77.78	64	53.33
1 day	31	64.58	12	16.67	43	35.83
>1 days	9	10.75	4	5.55	13	10.83
Total	48	100.00	72	100.00	120	100.00

Source: Compiled from survey data

5.2.6.2 Credit Services

Based on the survey 79% of the sample respondents have received credit to purchase agricultural inputs mainly fertilizer and seeds in the 2000/01 production year. Of the sample farmers who used credit, 33% were adopters of CBDCs. However, no credit was given to the farmers for the purchase of CBDCs during the cropping seasons under consideration due to unavailability of credit for this purpose. Unavailability of credit directed to CBDCs would, therefore, be one of the major bottlenecks for low level of adoption of CBDCs in the area.

5.2.6.3 Market Services

Most of the sample farmers have to walk a long distance from home to the nearest market center to sell their agricultural products. The average distance from home to the nearest market center was found to be 7.78 km for sample HHs. About 25.83% of the sample respondents had to travel more than 10 km to reach the nearest market place and most of these farmers are found to be non-adopters of CBDCs (Table 23). The independent sample t-test result indicates that the mean difference between adopters and non-adopters of CBDCs in terms of distance of market from sample farmer's residence was significant at less than 1% probability level. This leads to the conclusion that adopters of CBDCs had better access to market than non-adopters.

Table 23. Distance from Market by Farmer Groups

Distance (Km)	Farmers' Group				Whole sample	
	Adopters		Non-adopters			
	Number	%	Number	%	Number	%
<1km	2	4.17	1	1.39	3	2.00
1-5km	28	58.37	26	36.11	54	45.00
6-10	13	27.08	19	26.39	32	26.67
11-15	5	10.42	21	29.17	26	21.67
>15	0	-	5	6.94	5	4.16
Total	48	100.00	72	100.00	120	100.00

Source: Compiled from survey data

5.2.7 Farmers' Perceptions of Dairy Technologies

Farmers' perception of specific technology influences their adoption decisions. Adesina and Zinnah (1993) noted that difference in individual farmers' perception of future benefit and cost of a new technology is an important factor explaining their adoption decision. Farmers were asked to give their opinion about the crossbred dairy cows and their performance. About 38% of sample respondents reported that CBDCs are better in milk production than local breed. However, 29% of the sample farmers responded that their feed requirements are higher than local breeds and of all farmers interviewed about 16% had no idea about CBDC (Table 24). Almost all farmers who were aware of the technology felt that bull service and AI were both efficient in minimizing cost, while about 42% of the sample farmers had no idea about it (Table 25).

Table 24. Farmers' Perception of CBDCs

Technology Attributes	Number	%
Higher milk production per cow than local cattle	46	38.33
Higher feed consumption	35	29.17
Labor intensive	8	6.67
Health problem and not adaptable	5	4.16
High traction power and high milk	5	4.17
Heifers have good price	2	2.67
No idea about CBDCs	19	15.83
Total	120	100.00

Source: Compiled from Survey data.

Table 25. Farmers' Perceptions of Dairy Technologies in Minimizing Cost

Type of technology in minimizing cost	Number	%
AI	32	26.67
Bull service	23	19.16
Both AI and Bull service	14	11.67
Distribution of heifers	1	0.83
No idea	50	41.67
Total	120	100.00

Source: Compiled from survey data.

5.2.8 Rate of Adoption of CBDCs in Tiyo and Lemu-Bilbilo Woredas

In all PAs, all the sample respondents were smallholder farmers practicing mixed crop-livestock farming. Table 26 shows the distribution of sample households by woreda and rate of adoption of CBDCs. As indicated in the Table, the rate of adoption for Tiyo and Lemu-Bilbilo woredas was 36.2% and 43.5%, respectively, and 40% for the whole sample.

Table 26. Rate of Adoption of CBDCs by Woreda

Woreda	Number Interviewed		Whole Sample	
	Adopters	Non-adopters	Number	% of total
Tiyo	21	37	58	36.20
Lemu-Bilbilo	27	35	62	43.50
Total	48	72	120	40.00

Source: Compiled from survey data

5.2.9 Non-adopters Interest in CBDCs

Non-adopters of CBDCs were asked whether they are interested to adopt CBDCs or not. About 61 (85% of them) were interested to adopt CBDCs, while the remaining 11 HH heads (15.28%) were not interested to adopt CBDCs. It was also attempted to examine why these farmers were not interested. About 18% of them had no knowledge about CBDCs technology (Table 27). The other major reasons given by respondents were that CBDCs are not adaptable to their area because of cool weather condition and disease. Few farmers (18.18%) also mentioned land as a constraint. As shown on Table 28, farmers who were interested did not adopt the technology because of land shortage (29.5%), high price of the technology (42.62%), low income and lack of credit (14.75%), unavailability of CBDCs (5%) and about (8%) due to lack of access to market.

Table 27. Non-adopters Interest to Adopt CBDCs in Future and Reasons for Lack of Interest

Interested to adopt CBDCs	Number	%
Yes	61	84.72
NO	11	15.28
Total	72	100.00
Reasons for lack of interest	N=11	%
CBDCs are not adaptable (too cool weather)	3	27.27
Land shortage	2	18.18
Susceptible to disease	1	9.10
I can't handle	3	27.27
I don't know about it	2	18.18
Total	11	100.00

Source: Compiled from Survey data.

Table 28. Reasons for Non Adoption of CBDCs Among Interested Farmers

Reason	Number	%
Shortage of land	18	29.51
Too high price of CBDCs	26	42.62
Low income and lack of credit for CBDCs	9	14.75
Lack of access to market	5	8.20
CBDCs are not available	3	4.92
Total	61	100

Source: Compiled from Survey data.

5.2.10 Types of Dairy Technologies Adopted by Farmers

Based on the data obtained from the respondents, adoption level of CBDCs was found to be 40 percent (48 out of 120). Farmers in the study area adopt CBDCs by using one or a combination of three technologies that were available in the study area, namely bull service, AI and purchasing crossbred heifers (Table 29).

Table 29. Adopters of CBDCs by Types of Dairy Technology Used

Type of Technology	Number	% of total
Bull service	18	37.50
AI Service	13	27.10
Purchasing crossbred heifers	7	14.58
Combination of three	10	20.83
Total	48	100.00

Source: Compiled from Survey data.

The sale of crossbred heifers to farmers was constrained by shortage of supply and it was reported by almost all sample respondents that the price of heifers was high. The majority of the sample farmers, thus, adopted CBDCs by using AI and bull services. Only about 15% adopted via the purchase of crossbred heifers. As it was pointed out earlier, this was due to unavailability of crossbred heifers and their high price in the study area.

5.3 Econometric Results

To achieve the objectives of this study, attempts have been made to examine factors affecting adoption of CBDCs and their relative importance using econometric analysis. This section presents the outcome of the analysis. Many variables can influence farmers' decision to adopt CBDCs. The variables used in the analysis have already been defined in Section 4.9. The logit econometric model was used to predict the effects of explanatory variables on farmers' decision regarding the adoption of CBDCs.

The model was estimated using the Maximum Likelihood procedure and Statistical Package for Social Sciences (SPSS) for window version 9.00. Variables with statistically significant coefficients were then identified in order to measure their relative importance in influencing farmers' CBDCs adoption decision. Table 30 presents the description of the variables used in the model.

To check whether the two woredas from which the samples were drawn were homogeneous or not, F-test and chi-square test were used for continuous and dummy variables, respectively. The homogeneity test indicates that the two woredas were homogeneous with respect to most of the variables in the model. Based on statistical test and other social and ecological conditions, the two woredas were, thus, found to be homogenous. We thus carried out the analysis by combining samples taken from the two woredas.

Table 30. Summary of Explanatory Variables Used in the Logit Model

Variable	Unit	Value	% With a value of 1	Mean	S.D.
FEDGRDL	Year	Formal education grade level of household head completed		2.60	3.72
FMLSIZE	No	Total family size of household		8.40	3.67
TACULT	Ha	Total land cultivated		2.12	1.14
TLLK	No	Total local livestock the farmer owned in TLU		10.13	6.33
MKDST	Km	Market distance from the farmer's residence		7.30	5.25
AGE	Year	Age of HH head		49.13	14.33
CREDIT	Binary	1 if a farmer had access to credit during the last 3 years, 0 otherwise	95.00		
ATAISR	"	1 if a farmer had access to AI during the last 3 years, 0 otherwise	11.00		
ATBUSR	"	1 if a farmer had access to bull service during the last 3 years, 0 otherwise	18.33		
POSITION	"	1 if a farmer had some leadership position in the community, 0 otherwise	34.17		
CONDA	"	1 if a farmer was visited by DA at least once within a month, 0 otherwise	59.17		
OFFICM	"	1 if a farmer has off-farm activities during the last 3 years, 0 otherwise	15.00		

Sample size = 120 S.D = Standard Deviation

The degree of association among the explanatory variables was also checked to avoid the problem of multicollinarity. Partial correlation coefficients and VIF for continuous variables (Table 31 and Appendix 4) and contingency coefficients for dummy variables (Table, 32) were computed to see the existence of multicollinarity among the variables. Farming experience and total farm size dropped from the list of explanatory variables due to the collinarity with age, and cultivated land and livestock holding, respectively. There was no problem of multicollinarity between the variables that were used in the estimation of the logit model.

Table 31. Partial Correlation Coefficients between Continuous Explanatory Variables

Variables	FEDGDL	TFMLSI	FRMSIZE	TLLK	MKDST	FRMEXP	AGE	TACLTV
FEDGDL	1	-01890	0.0794	0.1212	-0.1018	0.4095	-0.4670	0.2210
TFMLSIZ	-	1	0.1889	0.1176	0.0029	0.0375	0.0133	0.3562
FRMSIZE	-	-	1	0.5715	0.2701	0.0066	0.0427	0.6851
TLLK	-	-	-	1	-0.3780	0.0244	0.0640	0.4651
MKDST	-	-	-	-	1	0.1023	0.0440	0.0899
FRMEXP	-	-	-	-	-	1	0.7693	0.2044
AGE	-	-	-	-	-	-	1	0.0644
TACLTV	-	-	-	-	-	-	-	1

Source: Computed from survey data

Table 32. Contingency Coefficients for Binary Explanatory Variables

	CONDA	CREDIT	ATAISR	ATBUSR	Position	OFFICM
CONDA	1	0.075	0.229	0.131	0.201	0.073
CREDIT	-	1	0.112	0.172	0.233	0.046
ATAISR	-	-	1	0.305	0.250	0.152
ATBUSR				1	0.220	0.084
Position	-	-		-	1	0.086
OFFICM	-	-		-	-	1

Source: Computed from survey data

To identify the independent variables that have influence on farmers' adoption of CBDCs, a logit model was estimated using enter method of maximum likelihood estimation procedure. Six continuous and six dummy explanatory variables were used in the estimation of the logistic model. All the variables were entered in a single step and the estimation process took four iterations.

Different goodness of-fit measures show how good the estimated logistic model is. The log likelihood ratio test indicates that the explanatory power of the independent variables taken together was highly significant at less than 1% probability level. This indicates that the hypothesis that all the coefficients except the intercept are equal to zero is rejected. The value of Chi-square shows the goodness-of-fit of the model at less than 1% probability level. The likelihood ratio index indicates that the logit model explains approximately 56% of the total variation in the dependent variable.

Another measure of goodness of fit of the model is based on a scheme that classifies the predicted value of events as one if the estimated probability of an event is equal or greater than 0.5 and 0 otherwise. From all sample farmers, 86.67% were correctly predicted into adopters and non-adopters categories by the model. The correctly predicted adopters and correctly predicted non-adopters of the model were 80% and 91.67%, respectively. The estimated model, thus, groups adopters and non-adopters of CBDCs accurately. The results of the maximum likelihood estimates are presented in Table 33.

Table 33. Factors Influencing Adoption of CBDCs in the Study Area

Explanatory Variable	Coefficients	Odds-Ratio	Wald statistic
Constant	-7.2458***	-	8.6586
FEDUGRDL	0.2195**	1.2455	3.9786
POSTION	1.5187*	4.5665	3.3764
TFMLSIZ	0.2001*	1.2215	3.5252
TLLKTLU	0.2246***	1.2519	8.2672
MKDST	-0.3131***	0.7312	9.1756
CREDIT	1.7218*	5.5944	3.3672
CONDA	1.6227**	5.0669	4.2408
ATBUSR	3.1282***	22.8320	9.2965
ATAISR	3.9329**	51.0566	6.0806
OFFICM	0.0558	1.0574	0.0046
AGE	0.0273	1.0276	0.8054
TACULTD	-0.5107*	0.6001	2.7355

Likelihood Ratio index (McFadden R^2)………………………………… 0.56
-2Log likelihood Ratio……………………………………………….. 71.37***
Chi-square (x^2)…………………………………………………….91.15***
Correctly predicted (Count R^2)…………………………………….86.67
Correctly predicted adopters……………………………………… 80.00
Correctly predicted non-adopters…………………………………… 91.67
***, **, and * refer to significance at less than 1%, 5%, and 10% probability levels, respectively

Out of the twelve explanatory variables assumed to affect the adoption of CBDCs among sample farm HHs, ten were found to be statistically significant with expected signs. The results show that formal education (FEDEDL), total local livestock holding (TLLK), extension contact (CONDA), leadership position (POSITION) and access to artificial insemination (ATAISR), access to bull services (ATBUSR), CREDIT and total family size (TFMLSIZ) were positively and significantly related to farmers' adoption decision of CBDCs in the study area. However, distance from farmers' residence to market (MKDST) area cultivated (TACULT) had negative and significant influence on the adoption decision of CBDCs in the area. The effects of the model estimates were interpreted in relation to the significant explanatory variables in the model as follows.

Formal education: Formal education is statistically significant at less than 5% probability level with expected sign. The model result confirms that educated farmers are more likely to adopt CBDCs than those who are not educated. This result is consistent with most adoption studies (see Mulugeta, 2000; Brehanu 2001). This result implies that education enhances farmer's awareness towards the new technologies. Educated farmers have more access to information and they become aware to new technology, and this awareness enhances the adoption of technologies. The odds-ratio of 1.2455 for education implies that other things being kept constant, the odds-ratio in favor of adopting CBDCs increases by a factor of 1.2455 as a farmers' education level increases by one grade.

Position: The result of the model shows that the coefficient of leadership position is significant at less than 10% probability level. Farmers who have some leadership position in local organization are more likely to adopt CBDCs. The possible explanation for this is that those farmers who have leadership position are more likely to be aware of new practices as they are better exposed to information. The result, therefore, supports the hypothesis that leadership position in local organization positively influences the adoption of CBDCs. This finding is consistent with that of Legesse (1992). The odds-ratio in favor of adopting CBDCs, other factors kept constant increases by a factor of 4.5665 for the farmer whom assumed leadership positions than that who did not.

Total family size: The model result reveals that as expected this variable has a positive and significant influence at less than 10% probability levels on the adoption of CBDCs in the study area. The possible explanation is that HHs with many family sizes can get adequate labor required to undertake livestock management. Since dairy technology is labor intensive farmers with large family size thus, had adopted CBDCs than those with low family size.

Total local livestock holding: Local herd size owned by the farmer has positively and significantly influenced farmers' adoption decision of CBDCs. This is explained by the fact that herd size is a proxy for wealth status of farmers. Those farmers with large herd size have better chance to earn more money to invest on CBDCs. This result is consistent with the findings of Chilot et al. (1996) and Brehanu (2001). The odds-ratio in favor of adopting CBDCs, other factors kept constant increases by a factor of 1.252 as livestock increases by one TLU for an average farmer.

Market distance: As expected, the relationship between market distance and adoption of the CBDCs was negative and significant at 1% probability level. The implication is that the longer the distance between farmers' residence and the market, the lower will be the probability of CBDCs adoption. Market accessibility is very important for farmers who have CBDCs as it facilitates easy sale of milk and milk products they produce in relatively large quantities and assists them to procure the necessary inputs at fair price.

Proximity to market also reduces marketing costs. The odds-ratio of 0.73 for market distance implies that other things being kept constant, the odds-ratio in favor of adopting CBDCs decreases by a factor of 0.73 as the market distance increase by one kilometer. This result is consistent with other studies by Simeon and Naga (1997), Brehanu (2001).

Extension contact: The logit model estimates indicate that this variable was positively and significantly related to farmers' adoption decision of CBDCs in the study area. Farmers who have regular contact with extension agents were more likely to adopt CBDCs than those who had no access to extension advice. This is because extension contact gives farmers access to information. This result is consistent with other findings on the impact of extension variable on adoption of agricultural technologies (Chilot et. Al., 1996; Teressa and Heidhues, 1996; Brehanu, 2001). Keeping other factors constant, the odds-ratio in favor of adopting CBDCs increases by 5.067 for the farmer who had access to extension through development agent than that farmer who did not have access to the service.

Access to AI service. As expected, this variable was positively and significantly related to CBDCs adoption decision at less than 1% probability level. This indicates that access to AI service was one of the most important determinants of the adoption of CBDCs in the area. The very strong relationship between AI, adoption of CBDCs is that those farmers who had access to the service were more likely to adopt CBDCs than those who had no access to this service. The odds-ratio of 51.056 indicates that, if other factors are kept constant, the odds-ratio in favor of

CBDCs adoption increases by a factor of 51.057 for farmers who had access to AI service than that farmer who did not have access to the service..

Access to bull service: As expected, this variable was also positively and significantly related to CBDCs adoption at less than 1% probability levels. The odds-ratio of 22.83 for this variable indicates that, if other factors are kept constant, the odds in favor of adopting CBDCs increase by a factor of 22.83 for a farmer who gets access to this service than that farmer who do not have access to the service**.** This result is consistent with the finding of Brehanu (2001), which found that bull service had a significant and positive influence on farmers' decision to adopt CBDCs in Selale zone.

Credit: Credit helps to improve the ability of farmers at critical times of the year to buy inputs and encourage farmers to adopt CBDCs. The model result confirms that credit is statistically significant at 10% probability level with the expected sign. The influence of credit on adoption of CBDCs is very low when compared to most of the variables in the model which have influence on the technology. This is because as discussed in section 5.2.6.2 the credit was not directed to the dairy development. However, the credit used for other agricultural inputs improve their productivity and increase the farm income and wealth status of the farmers and those farmers with better wealth status adopted CBDCs technology than the others. The odds-ratio of 5.594 indicates that, if other factors are kept constant, the odds in favor of adopting CBDCs increase by a factor of 5.594 for a farmer who gets access to credit than those farmers who do not have access to credit. This result indicates that those farmers who had access to credit were more likely to adopt CBDCs than those who had no access to credit.

Total area cultivated: This variable was related negatively and significantly (at 10% probability level) with the adoption of CBDCs. This supports the hypothesis that cultivated land has a negative influence on the adoption of the technology. The possible explanation is that as cultivated land increases, grazing land tends to decrease and availability of feed resources would not be ensured. Since most of the feed sources in the area are from native pasture and grazing is the predominant form of feeding system, the quantity and quality of this feed source gradually declined with extensive crop farming because of increasing shift from grazing to arable land to satisfy the growing food demand of growing population. The pasture land which form the basis of livestock feed in the area has declined as a result, whatever amount of available crop residues are not properly utilized, and mostly used for oxen as replied by majority of the farmers. On the other hand, feed requirements of CBDCs are high as compared to indigenous cows as perceived by many farmers. Since inadequate feeding of CBDCs seriously affects the productivity of CBDCs those farmers who had less pastureland may not adopt the technology. Thus cultivated land has adverse effect on CBDCs adoption in particular and livestock production in general. This result is consistent with the work of Brihanu (2001), which found that cultivated land had negative influence on farmers' adoption decision of CBDCs in Dagam woreda Salale zone. The odds-ratio of 0.600 for this variable indicates that as cultivated land increases by one hectare if other factors are kept constant the odds in favor of adopting CBDCs decreases by a factor of 0.600 for an average farmer.

5.4 Sensitivity Analysis

All the independent explanatory variables appearing in the logit model estimate do not have the same level of impact on the farmers' adoption decision. In order to compare the relative impact of each explanatory variable on the probability of CBDCs' adoption, probability was calculated by keeping the continuous variables at their mean values and the dummy variables at their most frequent values (one or zero). In order to rank the relative influences of the explanatory variables in terms of their relative effect one has to define an "average farmer".

An average farmer is defined by the most frequent values of the qualitative variables in the model. An average farmer is, thus, one who has contact with development agent (59.17%) and has access to credit (95%). In this particular study, the probability of adoption of CBDCs for an average farmer, evaluated at the sample means of continuous explanatory variables and at most frequent values (one or zero) of dummy variables in the model was 0.20. Table 34 shows the effect of changing the values of statistically significant qualitative explanatory variables in the model on the probability of CBDCs adoption.

Table 34. Change in the Probabilities of Adoption of CBDCs due to Changes in Qualitative Explanatory Variables

Variable	Probability	Change in Probability	% Change in probability
-Average farmer	0.20		
-Average farmer but has access to AI	0.92	0.72	360.00
-Average farmer but has access to bull service	0.85	0.65	325.00
-Average farmer but has Leader ship position in the community	0.53	0.33	165.00
-Average farmer but has no access to credit	0.04	-0.16	78.50
-Average farmer but no access to extension contact	0.05	-0.15	76.50

Source: Computed from model output

It is evident from the Table that the probabilities of CBDCs adoption among farmers are influenced by changes in the significant qualitative variables in the model. Accordingly, an average farmer who has no access to credit and extension contact has the lowest probabilities of adoption of 0.04 and 0.05, respectively. That is the probability of adopting CBDCs adoption role decreases by 78.50% and 76.50%, respectively.

Similarly, the probability of adoption of CBDCs by a farmer who assumed leadership position in the local organization increases by 0.33 (a rise of 165.50%). On the other hand, the probabilities of adoption of CBDCs by an average farmer that have access to AI service and bull service increase by 0.72 (360% increment) and 0.65 (325% increment). From these results, one can conclude that the relative importance of each dummy variable in influencing the adoption of CBDCs is different.

The relative importance of the quantitative explanatory variables in the adoption decision of CBDCs can be examined by using elasticity, which is defined as the percentage change in probability of adoption that would result from one percentage change in the value of each explanatory variable (Table 35).

If an average farmer increases his education by one grade level, the probability of adopting CBDCs for an average farmer increases by 0.04 (about 20% increments). An increase in the total local livestock holding by one TLU increases the probability of adopting CBDCs by 0.037 (about 18.5%) for the average farmer. The probabilities of CBDCs adoption increase by 0.05 (25%) if the markets distance from farmers' residence to market decreased by 1km. Increases in the cultivated land by one-hectare decrease the probability of CBDCs adoption by 35.50%. From this sensitivity analysis, it can be concluded that the importance of each continuous explanatory variable on the adoption of CBDCs is not the same.

Table 35. Change in the Probabilities of CBDCs' Adoption due to Changes in Quantitative Explanatory Variables

Variable	Probability	Change in probability	% Change in probability
-Average farmer	0.20		-
-Decrease in market distance by 1 Km	0.25	0.05	25.00
-Increase in cultivated land by 1 hectare	0.13	-0.07	35.50
-Average farmer increase in the education by one grade	0.24	0.04	20.00
-An increase in the total local livestock by one TLU	0.24	0.04	18.50
-Increase in family size by one person	0.23	0.03	16.50

Source- Computed from the model output.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

6.1 Summary

As in many developing countries, agriculture is the mainstay of the Ethiopian economy employing about 85% of the population. However, the growth of the agricultural sector (both crop and livestock) is very low when compared to the high population growth rate.

Ethiopia has the largest livestock population, which puts her first in Africa. However, the contribution of the livestock sub-sector to the Ethiopian economy has not been up to the expected level. Among main livestock production constraints are low genetic potentials of the indigenous stock, lack of efficient extension services, livestock diseases and lack of veterinary services, shortage of grazing land and inadequate capital investment. Improvement in the performance of the sub-sector calls, among other things, for the use of better technologies.

Accordingly, different livestock technologies have been released by research centers to improve livestock production and productivity in Arsi zone and the country at large. More specifically, efforts have been made to produce and disseminate crossbred dairy cows in the zone and in the country over the last three decades. Despite these efforts, there have been very few studies that addressed the adoption of this technology among farm households.

Different theoretical and empirical studies conducted elsewhere on factors influencing adoption of agricultural technologies have underlined that factors, such as characteristics of households, farm characteristics, wealth status, contact with extension workers, access to technology, price, access to credit, and leadership position of farmers in local organizations are important determinants of adoption of new technologies. At the same time, the relevance and significance of each of these variables with respect of their impact on technology adoption vary from place to place. This necessitates location specific research on the issue. This study was, therefore, conducted to examine the influence of different factors on farmers' adoption decision of crossbred dairy cows in two purposively selected woredas, namely Tiyo and Lemu-blbilo woredas in Arsi zone, Oromiya National Regional State.

Arsi zone is one of the twelve zones of Oromiya National Regional State. It has 20 woredas and 525 peasant association with an area of about 23,769.7 Km^2. The zone is characterized by mixed crop-livestock farming system. The zone ranks first in both cattle and sheep population in the region as well as in the country.

A two-stage sampling procedure was employed to draw 5 peasant association and then a total of 120 farm household heads (58 from Tiyo and 62 from Lemu-Bilbilo) using proportion to size random sampling method. The required data were collected through personal interviews of farm household heads based on structured questionnaire using well-trained enumerators speaking the local language and well aware of the study woredas. The household responses were coded into about 300 variables.

The survey data were analyzed using both descriptive analysis and econometric model with the help of SPSS for window (version 9). Descriptive statistics used to understand the socioeconomic situations of the sample respondents. T-test was conducted for a number of continuous variables to check for the mean differences between adopters and non-adopters of crossbred dairy cows.

Chi-square test was also used for different dummy variables to examine the significant differences between adopters and non-adopters of crossbred dairy cows.

The survey result has revealed that 40% of the sample farmers adopted crossbred dairy cows in the study year. The average land holding and livestock ownership of the sample farmers found to be 3.2 hectares and 10.13 TLU, respectively. It was also found that adopters of crossbred dairy cows had significantly more land (3.85 hectares) and livestock (about 15 TLU) than the non-adapters (3.2 hectares) and about (about 9 TLU) respectively.

A logistic regression model was estimated using maximum likelihood estimation procedure to examine explanatory variables that have influence on farmers' adoption decision of crossbred dairy cows. The estimated model correctly predicted adopters and non-adopters in about 86.67% of the observations. Among twelve explanatory variables included in the model, access to artificial insemination, access to bull services, access to credit, extension contact, access to market, formal education, total local livestock holding, family size, cultivated land, and farmer's leadership position in farmers' organization have influence on farmers' adoption decision of crossbred dairy cows.

The probability that the average farmer adopts crossbred dairy cows estimated using the sample means of continuous explanatory variables and the most frequent values (one or zero) of dummy variables and found to be 0.20. The relative influence of each significant explanatory variable on the probability of adoption of the technology was also quantified by sensitivity analysis. Accordingly, accesses to artificial insemination and bull services increase the probability of crossbred dairy cows' adoption by 0.72 (360%) and 0.65 (325%), respectively. Absence of extension contact and credit decreases the probability of adoption of crossbred dairy cows by 0.15 (76.50%) and 0.16 (78.50%), respectively. A decrease in market distance by 1Km increases the probability of adoption by about 0.05 (by 25%) and an increase in total local livestock by one TLU increases the probability of adoption by 0.04 (about 18.50%). On the bases of the above descriptive and econometric results of the study, the following conclusions and policy implications are drawn.

6.2 Conclusions and Policy Implications

The study revealed that extension contact significantly affects the adoption of crossbred dairy cows, although the spread of the technology is not up to the expected level. The extension service should, thus, be further strengthened to change the current livestock production practice in the area and to enhance the existing low adoption rate of crossbred dairy cows. Due attention should be given to the livestock sub-sector particularly to dairy by increasing the number of development agents to reduce the existing ratio of 940 farmers to1 development agent.

The empirical result of this study figures out that access to credit is positively and significantly related to the adoption of crossbred dairy cows. One way of extending crossbred dairy cows among farm households is through distribution of crossbred heifers. As reported by the majority of farm households in the sample, crossbred heifers or cows are expensive in the study area much beyond the financial capacity of many farm households. On the other hand, the existing agricultural credit system focuses on short-term credit given mainly for fertilizer and seed. The provision of medium and long-term credit specially from formal sources directed to the promotion of dairy development would, therefore, is a vital step to foster the adoption of crossbred dairy cows.

Accesses to artificial insemination and bull services have positive and significant influence on the adoption of crossbred dairy cows. From sensitivity analysis, they are found to be the most important factors in influencing the adoption of the technology. Furthermore, these methods minimize the cost of disseminating and adoption of the technology in comparison with the distribution of heifers. The government and other concerned bodies need to strengthen the services and expand area coverage by establishing additional bull service stations and increasing the number of inseminators should, thus, give special attention.

The distance between farmers' residence and the nearest market has a negative influence on the adoption of crossbred dairy cows. This is in line with the findings of the various studies that suggested that access to market is very critical in technology adoption. The establishment and improvement of marketing infrastructure should receive due attention to further enhance adoption of crossbred dairy cows.

Out of 72 non-adopters of the technology, 61 (about 85%) were found to have interest to adopt crossbred dairy cows. However, 26 of them (about 43%) did not adopt the technology mainly due to high price of crossbred dairy cows that were supplied by agricultural bureau as extension component. The price of crossbred heifers must, therefore, be considered in view of the purchasing power of small-scale farmers so that they would get access to the technology. This could be done through reducing the costs of producing crossbred dairy cows or heifers by improving the management system of existing ranches and/or subsidizing poor farmers.

Education has positive and significant influence on farmers' adoption decision of crossbred dairy cows. The diffusion of the technology could, thus, be facilitated through educated farmers to be used as contact farmers, besides improving farmers' level of education.

The size of local livestock owned positively and significantly influence farmers' adoption decision of the technology. As the variable was used as a proxy for farmers' wealth status, farmers with large wealth can earn relatively more cash income that could enable them to purchase crossbred dairy cows. This implies that improvement in the wealth status of farmers would enhance the adoption of crossbred dairy cows and it should receive proper attention.

Cultivated land has unfavorable influence on the adoption of crossbred dairy cows. This finding is in conformity with the response of the large number of farmers who felt that land shortage was the main reason for not adopting or not at least interested to adopt the crossbred dairy cows in the study area. At present situation it was also found that there is high competition for land between livestock and crop production rather than become complementary. The extension system should, therefore, make concerted efforts towards pasture improvement and management, feeding practices and extending improved forage in order to promote the adoption of crossbred dairy cows and ensure systematic integration of the crop-livestock sub-sectors to reverse the direction of the influence.

Farmer's position in local organizations has a positive influence on the adoption of crossbred dairy cows. This tends to reveal that farmers with positions are more likely to have easy access to information. It is necessary to correct such biased flow of information towards positioned farmers and ensure evenly dissemination of information on new agricultural technologies through farmers' local organizations.

It is assumed that the use of crossbred dairy cows increases farm income. However, there is no empirical evidence on the impact of CBDCs on smallholder farmers' income in the study area. Research on the impact of the technology is, thus, essential in order to generate information on the economic returns from CBDCs.

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7. APPENDICES

APPENDEX 1. Conversion Factors Used to Estimate Tropical Livestock Unit (TLU)

Types of Animals (spices)	Indigenous Breed Live weight (Kg)	TLU	Crosse breed Live weight	TLU
Cow	250	1.0	380	1.5
Heifer	125	0.5	150	0.6
Oxen (Young bull)	250	1.0	300	1.2
Calves	50	0.2	50	0.2
Sheep and goat	22	0.1		
Horse and Mule	200	0.8		
Donkey	90	0.4		

Source: Varvikko (1991)

APPENDEX 2. Summary of T-test for Means Differences of Continuous Variables Between Adopters and Non-adopters of CBDCs

Variable	T-value	Sig.	Mean diff.	S.E	Mean		
					Adopt.	Non adopt.	Sample
Age	0.544	0.562	1.46	2.68	48.25	49.71	49.13
Level of education	-3.895	0.000**	-2.55	0.69	4.13	1.57	2.60
Farming Experience	0.462	0.645	1.14	2.47	27.8	28.93	28.48
Family size	-3.642	0.000**	-2.37	0.65	9.81	7.44	8.40
Area cultivated	-1.942	0.055*	-0.597	0.31	2.40	2.00	2.12
Total local livestock	-3.526	0.001**	-4.23	1.201	11.26	7.10	8.72
Market distance	4.232	0.006*	3.554	0.839	5.17	8.73	7.30
Farm size	-3.555	0.001**	-1.02	0.290	3.85	2.85	3.20
Oxen ownership	-3.838	0.000**	0.910	0.333	3.06	2.15	2.52

Source: Computed from survey data

**, and *, refers to Significant at less than 1% and 5% probability level, respectively

Appendex 3. Summary of Chi-square Test of Dummy Variables for Difference Between Adopters and Non-adopters of CBDCs

Variable	Score	Adopters	Non-adopters	Sample	X^2 value	Sign.
Sex	0	9	5	14.00		
	1	43	63	10.60	0.121	0.728
OFFINC	0	38	64	102.00		
	1	10	8	18.00	2.135	0.144
ATBUSR	0	28	70	98.00		
	1	20	2	22.00	29.09	0.000**
ATAISR	0	36	71	107.00		
	1	12	1	13.00	16.62	0.000**
CREDIT	0	8	17	25.00		
	1	40	55	95.00	0.842	0.359
POSITION	0	31	55	86.00		
	1	17	17	34.00	0.056	0.814
CONDA	0	9	40	49.00		
	1	39	32	71.00	16.148	0.000**

Source: Computed from survey data

** Significant at less than 1% probability level

Appendix 4. VIF of the Continuous Explanatory Variables (X_j)

Variable	R^2	VIF
FEDGDL	0.263	1.36
TFMLSIZE	0.238	1.31
FRMSIZE	0.455	1.83
TLLK	0.372	1.59
MKDST	0.072	1.08
FRMEXPR	0.746	3.94
AGE	0.78	4.50
TACULT	0.542	2.18

Source: Computed from survey data

Appendix 5. Summary of Survey Questionnaire

General Instruction

Respondent's name________________________ PA ______________
(Farmer's)
Wereda _________ Name of the enumerators ____________ Date ___________

Section 1:- Respondent's Socio-Economic Characteristics

1.1 Sex 1. Male 2. Female
1.2 Age __________ Years.
1.3 Ethnicity 1. Oromo 2. Amhara 3. Others(Specify) ____________
1.4 Religion 1. Muslim 2. Orthodox Christian 3. Protestants 4. Others (Specify)
1.5 Marital status 1. Married 2. Single 3. Divorced 4. Widowed 5. Others (Specify)
1.6 Can you read and write?
1. Yes 2. No
1.7 If yes, level of education grade__________
1.8 Farming experiences; Number of years since started farming __________ years.
1.9 Do you have any other occupation in addition to farming
1. Yes 2. No
1.10 Did you have some social position (PA, Sc, Idir etc) in the community so far?
1. Yes 2. No
1.11 If yes, what is your position and type of organization were you participated______
1.12 Type of your house
1. Grass roofed 2. Corrugated iron roofed house

2. Labor availability and utilization

2.1 What is the size of your family ___________ Male _________ Female _____
2.2 Number of adults' male (15 to 60 years age) ______________
2.3 Number of adults' Female (15 to 60 years age) _____________
2.4 Number of old person (above 60 years of age) ___________
2.5 Number of children 10 to 15 years age _________
2.6 Number of children below 10 years of age _________
2.7 Number of Family members' permanently working full-time on farm ________
2.8 Number of family members working
i, full-time off-farm _______
ii, part time off-farm __________
2.9 Number of family members' (students) working part time on farm __________
2.10 Do you face labor shortage?
1. Yes 2. No
2.11 If yes do you think it is a Major problem?
1. Yes 2. No
2.12 Time (month) of labor shortage ______________
2.13 For which kind of farming activities do you face labor shortage?
1. Ploughing and seeding (Food crops)
2. Weeding (Food crops)
3. Harvesting (Food crops)

4. Harvesting (Forage)
5. Herding
6. Soil conservation activities
7. Others (Specify) ____________________

2.14 If you face labor shortage how do you solve the problem of labor Shortage?

1. Hiring   2. Labor exchange (wonfel)
3. Others (Specify)

3. Land holing and utilization

3.1 indicate the amount of land you have by source

1. PA given land__________ha
2. Inherited from parent____________ ha
3. Parent given land _______________ha
4. Rented in land__________________ha total cost ________Birr
5. Taken for share cropping __________ha
6. Other(specify)________________ ha

3.2 Indicate the utilization of the land

1. Cultivated for crop _________ ha
2. Fallow________ ha
3. Grass land(can't be plowed)_________ha
4. Cultivated for oat________ha
5. Cultivated for vetch_______ha
6. Under hay production________ha
7. Cultivated for fodder beet________ha
8. Rented out field__________ha
9. Home stead_________ha
10. Woodlots_________ha
11. Other (specity)_____________ha
12. Rent out land ____________ha

3.3 If you rent out land, why?

4. Livestock production and types of dairy technologies promoted to small holders

4.1 Type of livestock kept (local and crossbred)

Type of lives stock	Local(number)	Crossbred(number)
Cattle Cows	___________	________________
Oxen	___________	________________
Heifers	___________	________________
Bulls	___________	________________
Calves	___________	________________
Heifer		
Small ruminant		
Sheep	___________	________________
Goats	___________	________________
Equine		
Hours	_________	______________
Donkeys	_________	______________
Mules	_________	______________
Poultry	_________	______________

4.2 Describe the reason why you keep livestock?

(Mark with **X**)

No	Purpose	Cattle		Sheep and goat	Equines	Poultry
		Local	Crossbred			
1	Milk					
	Meat					
	Eggs					
	Ploughing					
	Transportation					
	Threshing					
	Cash					
	Others					

4.3 Do you know about the improved dairy cows?

1. Yes 2. No

4.4 What is the length of time since you first heard about the improved dairy?
Cows? ____________ Years.

4.5 Do you have crossbred cows? 1 yes 2. No

4.6 If yes how did you obtain crossbred cow first?

1. Purchase from agricultural Bureau _________ birr
2. Purchase from local market _________ birr
3. Used AI
4. Bull service
5. Obtained on credit from agricultural Bureau
6. Purchased in the village/from relatives

4.7 Year you first obtain crossbred cows._______

4.8 If you do not have crossbred cows reasons.

4.9 Have you used bull service during the last 2-3 years?

1. Yes 2. No

4.10 If yes what was the cost Per effective service you incurred in 1992/93
______ birr

4.11 Have you used AI service during the last 2-3 years?

1. Yes 2, No

4.12 If yes what was the Cost per effective service you incurred in 1992/93?
_____________________ Birr.

4.13 In your opinion is the price of crossbred heifers too expensive?

1. Yes 2. No

4.14 In your opinion is the price of AI service too expensive?

1. Yes 2. No

4.15 In your opinion is the price of bull service too expensive?

1. Yes 2. No

4.16 Type of animal diseases found in the area

4.16.1 What are the major diseases of livestock in your area?

____

____

4.16.1 Which breed is more susceptible to disease?
1. Local 2. Cross

4.16.2 At what season does high death of cattle have been observed due to disease in your area?
____
____

4.16.3 How frequently you get vaccination service in your area?
1. Very frequent 2. Yearly 3. Only during outbreak 4. Less frequent 5. Never

4.16.4 Have you ever-got animal health service (excluding vaccination)?
1. Yes 2. No

4.16.5 If yes, who has given health services for livestock in your area?
1. Agricultural Bureau 2. NGO
3. Others (Specify) _______________________________________

4.16.6 what was the total cost you incurred for veterinary service during 1992/93? _______________ birr.

4.17 Housing and watering condition

4.17.1 where do you keep your cattle during the night?
a, Local 1. In the house 2. Traditional barn
3. Improved barn 4. Others
b, Crossbred 1. In the house 2. Traditional barn
3. Improved barn
4. Others

4.17.2 Is their water shortage problem during dry season?
1. Yes 2. No

4.17.3 If yes, how do you solve the problem? ________________
How far the watering place _________________ km

4.18 Animal feeding system

4.18.1What are the major livestock feeding systems you use?
1. Free grazing 2. Zero grazing
3. Rotational grazing

4.18.2 Do you have feed shortage?
1. Yes 2. No

4.18.3 If yes, What are the main causes for the problem
1. Lack of rain 2. Lack of grazing land
3. Increased livestock population
4. Poor pasture quality 5. Others (Specify)

4.18.4 Do you grow tree Lucerne?
1. Yes 2. No

4.18.5 What fodder and forage crop you have grown?
1. Fodder beat 2. Elephant grass 3. Tree legumes 4. Oat
5. Others

4.18.6 Do you feed your livestock concentrate?
1. Yes 2. No

4.18.7If yes which livestock category you often feed concentrates?
1. Local cows 2. Crossbred cows 3. Oxen

4.18.8 Describe concentrate type and amount purchased during 1993

No	Type of concentrate	Amount bought	Unit price	Source
1	Fagulo (Qt)			
2	Furshika (Qt)			
3	Salt (Kg)			

4.18.9 Are concentrates available at required amount and time?

1. Yes 2. No

4.18.10 Do you use hay (from traditional pasture) for live stock feeding?

1. Yes 2. No

4.18.11 What are the main sources of live stock feed during dry season?

1. Crop residue 2. Hay 3. Tree legumes (leaves)
4. Others ___________________

4.18.12 Do you use crop residue (straw) for live stock feeding?

1. Yes 2. No

4.18.13 If yes, where do you get it

1. From own farm 2. By purchasing
3. Others specify

4.18.14 If purchased specify the total cost you incurred to buy crop residue during 1993 E.C ________________ birr.

4.18.15 Specify type of pastureland and its availability found in your area.

1. Communal grazing 2. Individual grazing
3. Others (Specify)

4.18.16 Is there a seasonal feed shortage problem?

1. Yes 2. No

4.18.17 If yes in which season it is a serious problem?

__________________ Months.

5. Yield and income

5.1 List your major source of income by order of importance.

1. Crop production_____
2. Livestock production_______
3. Both equally ________
4. Others (Specify) _______

5.2 Crop grown, production and Utilization During 1992/93(Meher and Belg)

Type of crop	Area planted ha	Total production	Amount consumed at home(qt)	Amount sold (qt)
Wheat				
Barley				
Teff				
Lentils				
Pea				
Beans				
Linseed				
Others(specify)				

5.3 Livestock Production Status During 1992/93 Production Year.

Type of Livestock	No of livestock during the year (No)		Sold during the year				Died during the year		Existing at the end of the year 1992/93	
	local	crossbred	local		crossbred		local	crossbred	local	cross
			no	value	no	value				
Oxen										
Cows										
Bulls										
Heifers										
Calves										
Sheep										
goat										
Horse										
Donkey										
Mules										
Poultry										

5.4 What is the daily output of a dairy cows?

1. Local ___________________ litres/cow/day
2. Crossbred_______________ litres/cow/day

5.5 Did you sell live stock products like milk, cheese, butter, hide and skin, cow-dung, egg, etc. during 1992/93?

1. Yes 2. No

5.6 If you did not sell milk and milk products what were the reasons?

1. Price too low 2. No surplus to be marketed
3. No Market 4. Others (Specify)___

5.7 Do you (Your family) under take some additional income generating activities of off farming during the last 2-3 years?

1. Yes 2. No

5.8 If so amount of income earned during the same year from off-farm activities.

Source of Income	Amount (birr)
- Hand craft	__________
- Casual labor	__________

- Local beverage __________
- Selling fire wood __________
- Others (Specify) __________
- Petty trade

6**. Market service**

6.1 Did you sell your animal and animal products during the last cropping Season?

1. Yes 2. No

6.2 If yes, where do you sell your animal products?

1. At farm gate 2. Taking to local market
3. Others(specify)

6.3 For how far do you have to walk from your home to sell your animal Products? _______________ kms.

6.4 Who is responsible for selling the following animal and animal products?

1. Milk ____________
2. Butter ___________
3. Egg __________
4. Sheep/goat _________
5. Cattle ______________

6.5 At what season you most sell your farm products?

1. Crop _________________ month
2. Livestock ______________ month
3. Milk __________________ month
4. Butter ________________ month
5. Hide and skin __________ month

6.6 Are you satisfied with the prices received for livestock and livestock products?

1. Yes 2. No

6.7 If not, for which livestock and livestock products you were dissatisfied?

____

____

6.8 What are the major livestock product marketing constraints you observe?

6.9 What are the major Livestock and Livestock products marketing constraints you have observed?

____

____

7. Credit Provision

7.1 Did you get credit during the last 3 production years?

1. Yes 2. No

7.2 If yes, who did provide you?

1. Development Bank 2. Commercial Bank
3. Agricultural Bureau 4. NGO
5. Local moneylender 6. Service cooperatives
7. Others (specify)

7.3 For what development activities did you get credit during the year?

1. To purchase fertilizer _____________ birr
2. To purchase crossbred cows_________ birr
3. To purchase seed ____________ birr
4. Others (specify) ________________ birr

7.4 On what basis did you get credit?

1. Individual basis 2. Group basis

7.5 If you got credit for crossbred cows, in what form did you receive?

1. In kind 2. In cash

7.6 If you obtain credit for crossbred cow, how mach was the down payment?
__________ Birr

7.7 What was the duration for loan repayment?_________ Years

7.8 What was the interest rate for the credit you received? _____________ %

7.9 If you have not used credit so far for livestock, what were the main reasons?

1. Due to high interest rate 2. Shortage of down payment
3. Inaccessibility to credit 4. Unavailability
5. Others (specify)

8. Availability of Technology

8.1 Are crossbred cows available in your area if you want to buy?

9. Extension services and Farmer's perception

9.1 Is a development agent assigned to your PA?

1. Yes 2. No

9.2 Have you ever consulted a development agent?

1. Yes 2. No

9.3 Have you received extension advice on dairy technologies and crossbred cattle practices during the last 3 to 5 years?

1. Yes 2. No

9.4 If yes, which of the following have you heard so far?

1. Crossbred 2. Improved feeding
3. Bull services 4. AI service 5. Others (Specify)

9.5 On average how many days during the month has the development agent Visited you during the last crop season? _______________ Days/month.

9.6 Have you found the advice given to you very important in improving your Livestock management

1. Yes 2. No

9.7 Have you ever attended any livestock husbandry training?

1. Yes 2. No

9.8 If yes, mention the type of training ______________________

9.9 Duration of training ______________________________________ days.

9.10 How do you evaluate the training given on crossbred cows production and Management?

1. Excellent 2. Very good 3. Good 4. Fair
5. Poor 6. Others (Specify)

9.11 Which kinds of technologies have you been adopted

1. Crossbred cows 2. AI 3.. Bull service

9.12 Which kinds of technologies you found is better in minimizing costs?

1. AI 2. Bull services 3. Crossbred heifer distribution

9.13 How did you decide to use crossbred dairy cow, If you have local cows.

1. Observed the benefits that other farmers obtained from using it.
2. Persuaded by other farmers
3. Persuaded by change agents
4. Others (specify) ____________________

9.14 If you have crossbred cows what are the problems that you have faced in Using crossbred dairy cows?

1. Land shortage 2. Labour shortage
3. Feed shortage 4. Lack of government assistance
5. Health problem 6. Market problem
7. Lack of credit regarding crossbred dairy cows
8. Management cost is too high 9. Others (specify) ____________

9.15 If not used, have you heard/observed when other farmers use crossbred technologies?

1. Yes 2. No

9.16 Do you have interest in using dairy technologies.

1. Yes 2. No

9.17 If yes, Why have you not used so far?

____

9.18 If you are not interested in using the technologies what are your reasons?

____

9.19 What is your opinion about the performance of crossbred cows in your area?

____

9.20 If you used, what advantage do crossbred cows have over local breed cows ?

1. To reduce over stocking
2. Increase milk yield
3. Others (specify) ____________________

9.21 Have you used others agricultural inputs (Fertilizer, Seed herbicides etc.)

1. Yes 2. No

9.22 How do you see the availability of crossbred cows?

1. Adequate 2. Inadequate

9.23 Is agricultural inputs provided at required amount and time?

1. Yes 2. No

9.24 What are the inputs not provided at the required time and amount? Specify

____

10. Institutional support and awareness of dairy technology.

10.1 Do you know the existence of dairy technology in your area?

1. Yes 2. No

10.2 If yes, would you please mention some of them?

1. Crossbred heifers 2. AI service 3. Bull service
4. Improved forage 5. Others (specify) ___________

10.3 Is there any government, private, NGO etc. working on dairy development activities in your area?

1. Yes 2. No

10.4 If yes, which organizations are working on dairy development?

____

10.5 Have you been supported by any of these organizations to improve dairy Development activities?

1. Yes 2. No

10.6 If yes specify the support you have got so far

____

10.7 Do you use fertilizer for crop production?

1. Yes 2. No

10.8 Did the use of fertilizer bring change on livestock feed availability through the year ?

1. Yes 2. No

10.9 If yes, how ________________

10.10 Do you have a radio?

1. Yes 2. No

10.11 Do you listen to agricultural programs on radio?

1. Yes 2. No

- Pleas mention all problems associated with livestock production in your area.
- Describe any social economic and environmental problems you have in the PA
- What change have you observed in your farm after adopting crossbred dairy technologies?
- What intervention must be used for better implementation of dairy technologies in the future?
- Any idea with regard to the negative impact of crossbred dairy cows
- What are the constraints for the adoption of dairy technologies in general and crossbred cows in particular.

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