ADDIS ABABA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

SMALLHOLDER DAIRY PRODUCTION TECHNOLOGY TRANSFER AND ADOPTION CONSTRAINTS IN MIXED FARMING SYSTEM IN GIRAR JARSO WOREDA OF NORTH SHOA ZONE OROMIA REGIONAL STATE

BY

TOLERA DEBELLA BOBOSHA

JUNE 2007
DEBRE ZEIT, ETHIOPIA

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A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master in Tropical Animal Production and Health

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DEDICATION

I dedicate this thesis manuscript to my LORD for giving me health, strength and support for completion of my study, really unpaid: and to my beloved wife Sara Daribe and my two daughters Meti and Lensa Tolera by wishing a successful future to them in the coming millennium.

BIOGRAPHY

The author was born in Nedjo Woreda, West Wollega Zone of Oromia National Regional State, in October 1971.

He attended his elementary and junior secondary education at Nedjo Hunde Bekumsa Junior secondary school. Then, he joined Nedjo secondary high school and completed his secondary education in year 1992/93.

In year 1993 he successfully passed the Ethiopian school leaving certificate examination and, the author joined Alemaya University of Agriculture (AUA) and graduated with Bachelor of Science degree in Animal Sciences in July 1996.

Soon after graduation, the author employed in North Shoa Zone agricultural development department and served as an expert, department head, project co-coordinator, and head of Woreda agriculture and rural development office until he joined under the sponsorship of Girar-Jarso Woreda agriculture and rural development office for Master of science degree in Tropical Animal Production and Health Department (TAPH) majoring dairy stream, Faculty of Veterinary Medicine (FVM), Addis Ababa University (AAU) in September 2005.

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LIST OF ABBREVIATIONS

AAU	Addis Ababa University
AI	Artificial Insemination
AADDP	Addis Ababa Dairy Development Project
ARDU	Arsi Rural Development Unit
AUA	Alemaya University of Agriculture
bST	bovine Somatotropine hormone
CACC	Central Agricultural Census Commission
CADU	Chilalo Agricultural Development Unit
CBPP	Contagious Bovine Pleuro-Pneumonia
CCPP	Contagious Caprine Pleuro-Pneumonia
DMI	Dry Matter Intake
DRDP	Dairy Rehabilitation and Development Project
EARO	Ethiopian Agricultural Research Organization
ESAP	Ethiopian Journal of Animal Production
ET	Embryo Transfer
FAO	Food Agricultural Organization
FC	Factor Change
FLDP	Fourth Livestock Development Project
FMD	Foot and Mouth Diseases
FVM	Faculty of Veterinary Medicine
HRC	Holleta Research Center
ILCA	International Livestock Center for Africa
ILRI	International livestock Research Institute
LDCs	Less Developed Countries
LSD	Lumpy Skin Diseases
MB	Mineral Blocks
MoARD	Ministry of Agriculture and Rural Development
MT	Metric Tones
NGOs	Non Governmental Organizations
NLDP	National Livestock Development Project
PA	Participatory Appraisal
PD	Pregnancy Diagnosis

SDDP	Small Holder Dairy Development
SHD	Small Holder Dairy
SPDDPP	Selale Peasant Dairy Development Pilot Project
SPSS	Statistical Package for Social Sciences
TAPH	Tropical Animal Production and Health
TLU	Tropical Livestock Unit
WADU	Walita Agricultural Development Unit

ABSTRACT

This study was carried out from September 2006 to April 2007 in four Kebeles' of Girar-Jarso Woreda, North Shoa zone of Oromia Regional State, Ethiopia to assess productive performance of dairy cows and technology use in 200 randomly selected market-oriented smallholder dairy farms. A structured questionnaire survey, farm visit, and PA discussion were conducted during the study. The overall mean family size of respondents in this study was 5.77±2.35 persons. The average number of economically active family members (greater than 15 years old) was 2.44 persons (1.20 ± 1.25 male and 1.24 ± 1.33 female). The average number of livestock owned by the respondent farmers was 16.65 ± 7.11animals or 9.47 TLU. Dairy cows constituted the highest proportion of the herd followed by draft oxen. Crossbred dairy cows represented the highest proportion of the cattle herd composition with the mean value of 1.83 (22.7%). There was statistically significant difference between crossbred and indigenous cattle in all production and reproduction performance parameters assessed ($p<0.05$). The respondent farmers pointed-out that scarcity of feeds, mainly during dry season, is the major limiting factor which affected the development of livestock sub-sector in general and the rearing of crossbred dairy cows in particular. Land allotted for livestock grazing was only 0.71 hectares. From a total of 21 dairy technologies identified in the study area crossbreeding and mastitis inspection had highest adoption rates, 91.5% and 95% respectively. The average numbers of dairy technology up take was 9.89 ±2.16 with a range from 5-16. Sex, age, level of education and farming experience were found important characteristics that influence demand for dairy technologies in the study area. The results showed that the female groups were less users of dairy technology averaged 9.26 ±1.90 compared to the male group (average 9.95±2.20); thus gender differences seem to have a significance influence on likelihood of technology uptake. Education was another important factor that favored the likelihood of technology uptakes. This suggests the important role of education in stimulating demand for technology use. Farm experiences also determine the use of dairy technology in the study area. Accordingly the t-values of the variables were computed and out of these variable the age, farm experience, and level of education were found to differ significantly ($p > 0.05$) probability level. As expected, sex is positively and is statistically significant ($p < 0.05$) for all technologies identified and adopted in the area. According to the survey result characteristics of the household head (84%) and source of information (68.5%) were the most frequent factors that influence the decisions of the household to choice new technologies.

1. INTRODUCTION

Globally, livestock production in developed countries accounts for about 43% of the gross value of agricultural production. In developing countries, this share is not more than one-third of agricultural production. This latter share, however, is rising quickly following rapid increase in livestock production as a result of population growth, change in life styles and dietary habits (Samuel, 2005). The world human population is increasing from time to time and there is a trend of increasing urbanization and elevated income that consequently lead to an increase in demand for food, especially proteins of animal origin.

In Ethiopia although there is huge livestock population, productivity levels are very low and could not meet the increasing demand for foods of animal origin like meat, milk and milk products. For instance, from 4,735,000 milking cows, a total of only 1,341,000 metric tones of raw milk are produced annually, with an average consumption rate of 19kg milk per annum (Tsehay, 1998).

To meet the increasing demand for milk and milk products, improvement of the productivity of dairy cattle through appropriate technologies such as breeding programmes, intensification of the dairy production systems and development of market infrastructures are crucial steps (Zumbach and peters, 2000). The dairy technologies available in developed countries cannot be readily adopted by smallholder farmers in developing countries due to their socio-economic and agro ecological conditions being greatly different from those in industrialized countries. Some dairy technologies may be appropriate for adoption by smallholder dairy farmers but most of these dairy technologies or dairy practices have never been transferred to smallholder farmers due to a lack of effective extension services (Chantalakhana, 1999).

Most improvements in the milk productivity of African cattle have been sought through cross breeding with high producing dairy breeds (Zumbach and Peters, 2000). High-grade cows, however, need elaborate management and maximal nutrient in take for optimal performance (Enyew *et al*., 2000). This calls for the use of more intensive technologies.

Smallholders are believed to have a comparative advantage in rearing dairy cows because of the high labor requirements of the activity and the great care that dairy cows need to reach their genetic potential (Baltenweck and Staal, 2000). Farmers with grade cows are usually market oriented since the higher production levels enable them to sell the surplus milk. The introduction of crossbred cows in small-scale dairy farm in Ethiopian highlands is said to have doubled farm incomes (De leeuw *et al*., 1999).

Thus, adoption of dairy technologies can have a positive impact on the welfare of smallholder farmers and promote agricultural development (Kaitho, *et al*, 2001). It is apparent that as population pressure increases, farmers must use more intensive technologies in order to increase livestock production and productivity. Some studies of smallholder farming system and resource levels (Nicholson *et al*., 1999) revealed that for the majority of households, agricultural change will be as sequential intensification through the adoption of individual technological components rather than through the adoption of a multi component package.

The dairy sector in Ethiopia is expected to continue to grow over the next one to two decades given the large potential for dairy development in the country. Smallholder dairying is currently the dominant dairy production system. To increase animal out put and productivity, agricultural polices advocate intensification of production, which requires external inputs and services.

In Ethiopia labour intensive, limited capital resources and subsistence system with moderate or low yields, high production risks and limited use and access to improved technology characterise agricultural production. Therefore, in this highly populated country agricultural growth can only be made possible through yield augmenting technological changes as well as by providing appropriate technologies and assistance to the farming communities. Arnon (1981) and Berhanu (2001) noted that subsistence farmers have not yet been able to benefit fully or partly from the fruits of technological innovations because of different factors hindering the adoption of farm technologies. The impacts of new technology on farmers yield and income have not adequately surveyed and quantified in Ethiopia. Generally, the information available is insufficient and the constraints that influence adoption of dairy technologies are not well understood. This is especially true for the study area where studies have not been done on the smallholder dairy technology transfer and adoption constraints.

In fact, the basic problems involved are complex and closely interrelated with health, breeding, feeding and management of livestock on the one hand and with socio-economic conditions and the general standard of living of smallholder population on the other hand. In general, the major livestock production constraints are under nutrition and, mal-nutrition, poor genetic potential, diseases, un-satisfactory managements and absence of appropriate market structure.

Past studies have shown that the introduction of crossbreeding dairy technology can be a possible means of reducing the aforementioned problems and alleviating the low milk production of indigenous animals provided that socio-economic constraints are identified and properly dealt with (Ramish, 1995 and Berhanu, 2001). The implication is that it remains crucial to look for ways of improving the productivity of traditional herd. These are being the problems associated with constraints of adoption of dairy technology are not yet identified and documented. Therefore, this study tries to inquire adoption constraints of dairy technologies by smallholder farmers in the study areas and to quantify the extent of dairy technology transferred at district level. Therefore, this study was initiated to fill this gap.

Objectives of the study

The objectives of this study were:

- To identify available technologies currently in use in the smallholder dairy farming systems
- To assess the extent of use of the available technologies
- To identify the major constraints for technology transfer and adoption
- To assess the relationship between the utilization of the available technologies and productive performance of dairy cows

2. LITERATURE REVIEW

2.1. Dairying in Ethiopia

As an integral part of the farming system, livestock activity contributes to the sustainability of agricultural systems by (1) utilizing crop residues and other feeds which can not be used by humans and converting them to milk and meat; (2) providing manure and traction; and (3) acting as a reserve to be converted in to cash in times of need. They are central to smallholder crop livestock production systems in Ethiopia. They convert low quality plant biomass in to high quality human food. More importantly, dairy is a biologically efficient industry that converts large quantities of inedible roughage in to milk, the most nearly perfect and nutritious food known to all mankind. It is a more efficient system in terms of nutrients and protein production for human consumption. The efficiency of dairy cattle in converting crude protein and energy is 25% and 17% respectively which stands next to hens that mean, 25% and 18% respectively (Hailmariam, 1995; Berhanu, 2001). The authors also reported that the conversion efficiency is about 6 times greater than beef cattle and sheep.

The Ethiopian government has been adopting a breeding program using Friesian sires (*Bos taurus*) and indigenous zebu (*Bos indicus*) cows and distributing crossbred heifers to farmers along with extension assistance. The aim of this program was to improve the over all smallholder farm productivity by increasing milk production and reducing herd size. In Ethiopia, several dairy and livestock development programs have been implemented. CADU/ARDU (1967-1985), WADU (1974 -1980), FLDP (1987-1992), funded by the World Bank, DRDP (1986 - 1992), financed by the African Development Fund, SPDDPP (1987-1994), funded by Finnish International Development Agency and SDDP (1995-2001) were parts of livestock development strategies. NLDP is currently operational in the country. Dairying provides a regular income to smallholder farmers in different parts of Ethiopia. Different authors confirmed that smallholders' crossbred dairy production system is a powerful means of raising farm incomes and welfare.

2.2. Milk production systems in Ethiopia

Four major dairy production systems have been recorded in Ethiopia. These include the lowland pastoral dairy system, rural highland smallholder dairy production system, urban and peri-urban small-scale dairy production system and large-scale dairy production system (Ketema and Tsehay, 1995; Kelay, 2002)

2.1.1. Lowland pastoral dairy production system

Even though information on both absolute numbers and distribution vary, it is estimated that about 30% of the livestock population are found in pastoral areas. The pastoralist livestock production system supports an estimated10% of human population and covers 50-60% of the total area mostly lying at altitude ranging from below 1500m.a.s.l. Pastoralism is the major system of milk production in the lowland. However, because of rain pattern and relative seasonal shortage of feed, milk production is low and highly season dependant (Ketema and Tsehay, 1995; Kelay, 2002).

2.1.2. Rural highland smallholder dairy production system

The Ethiopian highlands possess a high potential for dairy development. In the highland areas, agricultural production is predominantly subsistence smallholder mixed farming, with crop and livestock husbandry typically practiced within the same management unit. There are two types of livestock production systems, traditional system that is based on indigenous breeds and market oriented system that is based on crossbred dairy cattle. The milk produced by the traditional system is, mainly, for household consumption while most of the milk produced by market-oriented system is sold to generate income (Kelay, 2002). Market-oriented smallholder dairy farmers adopted small-scale milk processing technologies such as cream separators, churners, etc (SDDP, 1998).

2.1.3. Urban and peri-urban small-scale dairy production system

These systems are developed in and around major cities and towns, which are located mainly in the highlands of Ethiopia where there is a high demand for milk. The systems comprise small and medium size dairy farms based on crossbred and exotic dairy cattle. In these systems, farmers are using AI extensively but also bull as alternatives in times of AI failure (Ketema and Tsehay, 1995; Kelay, 2002). Cows under these systems have the potential to produce 1120-2500 liters over 279 days of lactation. These production systems are now expanding in the highlands among mixed-crop livestock farmers and serve as the major milk supplier to the urban market (Alemu, *et al*., 2000; Holloway, *et al*., 2000).

2.1.4. Urban and peri-urban large-scale dairy production system

Urban and peri-urban large-scale dairy production system is a specialized dairy farming practiced by the state and very few individuals. Most of the large-scale dairy farms are concentrated in and around Addis Ababa and keep high grade or exotic pure breed stock and the predominant mating method is AI. The urban and peri-urban dairy farms use AI as predominant mating method and produce only 2% of the total milk production of the country (Ketema and Tsehay, 1995; Kelay, 2002).

2.3. Milk and milk products consumption patterns

Milk and milk products form parts of the diets of many Ethiopians. They consume milk either as fresh milk or in fermented or soured form. Getachew and Gashaw (2001) estimated that 68% of the total milk produced is used for human consumption in the form of fresh milk, butter, cheese and yogurt, while the rest is given to calves and wasted in the process. The consumption of milk and milk products varies geographically between the highlands and the lowlands. In the lowlands, all segments of the population consume dairy products while in the highlands major consumers primarily include children and some vulnerable groups of women. The demand for milk depends on many factors including consumer preference, consumer's income, and population size, price of the product and other factors. Today, dairying offers good opportunities for improving the standard of living of smallholders through the sale of milk as well as higher consumption of milk (Baltenweck and Staal, 2000). Table 1 shows the estimates of milk production and consumption rates in Ethiopia.

Table 1.Estimated milk production and consumption levels in Ethiopia

Year	Cattle population	Milking cow	Milk production (MT)	Milk per capita (kg)
1975	27,926,944	3,490,868	774,923	25
1980	29,643,261	3,705,408	822,600	22
1985	31,465,058	3,933,132	873,155	20
1990	33,398,818	4,174,852	926,817	18
1995	35,451,422	4,431,428	983,777	17
2000	37,259,798	4,373,810	970,986	15
2001	37,632,395	4,894,986	1,086,687	16
2002	40,838,800	5,623,331	1,248,375	18

Source: SDDP (1998) and FAO (2003)

2.4. Problems and constraints of smallholder dairy

The dairy technologies available in developed countries cannot be readily adopted by smallholder farmers due to their socio-economic and agro-ecological conditions being greatly different from those in industrialized countries. Some dairy technologies developed in advanced countries may be appropriate for adoption by smallholder dairy farmers but most of these dairy technologies or dairy practices have never been transferred to smallholder farmers due to a lack of effective extension services (Chantalakhana, 1999).

Many factors influence a smallholder dairy farmer regarding scale of operation and the type of technologies to be employed or adopted. According to Chantalakhan (1999), the influencing factors are classified in to four categories as technical components, institutional support, government policies and farmers' socio-economic factors. Lack of any of these supportive factors could be a major constraint to any dairy development program.

2.4.1 Dairy technology gap in Ethiopia

The level of intensification of improved dairy production systems could be defined with respect to ownership, types of gene used, market orientation, housing and feeding, use of AI or natural bull, herd size, land use, processing facilities etc. (Azage *et al.,* 2000). Ahmed *et al*

(2006) indicated that advances in biological technologies in livestock have been introduced primarily to improve the yield of animal product per unit of feed or breeding stock. Analogous to the case of crop production, these advances typically involve one or more of the following elements:

- Improved feeding to provide satisfactory environment for animal growth and feed supplements to stimulate higher productivity.
- Disease control
- Better environments for animal growth, particularly shelter (housing)
- Selection of efficient breeds and
- Dairy market problem

2.4.2. Feed constraints

Lack of adequate feed resources as the main constraint to animal production is more pronounced in the mixed crop-livestock dominated highlands as well as in the mid altitude areas of the country, where most of the cultivated areas are located. These areas have a high human population density that has led to intensive crop-production causing continuous conversion of grazing lands for crop production. Mixed farming system was developed because of the beneficial effect resulting from interrelationship and complementarities between crop and livestock production, hence, the role of livestock is significant in this farming system. In the mixed crop livestock production system, livestock production ensures food security and income to the farming community since crop harvest is seasonal. However, lack of grazing land has induced most smallholder farmers to resort to using crop residues as the major feed resources (Daniel, 1988), since the allocation of more land for crop production resulted in availability of crop residues as stock feed, particularly in smallholder livestock production system (Alemayehu, 1998). The quality and quantity of feed supply for livestock in highlands and mid altitude areas is subjected to great seasonal variation. Generally, the availability of feed resources to support the performance of a given class of animal is affected by seasonal fluctuation of rainfall, altitude and soil type. An excessive supply of feed during the rainy season is usually followed by deficit in grazing in the following dry season (Alemayehu, 1998). Improved nutrition through the adoption of sown forage and better crop residue management can substantially raise livestock productivity. National and international research agencies, including ILRI, have developed several feed production and utilization technologies and strategies to address the problems of inadequate and poor quality feeds. So far, the adoptions on these technologies in Ethiopian highlands have been limited (Ahmed *et al*., 2006).

2.4.3. Genetic performance

Ethiopia is endowed with large livestock population, unlike other African countries; the large cattle population of Ethiopia encompasses relatively limited numbers of exotic dairy cattle and/or their crosses. Less than 1% of the 34.5 million cattle population of Ethiopia is exotic or crossbred dairy cows (Muriuki and Thrope, 2002). The genetic performance and the feed shortage problems are the bottlenecks of the smallholder dairy development in the country. The lack of suitable breeding stock poses major constraints. Local breeds need to be crossed with exotic high yielding breeds to increase production. However, according to (EARO, 2001 and Kelay, 2002) activities to improve genetic performance for dairy production in Ethiopia were constrained by a number of factors. The same authors further explained that, climatic stress in the form of erratic and inadequate rainfall, low fodder yield, high price for concentrate and susceptibility to a wide variety of serious diseases damagingly affect the productivity of genetically improved dairy cattle specially the upgraded ones. Poor education and management expertise of farmers have also been hindrances in the implementation and maintenance of genetic improvement programs. Irrespective of its immense potentials and contributions to the economy, due to different factors, livestock resources in general, and dairy in particular in Ethiopia are yet untapped and underutilized.

2.4.4. Dairy market problem

Even though there is a good start in participation to dairy market, the ability of poor smallholder farmers to reach markets and actively engage in them poses a development challenges. Difficult market access restricts opportunities for income generation. Remoteness results in reduced farmer gate prices and results in subsistence rather than market oriented production system. The question of how to expand the market participation of smallholder livestock producers is the major challenge in developing countries. Market access poses a key bottleneck to the expansion of smallholder milk production and processing. Generally, marketing of livestock and livestock products in Ethiopia are constrained by inadequate infrastructures, seasonal supply fluctuations, absence of market information and institutional issues (SDDP, 1998).

2.4.5. Animal health problem

One of the major constraints impeding the development of livestock industry in this country is animal disease. The prevalence of epidemic diseases and infectious diseases adversely affect the productivity of the animals. The great proportion of the lowland area is infested with trypanosomiasis, and its vector tsetse fly. Because of this infestation a vast area of fertile land could not be utilized. Disease commonly found in dairy cattle includes bacterial infections such as anthrax, blackleg, brucellosis, dermatitis, hemorrhagic septicemia, infectious foot rot, mastitis, metritis, pneumonia and tuberculosis. Common viral infections are bovine viral diarrhea, foot and mouth disease etc. Protozoal infections commonly found are, blood parasites as anaplasmosis, babesiosis, theilriosis, and trypanosomiasis (Falvey and Chantalakhana, 1999).

Many of the animal health problems in the country result from the interaction among the technical constraints themselves. For example, poorly fed animals develop low disease resistance. To overcome health problems and boost up the production and productivity of dairy cattle an integrated farm management should be encouraged and selection for genetic resistance to diseases should be sought (SDDP, 1998). Good health care, herd management and disease control programs impact on dairy cow productivity. Examination and diagnosis should be considered for the entire herd not only individual animals (Falvey and Chantalakhana, 1999)

2.4.6. Environmental problems

On a global scale, the serious environmental issues facing human development have led many researchers to seek alternative ways of describing the World and understanding complex relationships. Environmental issues associated with the pastoral and highlands smallholder dairy production systems are overgrazing and land degradation that are the result of continuous utilization of croplands and communal grazing lands with out rehabilitation and conservation works. Hygienic and sanitary hazards and pollution of soil, water and air due to a large volume of waste and close human-animal interaction are environmental risks associated with the urban, peri-urban and the intensive commercial dairy production systems (FAO, 1999; Kelay, 2002).

2.5. Technologies utilizable in dairy farming

2.5.1. Technologies in animal feeding

Relevant information required for the development of feed system, primarily on the quantity and quality of available feed resources is limited in Ethiopia. Natural pasture is utilized for grazing or hay or as green feed by cut and carry system of feeding. However, grazing is the predominant form of ruminant feeding system in most parts of Ethiopia where smallholder crop-live stock farming is practiced (Daniel, 1988).

In addition, teff (*Eragrostis abyssinica*) and wheat straws are also important source of livestock feed in the highland vertisol areas. Barley and Oat straws are also important in areas where they are produced. Straw supplementation is commonly restricted to working oxen and lactating cows during the dry season. The amount of straw fed depends on the work expected from the ox. During the peak period, on average 5 to 10kg of straw per day is fed to an ox (Getachew *et al.,* 1993; Kelay, 2002).

Crop residue can be grazed in the form of stubble or offered to animals after collecting the materials from the field. Animals are fed on crop residue mainly in two ways. The residues are piled in stacks near homesteads and animals are let to feed from the stacks or for working oxen, before and after work. Alternatively, the residues are left on the threshing ground and consumed by animals together with the standing straws, which are left for aftermath grazing. In some parts of Ethiopian central highlands, there is a strong tendency towards improving the utilization of crop residues by supplementing with molasses and/or urea (Daniel, 1988).
Agro-industrial byproducts are fed as supplement to roughage based diets, particularly in dairying or peri-urban fattening activities. Two or more by-products can be mixed and fed as concentrate or one by-product alone can also be used (Yoseph, 1999).

The urea-molasses mineral block that contain 40-45% molasses, 8-10% urea, 8-10% cement, 30% wheat bran, 5% salt and 0.2% trace-minerals has been developed in India and Philippines (Ranjhan, 1993). It is given as an excellent source of Nitrogen and mineral to the animals fed on straw. The block is easy to transport to any place. Depending on the local resources different formulas can be used and under Ethiopian condition the recommended ingredients and proportion are indicated in Table 2. Uses of mineral block over normal diets provide for milk yield & live weight gain in dairy cows under village conditions where balanced rations are scarce. Similarly various concentrations of urea in mineral block positively affect milk yield of indigenous dairy cows. Milk yield & total dry matter intake (DMI) were increased when the animal consumes 700g of the mineral blocks (MB) daily (EARO/HARC, 2004).

Table 2. Recommended ingredients and proportions in making Mineral Blocks for dairy cows under Ethiopian condition

Ingredient	Proportion (in %)	Uses (Purpose)
Molasses	31	Easily digestible energy and to some extent mineral
Urea	10	Nitrogen (ammonia) source: degradable at rumen
Wheat bran	25	Mainly energy source and in addition serve as source of protein
Noug cake	13	Protein source
Cement	15	Binding material
Salt	3	Mineral source

Source: EARO/ HARC (2004)

Grazing lands are decreasing in size in Ethiopia particularly in the high lands due to population pressure and encroachment of cropping to communal grasslands. On the other hand, livestock still derive over 90% of their diet from natural pastures that commonly occur on permanent grasslands, roadsides, pathways and spaces between cropped plants etc. This suggests the need for proper management and improvement of this feed resource for better livestock production (EARO/HARC, 2004).

Grazing land should be managed in such a way that, they would produce high amount of forage or pasture for livestock in a sustained way of the natural resource. Hence, application of manure at the rate of 10-15t/ha, legume establishment by over sowing, applying chemical fertilizers and optimum stocking rate should be allowed on the pasture grazing land (EARO/HARC, 2004).

A wide range of annual and perennial forage species were tested in areas ranging in altitude from 600-3000 meter above sea level (m.a.s.l) and some productive and better quality forage crops were selected for the different agro-ecological zones. The selected forage crops are generally high yielding and at better quality compared to natural pasture. Recommended forage crop species for different agro ecological zones in Ethiopia are listed below (EARO, 2001).

For high altitude areas the forage species recommended are: Oats, Phalaris, elephant grass, clover, alfalfa, Tree Lucerne, fodder beet, etc.

For mid-altitude areas: Rhodes grass, Elephant grass, lablab, Desmodium, Alfalfa, Sesbania, Leucanea, Acacia species, etc.

For low altitude areas: Sudan grass, Lablab, stylo, Alfalfa, Sesbania etc.

2.5.2. Technologies in animal breeding

A variety of modern reproductive technologies are now available to livestock breeders and these have revolutionized livestock production in industrialized countries. While some of these technologies are also applicable in tropical smallholder dairy systems with little modification, other requires comprehensive evaluation and adaptation under specific local conditions before they can be used effectively (Perera, 1999)

Crossbreeding

In the short term crossbreeding of indigenous cattle with those of temperate breeds offers a quick opportunity for increasing milk production. The manifestation of heterosis in the first generation crosses leads to good adaptability, improved fertility, reduced mortality, efficient growth and feed conversion (Preston, 1977). However, this advantage does not persist with later generation crosses, making this technology difficult to sustain. Further more, it requires high capital outlay.

Cross-bred with exotic inheritance of 50-62.5% is appropriate for smallholder dairy production in Ethiopia (Tesfaye, *et al*., 2004). Table 3.compares potential milk yields of local and cross breeds dairy cows. Selection for higher milk yields in indigenous cattle breeds through culling of inferior cows and selection of young bulls on dam's yield and body conformation is the origin of animal breeding (Falvey and Chantalakhana, 1999). In most herds, culling of cow was practiced after three or four lactations.

Table 3. Milk yields potential of local and up graded dairy breeds

Breed	Milk kg/cow/lactation	Duration of lactation
Indigenous breed		
Boran	494	150 – 200
Horro	675	150 – 200
Arsi	872	150 – 200
Fogera	1174	150 – 200
Dairy cross breed		
Fogera x Friesian	2472	305
Boran x Friesian	2056	368
Horro x Friesian	1565	319
Boran x Jersey	1600	338
Horro x Simmental	1437	290
Boran x Simmental	1695	333

Source: EARO, 2004

Artificial insemination

Artificial insemination is globally accepted method of breeding cattle and is a fast and easy means of the exploiting the genetic potential of proven male animals. Of all technologies that have been in use, AI is the one that has so far made the greatest impact on animal genetic improvement. In recognition of the low milk productivity of local cows, cross breeding, using artificial insemination allows to combine the superior performance of specialized dairy breeds with the superior adaptability of local stock (Perera, 1999; Falvey and Chantalakhana, 1999).

Pregnancy diagnosis

Pregnancy diagnosis is an important element in any breeding program. According to Frederico and Hansen (2003), there are several methods of pregnancy diagnosis in cattle. Some of them are rectal palpation, milk progesterone test, blood progesterone test, pregnancy specific proteins and ultra sound scanning. Rectal palpation is the most practical and commonly used method. The technique allows palpation of pregnancy through the rectal and uterine walls for fetal membranes, cotyledons and fetus. Rectal palpation is probably the most commonly used method for pregnancy diagnosis (Roberts, 1986; Fredrico and Hansen, 2003). Rectal palpation provides the advantages of being accurate, fast, relatively cheap method; that is less labor intensive as compared to the other methods. Nonetheless, training is necessary and the examination should be conducted by a veterinarian or by an experienced herd man. The main disadvantage of rectal palpation is that it cannot be performed until later ingestion than some other methods. Some experienced veterinarians are able to determine pregnancy by palpation as early as 35 days after insemination (Roberts, 1986; Fredrico and Hansen, 2003).

Synchronization of estrus

Synchronization of estrus is the act of making a number of cows came in to heat at the same time. This allows better planning of breeding activities and wider use of A.I. This technology has been used in smallholder systems in many countries with variable results. In order to ensure success it is important that animals selected for treatment are healthy, in good condition and cycling and are not stressed or handled roughly during treatment and A.I (Perera, 1999).

Embryo transfer

Embryo Transfer (ET) involves the use of superior females as donors of embryo. The embryos collected are then implanted in the recipients. Although embryo transfer is being used commercially in some industrialized countries, its main potential advantage for tropical countries may be in the possibility of importing frozen embryos instead of live animals. This might be justified where nucleus-breeding stocks need to be established on state or other institutional farms (Perera, 1999). The advent of embryo technologies, have now made it possible for animal breeders to increase dissemination of genes of selected females as well as males.

2.5.3. Technologies in animal health care

Vaccination is a practice of artificially building up in the animal's body immunity against specific infectious diseases (Sastry and Thomas, 1981). Vaccination is used to develop an immune zone all around an area of actual infection. This prevents the spread of disease.

In hot and humid areas it is almost essential to deworm livestock regularly (Sastry and Thomas, 1981). Most animals have a certain amount of internal parasites. Severe worm infestation, however, causes a severe drop in milk production and growth. Adult animal develop some resistance to worms but calves suffer badly from worm infestation. In places where heavy endo-parasite infections are found it is advisable to deworm dairy cows twice a year.

External or ectoparasites are major problem in Ethiopia (SDDP, 1998). Ticks, flies, fleas and lice infect dairy cattle with dangerous and often fatal diseases. Regular spraying or dipping is the only reliable methods in external parasite control. Dipping is not practical in most areas, so spraying for ectoparasites is more appropriate technology, because it can be done regularly and at a low cost (Sastry and Thomas, 1981).

2.5.4. Technologies in housing

Housing can be a main determinant of productivity (Falvey and Chantalakhana, 1999). Good housing and layout of the farm can reduce stress. There are two main types of dairy housing; loose housing and tie barns. Loose housing is recommended for most areas of Ethiopia. Loose sheds are usually provided with an open paddock so that the cows can lie indoor or outdoor depending on the conditions. In tie barns cows are, usually tied by neck chains in rows. Feed trough is provided along the length of the barn (Sastry and Thomas, 1981).

Traditional livestock husbandry practices across the Ethiopian highlands are more or less similar to each other. Livestock are kept in a "corral" during the night. During the daytime, they are herded on communal pasture, private grazing lands or in stubble depending on the season (Getachew *et al,* 1993). Improved types of housing constructed from locally available and cheap materials are used mainly by urban and peri-urban smallholder dairy farmers owning crossbred cattle (Kelay, 2002)

2.5.5. Technologies in animal husbandry

Animal identification

Identification of dairy cattle requires preliminary planning. Their name or a number depending on the preference of the smallholder may identify animals. The obvious use of identification and records is when somebody assists in milking and the identification of an individual cow can be used to provide specific instructions about any special care need during milking. Information should record when it occurs. A good herd recording system will include identification of each calf as soon as possible after birth (Risstrom, 1999). In addition to the identification of name or number, the calf's birth date, its size, name and its sire and dam's name should record on a simple identification record.

Identification system may be either temporary or permanent. Ear tags, neck chins, and ankle tags are usually temporary as an animal allowed to exercise or graze in a field can easily lose them. Permanent marks are those, which cannot be lost and include hot brand freeze brands, and tattoos and photographs. All identification systems have drawbacks such as the difficult application of brands and tattoos (Risstrom, 1999). For this reason a combination of systems may be used.

Where animals are maintained in a stall, a stall nameplate may be the most appropriate record. This may be made of durable paper or a blackened board on which the cow's name or number, date bred, date of calving, milk and fat production, feed type, recent health interventions and other information are recorded (Risstrom, 1999). The same author reported that identification information is useful to dairy farmers when: a sire is to be selected and one wishes to avoid in-breeding, heifers are evaluated for breeding and superior bull must be chosen, evaluating overall herd reproduction and determining the age of heifers at first heat, knowing the age at which a heifer should be targeted for breeding, determining whether an animal is an appropriate size for its age, comparing genetic lines across an area (with other dairy farms) to determine which animal to cull, and determining which animals to be culled on the basis of age.

Record keeping

An important aid for farm management is the keeping of records of all animals and events relating to animals through out their lives. In some countries, record keeping is provided, supported and designed by the government or dairy cooperatives. Records should be kept as individual cow cards or at the dairy health services or AI service center (Aiumlamai, 1999). Records are an indispensable component of modern dairy farming, but are usually non-existent on most smallholder farms (Perera, 1999). The animals may be identified only by name and are often confused, even by the farmer. Awareness among farmers about the purpose and value of recording has been minimal. Recording is usually linked with government control on the activities of the farm. The keeping of dairy records can be divided in to the main activities of: identification of cattle, breeding records, milk production records, feeding, and health records (Risstrom, 1999).

The main purpose of the records is for dairy herd management, breeding and progeny testing. Records of insemination, birth date, sire, dam, calving date, vaccination date, health problems, treatment, milk yield and feeding can help farmers to predict future or preventive needs for health care. They also provide beneficial and relevant information for veterinarians to make correct diagnoses. Therefore, it is best to have well organized records kept for each animal, with the farms designed to allow for easy interpretation. Smallholder farmers do not seem to pay sufficient attention to keeping good records (Aiumlamai, 1999).

As part of animal husbandry record keeping is an important means to monitor progress and identify problems in the dairying operation. According to Sastry and Thomas (1981) it is important that accurate records are kept on a dairy farm. Records must be simple and easy to understand in order to be effective. Accurate records are necessary for the following reasons:

- To monitor yields and performance on the dairy farm

- To identify management problems
- To plan a breeding program
- To monitor disease problems and for decision making

Hoof trimming

It is the most common in dairy cows kept in-door. Hoof trimming is removing of the deformed growth of hoof from dairy cows (Falvey and Chantalakhana, 1999). When cows are kept confined in the barn for considerably long period and when they pasture on soft soil, there is a tendency of the hoofs growing to fast resulting in the development of long toes. This may be corrected by chiseling off the fore part of the too and rasping off the excessive growth under neat (Mahanta, 1987).

Restraining facilities

There are different restraining facilities to handle aggressive animals such as nose ring, neck chain, anti-kicker, ropes etc. Fore better handling practices some of the usual habits of the cow should be known (Mahanta, 1987). The same author reported some cows acquire a habit of kicking during milking. This is must frequently developed as a result of wrong treatment when the heifer is first milked. The cow first kicks because of fear, but if she is maltreated at this stage it becomes a habit. When kicking during milking develops in to a habit nothing could be done to remove it and the only remedy is to tie the hind legs in order to protect the milkier. There are anti-kickers device for this purpose. This consists of two hooks like pieces of iron connected with a chain. A hook is placed above each hock with the chain passing in front of legs ((Mahanta, 1987).

2.5.6. Technologies in milk processing

Cooling facilities

Milk producers in the Tropics apply their ingenuity to cope with climatic and logistical adversities. The market is not always within easy reach for delivering fresh raw milk and local processors, if any exist, are constrained to take milk in excess of processing ability as they may be weighed-down by problems like cooling facilities. Producers, therefore, have adopted, over the generations, a variety of methods to minimize the loss in value of fat and SNF (solids-not-fat) in liquid milk. The products developed, either for direct consumption or as a base material may have some local variations, in terms of additives, but follow certain fundamental rule of preservation and conservation though, heat desiccation, fermentation, coagulation and clarification (Bachman, 1987). Majority of milk produced by the smallholder producers converted in to different dairy products to enhance shelf life (Shapiro *et al.,* 1992). Farmers in the central highland area preserve the fresh milk in cool place to enhance shelf life. Cooling of the milk at 4^0C, which is a contractual requirement, will reduce bacterial multiplication during storage of the farm. Some bacteria can grow slowly at low temperatures, but good hygiene will reduce their number in milk so that the bacterial count is not adversely affected during storage on the farm (Shapiro *et al*., 1992). Cooling facilities are not available under small-scale producers. Thus, small scale processing becomes appropriate in situations where transportation is a constraint, primary production is dispersed, quantity of marketed surplus is limited or immediate neighborhood demand is low. Since such plants process the milk in the production area it self, they have lower transportation/handling costs than big collectors and provide better returns to the producers by value addition. According to (Shapiro *et al.*, 1992), milk must reach a cooling facility or processing plan within two to five hours of milking, or chemical changes occur that make it unsuitable for processing.

Small-scale processing unit

Utensils and equipment commonly used in small-scale dairy processing unit are manual cream separator, butter churner, lactometer, thermometer, milk acidity tester, alcohol tester, manual stirrer, weighting scale, dip measure, milk can of different capacity, milk pail, milk strainer, porringer, butter spade, etc. are the major equipments used in small-scale processing units.

Thus, small-scale processing unit becomes appropriate in situations where transportation is a constraint. Such processing units process the milk in the production areas itself. Seventeen rural based milk marketing and processing units that are presently owned by farmers and operating profitably, have been established by SDDP project (SDDP, 1998). Each of these small farmer based enterprises is operated strictly on business farms.

The introduced technology chosen by the project was of appropriate level for acceptance, skill development and for farmers to handle with ease and confidence. No electric system and cooling facilities are required in this model. A milk collection and processing unit requires a functional building to shelter the utensils, equipment and capable to hold 500 liters of milk every day (SDDP, 1998).

An improved butter making technique (method), internal agitator fitted to the traditional clay pot, was introduced by International livestock Center for Africa (ILCA). According to the result obtained by ILCA traditional way of churning was found to be time consuming and inefficient in butter fat recovery; around two and half hours and butter fat recovery was in order of 60%. With the improved churn only 35 minutes for churning and 75% of butter fat recovery. The free rotation of the internal agitator by reducing the friction between the braces and the internal agitator reduces the workload of the person processing the milk (Zelalem and Yohannes, 2000).

2.5.7. Other appropriate technologies for smallholder dairying

Supplementing dairy cows with bovine somatotropine hormone (bST) safely enhances milk production and serves as an important tool to help dairy producers improve the efficiency of other operations. It is in use in many other countries. The use of supplemental bST by dairy farmers both large and small generally increases milk production by 10 to 15% (Bauman, 1987).

2.6. Importance of technologies for improved milk production

2.6.1. Effects on milk production

Intensification of smallholder dairy production that involves technologies like the adoption of cattle breeds with increased genetic potential for milk production and other complementary inputs increase milk production. Inputs may encompass production of improved forages, purchased feeds, disease control measures, improved management practices and improved record keepings. Milk production has risen rapidly due to the wide spread adoption of intensive dairy production with cross breed or high-grade cows (De Leeuw, 1996). Thus a change in management and adoption of technologies can contribute a lot towards an efficient and profitable milk production system. This has however, to be linked to milk handing, hygiene, processing, distribution and storage so that the primary producer benefits from the increased demand and product diversification (De Boer. 1981).

2.6.2. Effects on milk composition

Milk composition is an important parameter used to judge the quality of milk. Milk composition varies considerably among breeds of dairy cattle and among cows within a breed. The widest variation occurs with the fat, followed by protein. Lactose and the ash are the list varying milk components. Genetic, environment and various physiological factors greatly influence the amount and composition of milk that is actually produced. Thus selective breeding and other technologies that lead towards improved management, feeding and health care can be used to upgrade milk compositional quality.

2.6.3. Effects on lactation length

Lactation length refers to the period of time between calving and drying off. Breed, level of nutrition, parity, suckling, and other management factors affect lactation length. Indigenous zebu breeds were found to have shorter lactation length compared to crossbred dairy cows. Dairy cows on good feeding regime will have longer days in milk compared to those kept under poor feeding regime. Therefore attempts to increase milk yield through cross breeding, selection, better feeding and improved management will also extend lactation length.

2.7. Constraints of technology uptake

The implementation of new agricultural technologies has become a driving force for management change on smallholder farms. Identifying technologies and management practices could enhance the sustainability of agricultural production, as well as constraints to their adoption, is therefore an important element in attaining sustainable smallholder farming systems. Economic viability is a fundamental condition for the wide spread adoption of technologies and management practices that will help to achieve the goal of sustainable agriculture in general, and dairy in particular. Studies on the factors that influence adoption of agricultural technologies often focus on household resource endowments, characteristics of the household head, location of the household, the nature and extent of information provided before adoption, and characteristics of the technology (Feder *et al*., 1985).

Regarding household resource endowments it was found that initial costs of technologies determine adoption decisions especially in resource poor farmers. If farmers are resource poor and access to capital is limited, profitable technologies might not be adopted if they require a high capital outlay (Nicholson *et al.,* 1999).

Characteristics of the household head involve variables such as age, level of education, off-farm job and others. Regarding age, as per one study conducted in smallholder dairy farmers in Kenya, the probability of adoption decreases with increasing age of the household head. Older farmers were, therefore, likely to be more reluctant to adopt new technologies or practices.

Location of the household involves distance to road and markets so that a household could be able to sell his outputs, at least at current levels of production (Nicholson *et al.,* 1999).
The nature, extent and source of information provided was also found to be a factor that influences adoption decision. The Kenyan experience shows that information used by smallholder farmers to make adoption decision was sought primarily from government/project source and neighborhoods already owing the technology (Nicholson *et al*., 1999).

Characteristics of the technology refer to risk characteristics, complexity and the relative profitability of the technology. The risky production environment can explain the high influence of relative risk on adoption. As an example, the risk of loosing an animal due to diseases has been identified as constraining the adoption of smallholder dairy production in Kenya. The profitability of a technology compared to the traditional way of doing things, is also an overriding factor in farmer's decision making. Technologies on the other hand differ in their relative management complexity. Complexity is high when a farmer has to carry out many activities to establish and run a technology. Technologies with higher relative complexity diffuse more slowly than others and will finally reach a lower ceiling of adoption (Nicholson *et al*., 1999).

In recent years, smallholder dairy technologies consisting of crossbred cows, improved feed and improved management practices have been introduced in some parts of the highlands of

Ethiopia (Ahmed *et al,* 2006). The studies conducted by (Bulale, 2000) in Arsi zone showed that forage cultivation, bucket feeding and pasture fencing were the least adopted technologies with adoption rate of 40%. The level of adoption of Artificial Insemination was 46%. The highest adoption rates of 60% were for cowshed and concentrate feeding. Yield could be increased though intensive application of new technologies. Among the most widely emphasized technological factors that help in raising productivity substantially is the use of inputs and methods. Nonetheless cows, sustainable increase in productivity cannot be attained unless these are accompanied by complementary institutional arrangements like access to credit, extension services and marketing.

Failings of top-down technology transfer in the 1960s and early 1970s saw the wide spread application of technology transfer mode of development in less developed countries (LDCs). In the agricultural sectors technology transfer involved the use of more intensive farming systems, which had been developed in temperate regions of the Western countries and required the use of externally supplied seeds, fertilizers, pesticides, machinery and other inputs. However, the limitations of this form of technology transfer soon began to emerge (Simmonds, 1985).

First, it was evident that the benefits derived from the new technologies were restricted to farms in areas with favorable agro-climatic conditions i.e. areas for which the technologies had been originally designed, and technology uptake by farmers in more marginalized areas was low. According to Chamber and Ghildyal (1985), only resource-rich farmers with commercially orientated, often benefited from new technology, which were introduced to the farming systems.

2.8. Potential contribution of intensified dairy production

Technological progress in dairy production reduces unit production cost, resulting in a downward shift in the unit cost function and a shift to the right of the supply curve, i.e. the lower cost of production increases supply. The cost of developing crossbred cows technology in the study area was borne by the Ethiopian Government via the Ministry of Agriculture, FINNIDA and Smallholder Dairy Development Project (SDDP).

Improvements in livestock production in developing countries can contribute to food security in numerous ways. First, increased milk production and a steady flow of cash income from the daily sale of surplus milk and dairy products contribute to all dimensions of food security, including accessibility and stability. Besides increasing the availability and accessibility to more and better quality foods through increased milk production and higher incomes, a steady flow of cash income from the daily sale of milk may contribute to the stability of consumption in smallholder intensified dairying households. Second, livestock production and processing enterprises are labor intensive, thus increased production implies higher employment. This can secure incomes and food entitlements for the rural poor. Third, cost saving technological change increases production and keeps livestock product prices down, enabling more people from lower income groups to have access to food of animal origin. Fourth, increased domestic production may reduce imports and save foreign exchange, which may then be used to invest in productive activities that can indirectly contribute to food security.

Intensified dairying is the most regular generator of income for small-scale farmers. Dairy development has been shown to substantially raise milk production and household incomes in developing countries where development efforts are market-oriented and demand-driven (Walshe *et al*. 1991; Shapiro *et al.* 1998). The same authors reported that incomes of farmers who use intensified technologies for the production of meat and milk have been shown to increase by 50–100% Evidence from the Ethiopian highlands shows per capita food availability to be 67.5% higher in households with crossbred cows than in those with traditional cattle (Shapiro 1994). Returns from market-oriented small ruminant activities in the Sahel have been found to be 24% higher than in traditional practices and capital returns to be more than 50% (Shapiro 1994).

The structural changes taking place in SSA are expected to bring about more technological changes in livestock production in the next decade. Besides population growth, urbanization and rising incomes, recent currency devaluation and price liberalizations are additional factors pushing for intensification. Better integrated crop–livestock systems will need to be replaced by a more intensive and specialized crop and livestock system to obtain rapid growth rates and to respond to increasing demand for animal food products.

3. MATERIALS AND METHODS

The study was conducted in Girar Jarso "Woreda", considered to be a high potential crop-live stock zone and where dairy activities play a significant role in the livelihood of the farming community. Active and passive data were collected using questionnaire survey, farm inspection, animal examination and participatory appraisal methods (PA). Secondary data and background information on activities such as technology packages, extension services and animal health care related information were collected from the "woreda" Agriculture and Rural Development Office, Zone and Regional and other related sectors.

3.1. Description of the study areas

Girar Jarso "woreda" is one of the 16 "woredas" of North Shoa Zone of the Oromia National Regional State, located at a distance of about 110 km North West of Addis Ababa. The "woreda" has a total land area of about 42400ha, and is divided in to three agro ecological zones namely high lands (52%), mid-altitude (41%), and lowland (7%). The "woreda" has an altitude of 1300-2700 meter above sea level. The estimated total human population and density per square kilometer are, respectively, about 106,168 and 250 people per square kilometer. The high land areas of the "woreda" have a bimodal pattern of rainfall with a long rainy season from June to September and a short rainy season from March to April. The average annual rainfall ranges from 651 to 1115mm. The "woreda" has also average minimum and maximum temperature of $11.5^{o}{}_{C}$ and $35^{o}{}_{C}$ respectively (CACC, 2003). Mixed crop-live-stock production system is found to be a feature of the agricultural activity in the "woreda". There are about 65,632 heads of cattle, 30,206 Sheep, 15,034 goats, 2,230 horses, 21209 donkey, 407 mules, 37528 poultry and 2,926 beehives (CACC, 2003). An estimated livestock population in this area was 318 per square kilometer, which is greater than the mean average livestock population of the zone.

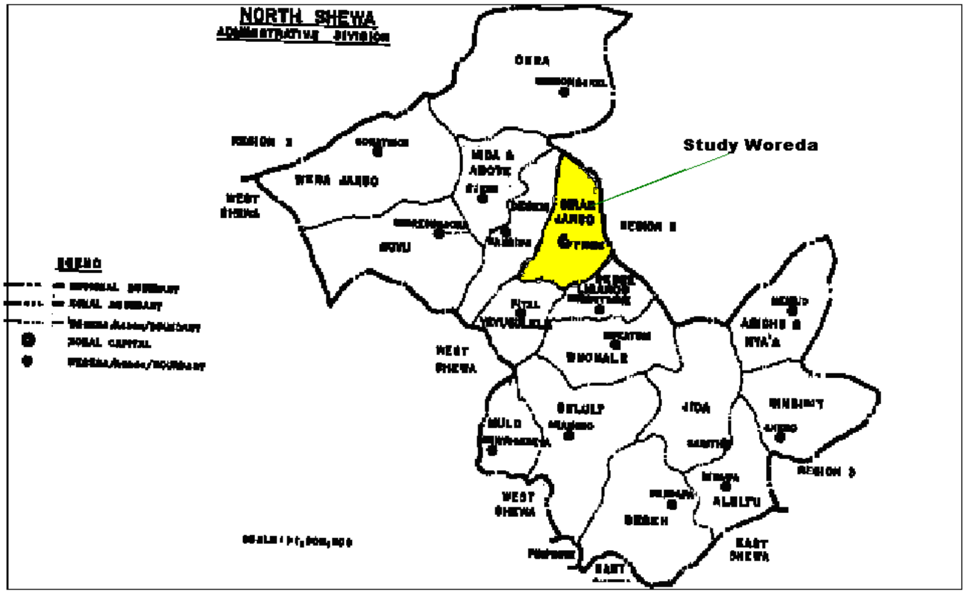


Figure 1. Map of the North Shoa administrative zone of Oromia National Regional State showing the study site

Source: Agriculture and Rural Development Office of North Shoa Zone of Oromia Regional State. Fitche, Ethiopia, 2006.

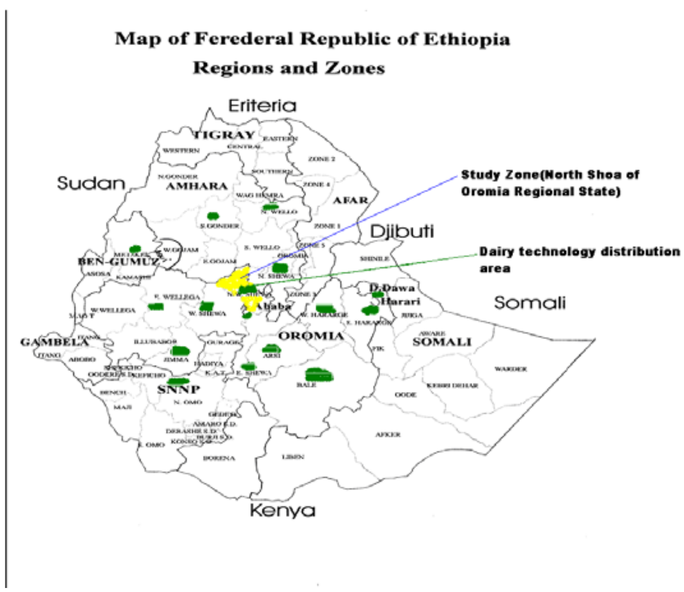


Figure 2. Distribution of Crossbred Dairy Technologies in Ethiopia.

Source: Ahmed *et al* (2006)

3.2. Study procedures

3.2.1. Stratification of the study area

Girar-Jarso woreda has 17 kebeles. In the past two decades, different livestock development intervention projects such as SPDDPP (FINIDA) (1991-1994), SDDP (1995-2001) and NLDP were implemented in the "woreda". The high land part of the Girar Jarso "woreda" with an altitude of 1500- 2500 meters above sea level is considered to be the high potential cereal crop-livestock production area. This high land part represent 6 "Kebeles" that are known to be dairy belt areas. Thus, the study population was selected from the dairy belt areas.

Livestock owners were interviewed in-groups. Each group was composed of individuals encompassing women, men, community leaders and other known and respected persons from the community. The production system dealt with was market oriented smallholder production system.

3.2.2. Sampling methods and strategies

The sampling unit of interest for PA interviews was the above-described groups of smallholders and for the structured questionnaire interviews, individuals who were selected randomly.

3.3. Sample size determination and sampling method

The sample size was determined at 99% confidence level and 10% confidence interval by using the following formula (Thrusfield, 1995).

$n = pq/ (SE) 2$

Where:

n = sample size

p = proportion of population possessing the major attribute (expressed as a decimal)

q = 1 - p

SE = standard error of the proportion

Accordingly the household size computed for the study was 200.

A two stage random sampling procedure was adopted for the selection of the 200 households (market oriented smallholder dairy farmers). In the first stage, from the 6 "Kebeles" known to have market-oriented smallholder dairy system (Girar-Jarso District MoARD office, 2006) 4 were randomly chosen.

In the second stage, given that number of smallholder farmers present in each "Kebele", the share of each "kebele" to make a total of 200 smallholder farmers was computed (Table 4). Then the corresponding numbers of smallholders from the participating "Kebeles" were randomly selected by using the list of farmers available at "woreda" agriculture and rural development office. The total number of farmers interviewed from each kebele was proportional to the number of households in the location.

Table 4. Total numbers of smallholders that participated in the study

District	Sampled kebeles	No.HH	Sample size	Proportion of the total (%)
Girar-Jarso	Torbanashe	1020	63	6.2
	Dire-doyu	837	52	6.2
	Wartu	489	30	6.1
	Girar-gabar	900	55	6.1
	Total	3246	200	6.1

No.HH= Number of households

Source: Data obtained from Girar-Jarso District MoARD office, (2006)

3.4. Methods of data collection

3.4.1. Questionnaire survey

Questionnaire survey was one of the instruments used to collect primary data. The questionnaire was closed type for its major part and administered by the same interviewer who speaks the same language (Afan Oromo) with the participant smallholders. The questionnaire, that was pre-tested and adjusted, was focusing on demographic characteristics, work load, land use pattern, management practices, livestock and livestock product marketing, milk yield and production performance, technology use and technology adoption constraints. It was conducted after thoroughly explaining the purpose of the exercise to the interviewees.

3.4.2. Farm inspection and animal examination

A one-time farm visit was also conducted at the same time as the interview. Activities accomplished during the farms visits were assessing housing situations, feeding practices, animal examination, and looking into the available farm records if any (Annex 2).

3.4.3. Participatory appraisal (PA)

The PA method used the "before" and "after" proportional piling tool (Catley, 1999) and preference proportional piling as described by Kirsopp-Reed (1994). A sample checklist, serving as a guide and consisting of the main points for the PA interviews were prepared, pre-tested, and adjusted prior to full implementation. Prior to the scoring exercises, the time-series approach were used to define the "before and after time frame" (Kirsopp-Reed, 1994 and Catley, 1999). Informants were asked to identify not more than six local indicators per parameter. All indicators for a particular parameter were written in the local language on pieces of papers, each paper bearing one indicator. The papers were then being placed separately on the ground or tagged on different objects like a piece of wood, a stone or tree leaves. Then the informants were asked to divide a pile of 100 pebble stones among the indicators according to their prioritization, to score the "before" situation. A literate informant in the group or an assistant was asked to read out these indicators from time to time to recall as they discussed and scored. During the scoring of the "after" situation the informants were free to increase, decrease or leave the "before" pile of pebble stones of an indicator, according to their perception for the "after" situation. The informants were also been allowed to rearrange the piles until they all arrived at an agreeable result. Factor change method was used to compute the scores attributed for the "before" and "after" periods. The difference between the scores, of the "before" and "after" periods were divided by the "before" value to obtain "Factor Change". Factor Change" value indicated both the direction and magnitude of the changes. A positive factor change (FC) for milk and other benefits indicated an increased quantity of milk and benefits compared to the before situation. However, a positive FC for diseases indicated increase in disease and, thus, no improvement.

Preference proportional piling was used to measure the most preferred technologies with respect to health, breeding, and feeding in the area, following the same procedures as in the "before" and "after" proportional piling by using pebble stones. Before conducting the PA exercise, the purpose of the exercise was thoroughly explained to the participants. Table 5 illustrates list of parameters assessed by groups of smallholder farmers using the PA method. Generally group discussions (interviews) in the PA method lasted for 2 to 3 hours. In all group discussions pebble stones were used for scoring.

Table 5. Parameters assessed by groups of smallholder dairy farmers using PA method

Parameters	Changes of an indicator to be measured	Methods applied
Disease control	Effect of improved health service	Before and after proportional piling
Animal health services	Preferences for service providers	Preference proportional piling
Production	Benefits derived, Milk usage	Before and after proportional piling
Breeding	Preference	Preference proportional piling
Feeding	Preference	Preference proportional piling

3.4.4. Secondary data collection

Retrospective (secondary) data were gathered from reports and records of the "woreda" Agriculture and Rural Development Office, Zone and Regional and other related sectors. These secondary data represents information already collected by the "woreda" Agriculture and Rural Development Office, Zone and Regional and other related sectors. The type of the data collected included data on available technologies in the Kebeles, extension services, AI services delivered to the smallholders, animal health and production information, local disease names, seasonal disease patterns, livestock populations, livestock management systems, etc.

3.5. Data management and statistical analysis

The data collected from the study area were entered into micro-soft-Excel spreadsheet computer program (2003) and analyzed using STATA (7.0, 2001), and SPSS (SPSS release 11.5, 2002) statistical computer soft ware programs.

Descriptive statistics like means, standard deviation and frequency distribution were used to describe the farming system characteristics in the study area. This was done by using Stat graphics, Plus 2.1 (Manguistics, Inc., Rockville, and Ma, USA). Computation of ratios and percentages were performed in Microsoft Excel (2003) (Microsoft Corp.). The General linear model (GLM) of the SPSS statistical computer soft ware program (SPSS release 11.5, 2002) was used to study the interaction between the farming system characteristics. Graphs were prepared using STATA from micro-soft-Excel program.

3.6. Triangulation

Triangulation refers to crosschecking information by taking the results of one method and comparing them to results of a different method or existing data. Preliminary analysis was carried out at the field level by comparing secondary data (records and reports) with actively collected data from different respondents by means of questionnaire survey and PA methods. Any pronounced difference was investigated and hypotheses for the difference made and tested (Cateley 1999a; Moriner, 1996; Mogga, 2001).

4. RESULTS

4.1. Results of questionnaire survey and farm visit

4.1. 1. Description of household characteristics

Some demographic characteristics of the smallholder dairy farmers are summarised in Tables 6 and 7. The average age of the farm owners was 46.6 years with a range from 24 – 75 years. They had an average farming experience of 25 years.

Table 6. Demographic characteristics of smallholder farmers (N=200) in Girar-Jarso Woreda, 2007

Characteristic	Category	Frequency	Percentage
Age (in years)	≤ 40	76	38
	41-55	78	39
	>55	46	23
Sex	Male	171	85.5
	Female	29	14.5
Marital status	Single	1	0.5
	Married	184	92
	Divorced	2	1
	Widowed	13	6.5
Land Holdings (in hectares)	≤ 2	35	17.5
	2.1- 4	126	63
	> 4	39	19.5
Farm experience			
	≤ 15	48	24
	16 -30	108	54
	> 30	44	22
Labor utilization	Owen& Family labor	115	57.5
	Hired labor	85	42.5
Income generating activities	Dairying + Crop production	198	99
	Dairying only	2	1
Educational status	Illiterate	79	39.5
	Basic education	43	21.5
	Primary level	43	21.5
	Junior and secondary level	35	17.5

Among the respondent farmers interviewed, the marjory (77%) were aged between 24 and 55 years, the highest proportions of them (92%) were married. Almost all the respondents (99%) were engaged both in dairying and crop production. Nearly 60% of the respondents had access to informal and/or formal educations thus can read and write. With the sex ratio of 1 male to 0.12 female (Fishers' Exact Test = 0.068), which is statistically not significant at ($p > 0.05$).

Table 7. Distribution of market oriented smallholder family members by age and sex groups in the study areas

Category	Mean	SD
Total family size	5.77	2.35
Male ≤ 15 years	1.56	1.13
Female ≤15 years	1.78	1.18
Male >15 years	1.20	1.25
Female >15 years	1.24	1.33

SD = Standard deviation

The overall mean family size for all respondents was 5.77 ± 2.35 persons. The average number of children who were less than 15 years old was 3.35 (1.56 ± 1.13 male and 1.79 ± 1.18 female). The average number of economically active family members (greater than 15 years old) was 2.44 persons (1.20 ± 1.25male and 1.24 ± 1.33 female). The family size ranged from 1 to 12 persons. More than 87.3% of the households had a family size that ranged 3 to 9 persons. While 27% of the male family members comprise less than 15 years in this study which was not statistically significant at ($p > 0.05$). The proportion of female-headed households was very small (14.5%).

4.1. 2. Description of land holding characteristics

The average farm size of respondents was 3.15 ±1.29 hectares. The land use pattern in the study area shows that 70% of the land (2.21±1.06 hectares) was used for cropping, 22.5% (0.71±0.37 hectares) for grazing and the rest as fallow land and for other uses

Table 8. Land use pattern and average cattle herd size (200 smallholder dairy farmers, 2006-2007)

Variables	Mean	SD
Total family size (P)	5.77	2.35
Total land size (ha)	3.15	1.29
Crop land size (ha)	2.20	1.05
Fallow land size (ha)	0.08	0.26
Grazing land size (ha)	0.71	0.36
Other land size (ha)	0.14	0.08
Total cattle herd (N)	8.07	2.9

SD = Standard Deviation P = person, ha = hectares, N = Number

The summary statistics indicates that land used for grazing purpose was very small and significantly lower than land allotted for other uses.

4.1. 3. Description of livestock holding characteristics

Table 9 illustrate the size and composition of livestock owned by the smallholder dairy farmers in study areas. All the surveyed smallholders owned cattle and the large majority (96.5%) also had shoats and equines. The average number of livestock owned by the respondent farmers was 16.65 ± 7.11animals or 9.47 TLU (Annex 1 conversion factors). Cattle were the predominant species representing 82.2% of the total TLU. The range of cattle herd sizes was 2 to 17. As to cattle breed types, 5.13 TLU (54.2%) were crossbreds with various levels of exotic blood and the rest 2.65 TLU (28%) were indigenous breeds of highland zebu whereas shoats and equines were 1.69 TLU (17.8%). Sources of crossbred animals were indicated as in-calf heifers purchased through formal credits, purchase from local markets, bred from established Holstein-Friesian bull stations and/or AI services.

Table 9. Livestock herd size and composition in TLU (N = 200) smallholder dairy farmers, 200/2007.

Livestock category	Mean	SD	TLU
Cattle	8.07	2.9	7.78
Indigenous cattle	3.13	1.82	2.65
Crossbred cattle	4.98	2.08	5.13
Sheep	6.33	4.6	0.63
Goats	0.18	0.9	0.02
Horses	0.35	0.5	0.28
Donkeys	1.68	1.1	0.67
Mules	0.06	0.2	0.05
Total size	16.65	7.11	9.47

1 TLU = 250kg live weight of livestock, SD = Standard Deviation, TLU = Tropical Livestock Unit, N = Number of smallholder dairy farmers

Eighty two percent of smallholders had cattle herd size of more than 6 animals. The proportion of smallholders that had more than 6 shoats and/or equines was 60%.

The cattle herd composition and breed ratio at the study area are indicated in Table 10. The sex ratio of oxen to breeding cows was 1:1, which have comparable number and highest proportions in the herd as compared to other breeds and sex groups. In addition, the overall breed and sex ratio (0.6:1) was statistically highly significant ($p < 0.05$) between the two breeds.

Table 10. Cattle herd composition by breed, sex and age groups, (200 smallholder dairy farmers, 2006/2007)

Category	Breed			
	Indigenous	Cross bred	Total	Breed-ratio
Calves	0.21 (0.41)	1.06(0.69)	1.27(0.82)	0.20:1
Heifers	0.27(0.51)	0.84(0.67)	1.11(0.85)	0.32:1
Bulls	0.40(0.60)	0.64(0.64)	1.04(0.92)	0.63:1
Oxen	1.73(0.81)	0. 62(0.80)	2.35(1.03)	2.80:1
Cows	0.54(0.61)	1.83(0.72)	2.37(0.99)	0.30:1
Grand total	3.13(1.82)	4.98(2.08)	8.1(2.90)	0.60:1

N.B.: figures within brackets indicate standard deviations

Dairy cows represented the highest proportion of the herd followed by draft oxen, calves, heifers and bulls in that order. Crossbred cows proportion was significantly higher (77.2%) than indigenous breed cows. The reverse was true regarding oxen.

Figure 3 shows the distribution of crossbred dairy cows among smallholder dairy farmers. Nearly 60% of the smallholders had two or more crossbred milking cows.

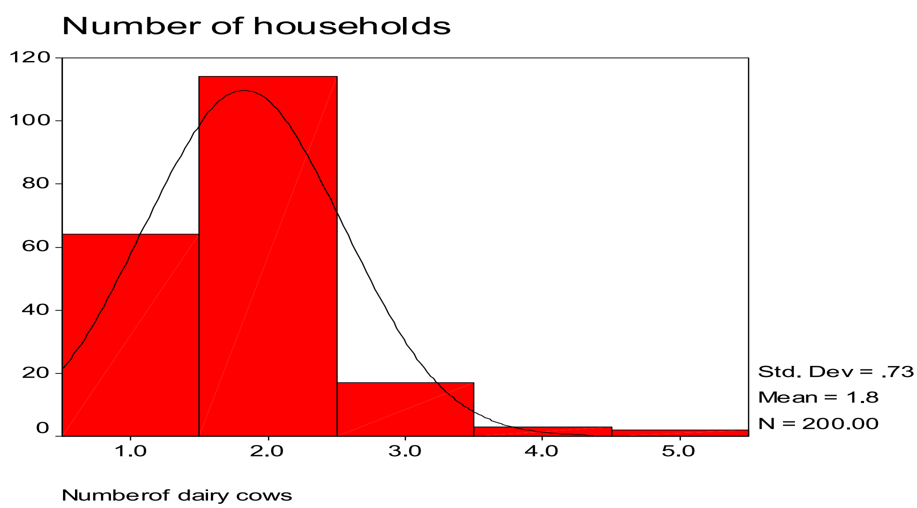


Figure 3. Number of crossbred dairy cows owned by market-oriented smallholder farmers in the area (200 smallholder dairy farmers, 2006-2007)

4.1.4. Objectives of dairying

The main objectives of keeping dairy cattle were to obtain income and provide food to the households. Fifty-nine point five percent (59.50%) of the household interviewed said that they produced milk as a source of income and for household consumption. The remaining percentages of the households in this study said that they produce milk only for household consumption. In this area 77% of the households sell their milk to dairy cooperatives for a price of 1.75 birr, while the rest 18%and 2.5% sell to dairy development enterprise (DDE) and Mama- agro industry for a price of 2.00 birr respectively, and the left 2.5% percentage sell to private consumers.

4.1.5. Dairy cattle husbandry practice

Husbandry practices cover all aspects of management, which include housing, feeding, breeding, health care etc. Managements of dairy cow involve doing a large number of small jobs at the proper time and in a proper manner. Husbandry practices form part of the immediate environment of the animals, and thus directly influence their performance.

Dairy management system

Based on the level of care given to dairy cattle (feeding practices, breeding systems, housing conditions, handling facilities, health care) the management systems experienced by the smallholder farmers were classified as extensive, semi-intensive, and intensive. Sixty-four point five percent (64.5 %) (n= 129) of the respondent farm households kept their dairy cattle under semi-intensive management system while 6% (n=12) were rated as intensive. The levels of care given to dairy cattle in the rest of the smallholder dairy farms were not much different from the traditional (extensive) production system. Figure 4 shows the distribution of smallholder farmers among the three management systems.

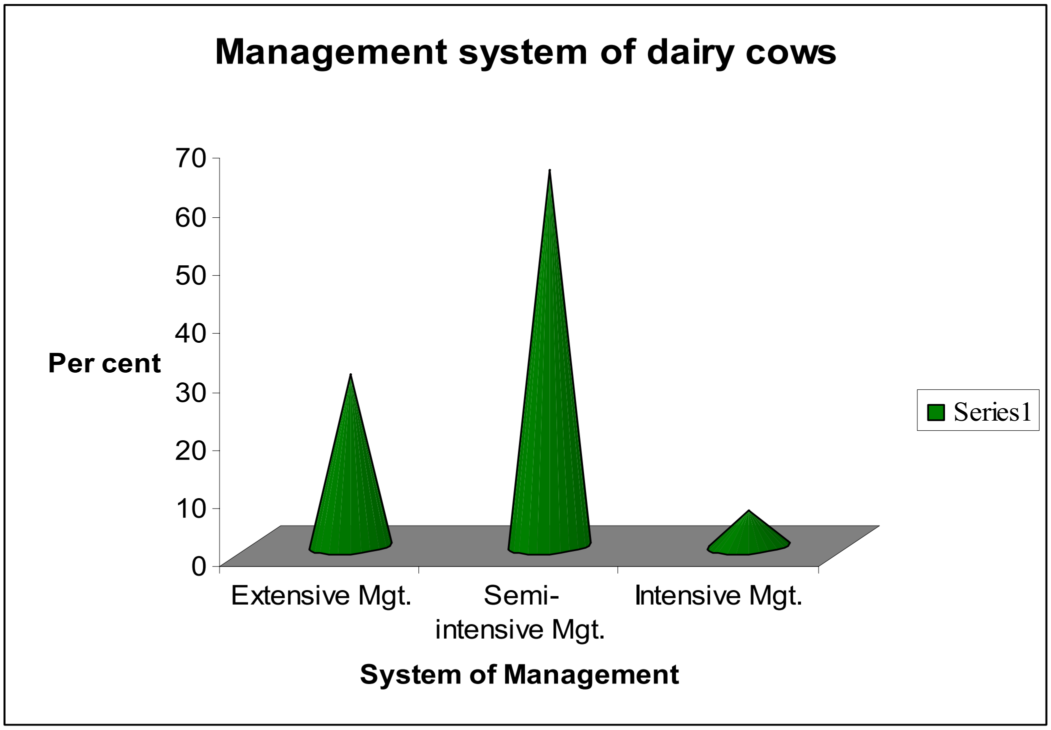


Figure 4. Distribution of smallholder dairy farms by management system (200 smallholder dairy farmers, 2006-2007)

Dairy cattle housing

In the study area 40% (n= 80) of the respondent households kept their dairy cattle in improved barns that were well constructed from locally available materials. The majority (59%) were using traditional hut. Open enclosures were used in only 1% of the farms as housing means.

Table 11. Summary of the dairy cattle housing situations, (200 smallholder dairy farmers , 2006/2007)

Factor and category	Frequency	Percentage
Housing type		
Traditional hut	120	60
Improved barn/hut	80	40
Floor types		
Paved	68	34
Unpaved	31	15.5
Scraping	5	2.5
Drainage system		
Good	36	18.0
Satisfactory	105	52.5
Poor	59	29.5

4.1.6. Dairy cattle production and reproductive performance

Table 12 illustrates the summary statistics of reproductive and milk productions performance of cattle as indicated by the respondents. Crossbred and indigenous cattle are kept principally for milk and draught power, but the crossbreds are mainly meant for dairy purposes and indigenous cattle are preferred for traction. Overall, the reported average performance levels of 72 indigenous and 200 crossbred cows for dairy and reproduction traits are summarized in Table 12. The reported average dairy performance values (lactation length and milk yield) for crossbred are much higher than those of the indigenous cows. Reported lactation yields for crossbred are over five times greater than those reported for indigenous cows. There was statistically significant difference between crossbred and indigenous cattle in all parameters assessed except weaning period for calves. The results of the survey revealed that age at first calving (AFC) of indigenous breeds and crossbred heifers was 4.7 ± 0.62) and 3.4 ± 0.56) years respectively, which is statistically significant at ($p< 0.05$). The milk yield obtained is 2.5 and 6.7 liters/day/cow on average for local breed and crossbred dairy cows in the study area, which is statistically significant at ($p < 0.05$) for both breeds. The average lactation length of the local breeds and crossbred dairy cows were 219 and 314 days and it is statistically significant at the ($p < 0.05$). The average weaning period of the local breeds and crossbred calves were 6 and 5.7 months respectively in the study area, which was statistically not significant at ($p > 0.05$). The mean average total milk yield of crossbred dairy cows in this survey study was 2216lit/lactation/cow, which was statistically significant at ($p < 0.05$).

Table 12. Summary of reproductive and milk production performance of cattle, (200 smallholder dairy farmers, 200/2007)

Performance parameters	Breed				P- value
	Local		Crosses		
	Mean	SD	Mean	SD	
Age at first calving (years)	4.7	0.62	3.4	0.56	.000
Average milk yield (lit/day/cow)	2.5	0.42	6.7	2	.000
Average lactation lengths (months)	219	56.8	314	56	.000
Average milk yield per lactation (lit.)	565.4	233.7	2216	1081.8	.000
Average weaning age (months)	5.9	0.95	5.7	2.26	.510*
Calving Interval (months)	24	1.82	21	2.46	.000

(* Means not significant at 0.05 level), SD = Standard Deviation

4.1.7. Dairy cattle health problems

The most common diseases in the study areas are black leg, anthrax, pasteurollosis, and foot and mouth disease *(*FMD*)*. External and internal parasites are also prevalent in the study area. Even if animal health problems are one of the major constraints, there was no area where livestock production was completely abandoned due to diseases. Table 13 shows ranking of diseases by respondent farmers in the study area of Girar-Jarso woreda.

Table 13. Ranking of livestock diseases by respondent farmers in the study area, (200 smallholder dairy farmers, 200/2007)

Variables	Dairy cattle (N = 200)	Small ruminant (N 200)	Equines (N 200)
	Rank	Rank	Rank
Internal parasite	4	2	1
LSD			
CBPP	7		
CCPP		4	
External parasite	6	3	3
FMD	5		4
Anthrax	2		2
Sheep pox		1	
Pasteurollosis	3	5	
Black leg	1		
Brucellosis	8		

N = Number of household surveyed, Blank space means the disease was not mentioned and therefore not scored in that species,(Rank 1: most important; rank 8:least important)

4.1.8. Dairy production constraints

Table 14 shows the list of constraints identified by smallholders and the summary statistics of the constraints. The respondent farmers pointed-out that scarcity of feeds, mainly during dry season, is the major limiting factor which affected the development of livestock sub-sector in general and the rearing of crossbred dairy cows in particular. In most cases low feedstock coincide with periods of peak labor demands in agricultural activities, for example July in our case.

Table 14. Constraints of livestock production as identified by the smallholder farmers

Constraints	Frequency	Percentage	Rank
Shortages of feeds	112	56	1
Shortages of grazing lands	111	55.5	2
Health problems	110	55	3
Low productivity	109	54.5	4
Predators	25	12.5	7
Water scarcity	32	16	6
Labor scarcity	54	27	5

4.1.9. Labor division among family members

Table 15 illustrated distributions of responsibilities among family members and hired labor in cattle management activities as well as in handling and marketing of products. Feeding, selling of livestock and handling of animals against diseases are mostly the responsibilities of the male household members whereas their female counterparts are responsible for milking, barn clearing, butter making, and selling of livestock products. Children and hired labor are given responsibilities mainly for herding and watering.

Table 15. Distribution of the responsibilities of the routine farm activities among family members and hired labor

Activities	Labor division between family members and hired labor of 200 stallholders dairy farmers			
	Husband	Wife	Children	Hired labor
Feeding	68(34)	62(31)	61(30.5)	9(4.5)
Herding	12(6)	15(7.5)	133(66.5)	40(20)
Milking	6(3)	181(90.5)	10(5)	3(1.5)
Barn clearing	0(0)	111(55.5)	78(39)	11(5.5)
Butter making	1(0.5)	188(94)	10(5)	1(0.5)
Watering	14(7)	39(19.5)	114(57)	33(16.5)
Selling of livestock	187(93.5)	12(6)	1(0.5)	0(0)
Selling of livestock products	2(1)	191(95.5)	6(3)	1(0.5)
Handling of diseases	188(94)	11(5.5)	1(0.5)	0(0)

Figures within brackets show percentages for that row

4.1.10. Feeding practice in the study area

Livestock feeding systems practiced in the study area include full time grazing, zero grazing (stall-feeding), and rotational grazing (Table 16). Free grazing and zero grazing were the most commonly used ones (75%) in the study area.

Table 16. Major feeding systems in the study areas as indicated by the farmers, 2006/2007

Feeding system	Frequency	Percentage
Full time grazing	39	19.5
Zero grazing/ Stall feeding	9	4.5
Rotational grazing	2	1.0
Free grazing & zero grazing	150	75.0

Respondent farmers pointed out that, because of the absence of feed improvement practices in the area, the productivity of grazing land was very poor. Animals were supplemented with crop by-products for example straw from teff (*Eragrostis abyissinica*), wheat, and barley. Animals graze on pasture 6 – 8 hours a day. The lactating cows were supplemented with commercial concentrates, native hay, noug (*Guizotia abyssinica*) seed cake, and crop by products, and milling by products. Much of the time, the animals grazed mixed with other herds. Access to most of the grazing lands was restricted during the long rainy season (June – October) for haymaking and individual grazing. The dairy cows were watered twice a day.

4.2. Dairy technology adoption

Table 17 shows list of technologies and levels of their use in the study areas. A total of 21 dairy technologies with different degrees of adoption were observed. Technologies that were widely adopted in the study areas were cross breeding, checking for mastitis, vaccination, concentrate supplements and growth of vetch/Oats. Technologies such as straw chemical treatment, pasture improvement; maintain of breeding bull, burdizo-castration and record keeping were the least adopted ones with in a range of 1 to 10 per cent adoption rates. Artificial insemination (AI), improved housing and pregnancy test were at comparable adoption level. Slightly higher and one third of the respondent farmers were using these technologies. Farmers in the study area were accustomed to planting oat and vetch separately. However, they did not successfully adopt back yard fodder crops and multi-purpose trees. They indicated that tree-Lucerne was not fed to dairy cows, but was used only as a hedge. In general, all the respondent farmers were users of at least five dairy technologies. Results of the survey showed that respondent farmers adopted less or equal to 7 technologies were 12% (n = 24) of which 12.5% were female. Sixty-seven percent (67 %) (n = 134) were adopting 8-11 technologies and the ratio of female was 14%. While 21 %(n = 42) adopted greater than 11 dairy technologies of which 17% were female respondents. This trend indicates the technology uses by female were increased.

Table 17. Adoption of some well-known dairy technologies by market-oriented, (200 smallholder farmers in Girar Jarso Woreda, 2007)

Dairy technology	Frequency	Percentage
1. Nutrition		
Straw chemical treatment	17	8.5
Mineral blocks	46	23
Pasture improvement	19	9.5
Growth of Vetch /Oats	156	78
Growth of tree-Lucerne	47	23.5
Growth of fodder beet	47	23.5
Concentrate supplements	138	69
2. Breeding		
Cross breeding	183	91.5
Maintain breeding bull	14	7
3. Reproductive technology		
Pregnancy test	73	36.5
Artificial insemination (AI)	73	36.5
4. Management		
Castration (traditional)	185	92.5
Burdizo-castration	15	7.5
Record keeping	15	7.5
5. Health cares		
Modern vet. Services	174	87
Traditional healing	99	49.5
Checking for mastitis	190	95
Vaccination	161	80.5
Deworming	123	61.5
6. Housing		
Traditional hut	120	60
Improved hut	80	40

Dairy technology uptake in the study area was constrained by different factors. The majority of the smallholders in the study areas indicated that shortage of land was the principal constraint affecting technology uptakes. Feed shortage and cost of crossbred dairy cows were identified as major bottlenecks next to land. Table 18 shows list constraints of technology uptake as indicated by smallholder farmers.

Table 18. Constraints of technology up take in the study area (200 smallholder dairy farmers, 2006/2007)

Constraints	Frequency	Percentage
Land shortage	188	94
Labor shortage	167	83.5
Feed shortage	187	93.5
Lack of Govt. assistance	105	52.5
Health problems	109	54.5
Market problem	159	79.5
Lack of credit	161	80.5
Cost of crossbred	179	89.5

Labor shortage was reported to be one of the problems that respondent farmers faced during the peak period. The sample respondent farmers underlined that overlapping of farm activities compounded the problem of labor; sample farmers indicated that they used different options to resolve the problems such as labor hiring and labor exchange. The proportion of sample farmers who received credit for the purpose of purchasing farm inputs was 26%. Whereas sample farmers that received credit for the purpose of purchasing crossbred cows were 10%. Some of the major bottlenecks for not using credit for the dairy technology uptake in the area were: high interest rate (20.5%), shortages of down payment (5%), no capacity to pay the loan (8.7%), inaccessibility to credit (63.4%), and own purchased (2.5%) were identified. About 80% of the farmers reported that market problems leads the farmers to sell the dairy product at low price and the price fluctuated from season to season.

The result of the present study shows that the average numbers of dairy technology uptake was 9.89 $\pm$ 2.16 with a range from 5–16. This shows the existence of variations in technology adoption between farmers. There were differences in the time of adoption of technologies by farmers living in the same area.

Four factor categories were selected to see the effects of different variables on the adoption of modern dairy technologies (Table 19). On the basis of preceding categorization, it can be concluded that sex, age, level of education and farming experience are important characteristics that favor demand for dairy technology uptake in the study area. The results of gender appear that there is a variation in technology uptake between the male and female sex groups. The female groups are less users of dairy technology averaged 9.26 ± 1.90 compared to the male group averaged 9.95 ± 2.20. Although not statistically significant, education was an important factor that favored the likelihood demands for dairy technology. This suggests the important role of education in stimulating demand for technology use. As the number of education increases the technology uses also increases. Dairy producers above 55 years of age have less users of dairy technology averaged 9.37 ± 2.32 compared to the other age category. Farm experiences also determine the use of dairy technology in the study area. Farmers with less farming experiences have higher adoption of dairy technologies. Thus, the mean values of the factor variables were compared using t-test. The test helps to check whether or not the mean values of a given variable significantly differ between the categories. Accordingly the t-values of the variables were computed and out of these variable the age, farm experience, and level of education were found to differ significantly at ($p > 0.05$) probability level. As expected, sex is of hypothesized positive and is statistically significant ($p < 0.05$) for all technologies identified and adopted in the area. This implies that male producers are more likely to use dairy technology compared to female household heads in the study area.

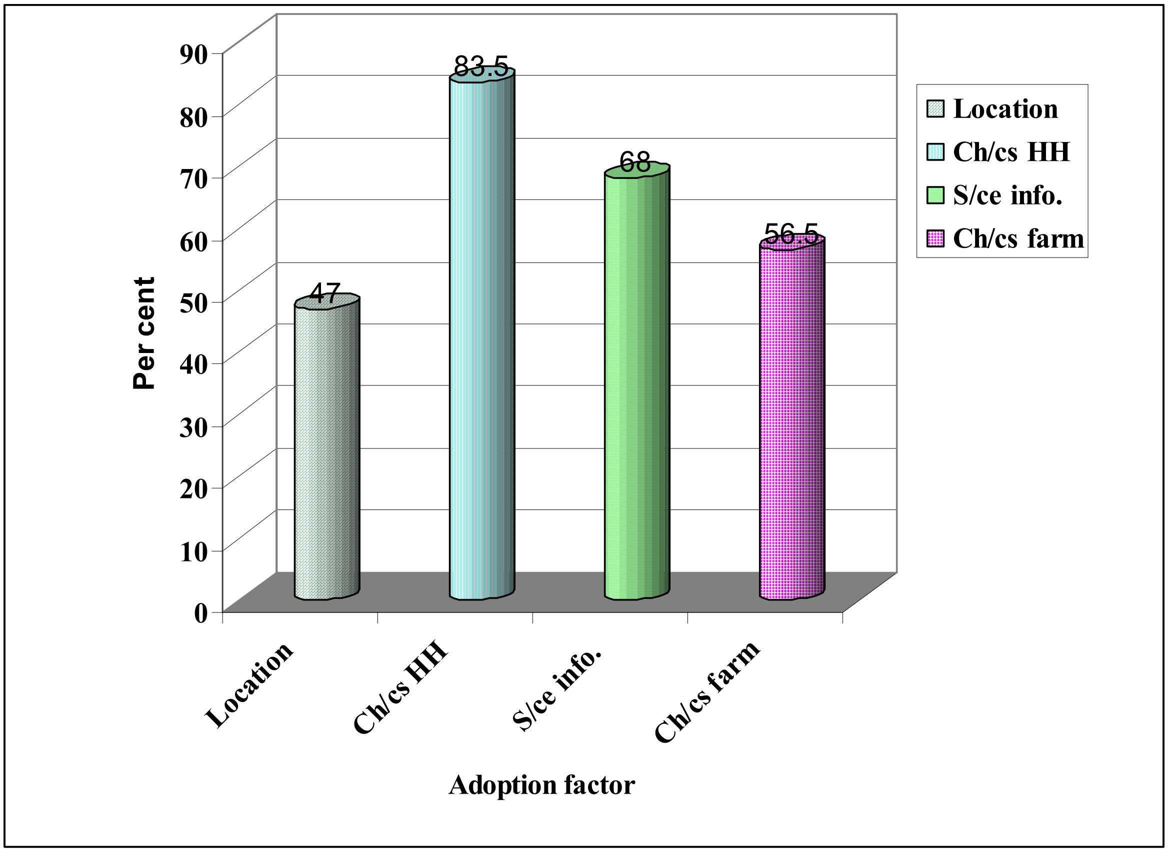
Table 19. Association of sex, age, level of education and farming experience on technology adoption (200 smallholder dairy farms, 200/2007)

	Factor category	Number	Number of technology adopted			
Sex			Mean	SD	df	t-test
	Male	171	9.95	2.20	1	.041*
	Female	29	9.26	1.90		
Age						
	≤ 40	76	10.17	2.05		
	41 - 55	78	9.74	2.17	2	.349
	> 55	46	9.37	2.32		
Level of education						
	Illiterates	79	9.35	1.98		
	Basic Education	43	9.88	1.95	3	.474
	Elementary	43	9.87	2.34		
	Above	35	10.15	2.45		
Farm experience						
	≤ 15	48	10.2	2.1		
	16 - 30	108	9.80	2.1	2	.924
	> 30	44	9.77	2.37		

SD = Standard Deviation, df= degree of freedom, t-test= test statistics

Further more, when adopted, the components were often not adopted at the recommended rates.

The survey results revealed that, results of the factors influencing adoption of dairy and dairy related technologies often focus on characteristics of the household head, location of the household, the nature and source of information before adoption, and the characteristics of the farm to adopt technology. Figure 5 shows factors affecting adoption of dairy technology in the area. According to the survey result characteristics of the household head (83.5%) and source of information (68%) were the most frequent factors that influence the decisions of the household to choose new technologies.



Ch/cs HH (characteristics of the household head), S/ces info (nature and source of information), Ch/cs farm (characteristics of the farm)

Figure 5. Factors affecting adoption of dairy technology in the study area (200 smallholders dairy farms, 2006/2007)

4.3. Participatory appraisal

In an attempt to relate the rationale of dairy technology transfer with the actual performance of dairy production, a PA assessment was conducted. In the study area Smallholder Dairy Development Project (SDDP) was implemented from 1995 – 2001 to improve the standard of living of smallholder farming families in a sustainable way by introducing different dairy technologies. Crossbred cattle and other dairy related technologies have been distributed to smallholder farmers on credit basis by this project. This time period was used as reference point to define the "before" and "after" situations and status of variables considered to assess the impact of dairy technology transfer.

A total of 4 informant groups (one group in each study area) were formed and participated in the PA discussions. Each group had 8 to 12 members in which the participation of all segments of the small holder farming communities (young, elders, community leaders, representatives of cooperatives and associations, etc.) was considered. Female participants' number in the groups was 30%.

4.3.1. Animal diseases status

Table 20 shows list of diseases identified and scored by groups of smallholder farmers. A total of ten animal diseases were identified in the area. In the "before" situation Black leg, Anthrax, Liver fluke and leech were identified and scored as the most important disease in that order. In the "after" situation, however, there was substantially decrease in the importance of most of these diseases. On the other hand, some diseases that had insignificant importance in the "before" situation became dominant health constraints despite improved access to veterinary services (after situation). These were mastitis, reproductive problems, respiratory problems, foot rot and FMD.

Table 20. Results of animal disease status scoring by smallholder farmers using preference proportional piling (200 smallholder dairy farms, 2006/2007)

Medical name (Local name)	Groups of informants (N=4)	
	Before/ After	FC
Anthrax (*Abbasenga*)	70/30	-0.6
Black leg (*Abbagorbaa*)	125/95	-0.2
Mastitis (*Dhukuba muchaa*)	15/60	3
FMD (*Kebenecha*)	35/38	0.1
Foot rot (*O'echoo*)	10/15	0.5
Reproductive problems	18/30	0.7
Leech (*Dhulandhula*)	45/72	0.6
Ticks (*Silmii*)	22/15	-0.3
Liver fluke (*Dodoo*)	50/35	-0.3
Pasteurolosis (*Gonnena*)	5/5	

4.3.2. Preference for the different veterinary services providers

The respondent groups were asked to identify different animal health services providers in their areas and to score according to their preference. Table 21 highlights the results of participatory appraisal of this variable. Among the five identified animal health delivery systems, religious and traditional healers were given highest scores for the "before" period. For the after period informant groups considered government service to be the best followed by private veterinary services. Religious healing and traditional treatments during the after period showed substantial decrease in importance for the after period. Primary animal health care was not mentioned for the "before" period. However, it had non-negligible score for the "after" period.

Table 21. Scoring of uses of different types of veterinary services by smallholder farmers using preference proportional piling (200 smallholder dairy farms, 2006/2007)

Types of veterinary serviceused	Groups of respondents (N=4)	
	Scores for before/after situations	FC
Religious healing	125/65	-0.5
Government vet. Service	70/140	1
Private vet. Service	25/85	2.4
Primary animal health care	/20	
Traditional treatments & drugs	180/90	-0.5

Blank space means the indicator was not mentioned and therefore not scored in the area

4.3.3. Benefits obtained from dairy production

Eight items were identified as indicators to assess benefits obtained from dairy farming. Table 22 shows the list of indicators with scores attributed by participant groups of smallholders. All the indicators showed significant increase for the "after" period. Milk was said to have increased by three fold, obtaining the highest score.

Table 22. Benefits of dairy production as scored by groups of smallholder farmers using proportional piling method (200 smallholder dairy farms, 2006/2007)

Indicators	Groups of respondents (N=4)	FC
	Scores "Before"/"After" situations	
Milk	55/150	1.7
Work	145/185	0.3
Manure	55/80	0.5
Sale of animals & its byproducts	80/130	0.6
As a reserve / Insurance	30/57	0.9
Gifts	15/19	0.3
Hides	8/14	0.8
Meat for home consumption	13/20	0.5

4.3.4. Milk uses

Seven important uses of milk were identified and scored by informant groups in the study area (Table 23). According to the result obtained, in the "before" situation the most important uses of milk were milk for butter making, milk for children, milk for home consumption and milk for cheese making, in that order. For the "after" period, milk for sale was given the highest score which was almost 6 fold compared to the "before" situation. All other milk use categories showed decrease for the after period.

Further investigations were carried out to determine the reasons for the decrease in all other use categories during the "after" period. According to the informants the decreases were due to low fat percentage of milk, time constraint to process to other dairy products (to save time for home duties) and a need to obtain daily income by selling fresh milk.

Table 23. Milk use categories as identified and scored by groups of smallholder farmers using proportional piling method (200 smallholder dairy farms, 2006/2007)

Indicators	Groups of informants (N=4)	
	Scores "before"/ "after" situations	FC
Milk for consumption	60/45	–0.25
Milk for children	85/61	–0.3
Milk for sale	41/250	5
Milk for butter making	95/45	-0.5
Milk for visitors	31/24	-0.2
Milk for cheese making	50/35	-0.3
Milk for cosmetics	33/25	–0.2

N = Number of informant groups, FC = Factor Change analysis

4.3.5. Breeding and feeding systems

Table 24 shows indicators of breeding and feeding systems that were identified and scored by groups of smallholders by using proportional piling methods. The dominant breeding method, "both" in the before and after periods, was natural breeding. Although the use of AI has shown an increase for the after period the level of use still appeared substantially low.

The feeding system was largely dominated by grazing on the natural pasture for the "both" period. This was shifted to zero-grazing system in the "after" situation. Other feed related technologies have also shown increase in their levels of use in the "after" periods.

Table 24. Breeding and feeding systems as identified and scored by groups of smallholder farmer using proportional piling method (200 smallholder dairy farms, 2006/2007)

Indicators	Groups of informants (N=4)	
Breeding	Scores for the "Before"/ "after" situations (N= 4)	FC
Natural Breeding	350/230	-0.3
AI	20/85	3
Both	30/85	1.8
Feeding system		
Grazing on traditional pasture	185/55	-0.7
Grazing on improved pasture	0/20	
Zero grazing	105/135	0.3
Rotational grazing	45/50	0.1
Concentrate feeding	10/45	3.5
Crop residues	55/80	0.5

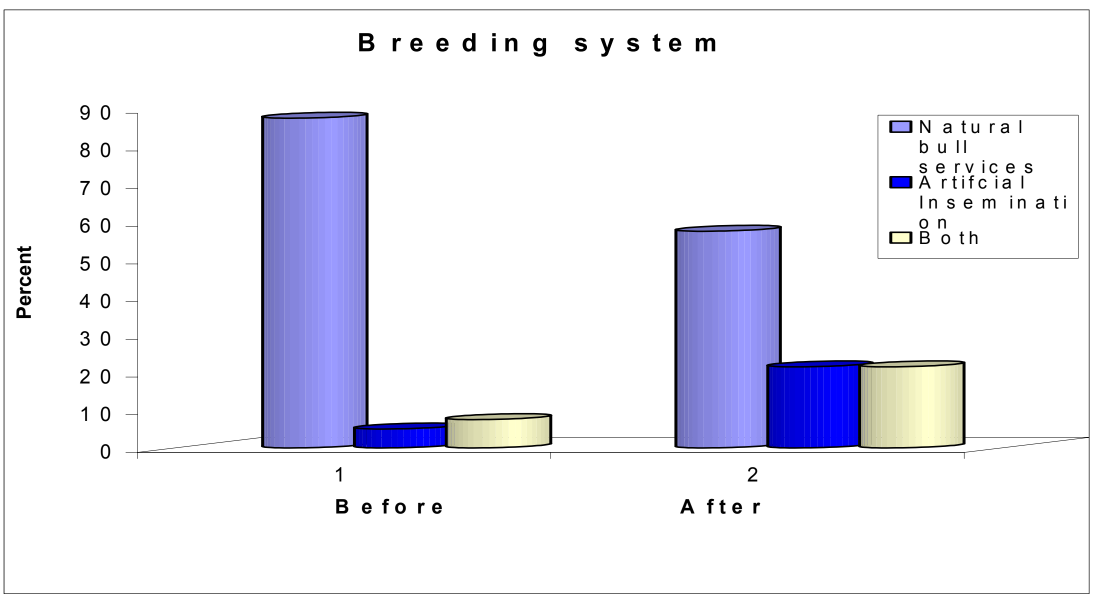


Figure 6. shows breeding system of dairy cows in the area, (200 smallholder dairy farmers, 2006/2007

5. DICUSSIONS

The family size obtained in the present study (5.77 persons) is less than what was those reported by Kelay (2002), 7.54 persons per household at Selale, and considerably higher than those reported by Niftalem (2000), which was 5.6 persons and 4.6 persons for Inewari and Debre Berhan, respectively.

The proportion of female-headed dairy farms was relatively small compared to studies conducted in other parts of the country (Mekonnen *et al*., 2005). Perhaps, this might reflect the increased inclinations of males towards dairy farming due to better economic opportunities from this sector and the resource limitation for females to go into the dairy business.

The present study also showed that cattle herd size was significantly and positively correlated to family size. Abdinasir (2000) also reported similar finding. Regarding labor division among family members in performing day-to-day farm activities, most of the responsibilities were on the shoulders of the farm owner and his spouse. This seems, most likely, due to the high economic value of crossbred dairy cows. Other reports that took in to consideration the whole livestock herd have shown that activities like milking and barn clearing were restricted to women and herding was taken care by children (MoA/FINNDA, 1996; Getachew, *et al*., 1993; Kelay, 2002).

The cattle herd compositions found in the study area were dominated by cows (29.14 %) most of which were crossbred (65.9 %). This finding is partly in agreement with what has been reported by Kelay (2002) for Selale where cows comprised 38.7 – 44.7% of the cattle herd, 62 - 74% of which were crossbred. The high proportion of cows in the herd and the increasing proportions of crossbred cows indicate the importance of dairying in the study areas.

Sixty percent of the sample respondents have access to education. This can be interpreted in such a way that farmers who are educated are more eager to grasp new ideas and allocate their resource to their best use. Besides, they could have a better understanding of the technology and could recognize the importance of having improved breeds and productive herd through better management and improved feeding system. Further more education has been shown to play a positive role in the adoption of new technology. Dairying is a labor-intensive activity, so that greater household labor availability is expected to foster adoption.

The survey results revealed that the human to land ratio was nearly 0.5 hectare per persons. Available land for grazing and for all other purposes other than cropping was only 1 hectare per family on which nearly 17 animals live. This clearly shows scarcity of land, which is known to be one of the principal constraints to the agricultural production in the area. In fact, land scarcity resulted in short fallow periods, which has negative influence on livestock production in general and rearing of crossbred dairy cows in particular. In case of land use, the area left to fallow in the district was very small. This implies that farmers cultivate their farmlands continuously, with little or no conservation measures.

Most of the cattle reared in the study area are crossbred cattle that comprise 4.98 TLU/head (52.6%) of the total livestock population. This might be probably due to the highland areas environmental condition that is conducive for crossbred cattle. The cattle herd was ranging from 2 to 17, which is generally taken to be characteristic of the mixed crop-livestock farming areas. The cattle herd composition in different sex and age groups clearly show the owner's production objectives. For instance, in breeding females groups that are mainly kept for milk production, the proportion of crossbred cows was significantly higher than the indigenous ones. In oxen groups, simply the reverse was true. Oxen are used for draught purpose.

Sixty four percent of the smallholder farms in the study area managing their dairy cattle in semi- intensive way of management, which were an encouraging sign of willingness of farm owners to improve the husbandry practices. Workneh and Row lands, (2004) in their reports of livestock breed survey in Oromia Regional State described the cattle management systems as extensive (47%), semi-intensive (45%), and intensive (7%). The housing conditions were found good in nearly half of the surveyed farms. This was in agreement with the reports of Mekonnen *et al*, (2005) and Azage and Alemu (1998) who described it as a classical problem of smallholders. .

Sixty nine per cent of the farms procured concentrate as supplementation through purchase. According to the finding of this study commonly used feedstuffs were crop residues such as (teff (*Eragrostic abyssinica*), barley, wheat, oat, and pulse) straws, wheat middling, "noug" cake (*Guizotica abyssinica*), traditional brewery by products and rarely improved forage (tree-Lucerne), fodder beet, vetch and oats were indicated by respondent farmers.

The major cattle diseases highly ranked by respondent farmers were black leg; anthrax, pasteurollosis, FMD, and internal parasites were more common in the study area, which were in agreement with the study of Workneh and Rowlands (2004) also reported the importance of Black leg and anthrax in Oromia region. The same authors reported that the prevalence of cattle diseases in North Shoa (Oromia) were black leg (100%), anthrax (38.3%), pasteurollosis (9.2%), foot and mouth diseases (FMD) (22.5%), and internal parasites (5%). Eighty percent of the smallholder farms vaccinated their animals against black leg, anthrax, pasteurollosis, and in some cases against foot and mouth disease (FMD). In addition 61.5% of the farmers dewormed their animals against internal parasites, mostly twice per year when their animals lose condition.

In this finding the overall reported age at first calving for local and crossbred animals were 4.7 $\pm$ 0.62 years (56.4months) and 3.4 $\pm$ 0.56 years (40.8months), respectively. The majority of milking cows have low production performance with the average age at first calving is 53 months and average calving intervals is 25 months reported by (Mukasa- Mugerewa *et al*, 1989). Mahadevan (1966) observed that irrespective of their origin the mean age at first calving under a given Tropical environment was essentially the same and ranged from 3 to 4 years. Pulan (1980) estimated that the traditionally herded, white Fulani heifers have their first calf at 5 years (60 months) of age, while Otchere (1983) reported 48 to 60 months (4 to 5 years) for the same breed, which is in agreement with the results of this study. Ababu (2002) reported age at first calving (AFC) for Boran heifers as 53.9 $\pm$ 0.7 months with coefficient of variation of 8.17%, which was lower than with the results of this study. Mean age at first calving was higher in indigenous breeds than the crossbred cows. On top of the breed effect, to difference in management factors between the breeds. Mean age at first calving have statistically highly significant ($p < 0.05$) between the breeds that is 4.7(56.4 months) and 3.4years (40.8 months) respectively. On the other hand, the finding of AFC in this study was slightly higher than the 40.1 months estimated for crossbred dairy heifers in Malawi (Agyemang and Nkhonjera, 1990), 58.3 months in smallholder dairy farms in Zimbabwe (Masama *et al.,* 2003) and 40.6 months in different production systems in central highlands of Ethiopia (Shiferaw *et al*., 2003). A number of previous works indicated that management factor especially nutrition determines prepubertal growth rates and reproductive development

(Negussie *et al*., 1998; Masama *et al.,* 2003; Shiferaw *et al*., 2003; Yefat, 2005). The better-managed and well-fed heifers grew faster, served earlier and resulted in more economic benefit inters of sales of pregnant heifers and /or more milk and calves during the lifetime of the animal. The present finding indicates that under smallholder dairy farm level, given reasonably good management AFC can be reduced.

The calving interval of both indigenous breeds and crossbred dairy cows identified were 24 and 21 months respectively. These results were similar with the findings of Mukasa-Mugerwa *et al.* (1989) that reported 25 months for highland zebu. For traditionally raised Ethiopian highland zebu cows Mukasa-Mugerwa *et al (1989*) reported a calving interval of 780 days (26 months), which was in agreement with the results of this study. Mekkonen and Goshu (1987) observed a calving interval of 474 ±10 days for Fogera cows maintained at a research station in Gonder. Similarly Azage (1981) reported a CI of 479.9 days for Boran cattle maintained at Abernosa ranch. For traditionally maintained white Fulani zebu animals, CI ranged from 24 to 27 months (Pulan, 1979; Otchere, 1983). Calving intervals of crossbred cows reported for Bilalo and Lemu in Arsi highlands, which were 558, and 582 days respectively (Bulale, 2000) are shorter than the results of this study. The result obtained showed that weaning age was slightly longer for indigenous breed than crossbred. The mean weaning period however was not statistically significant ($p > 0.05$) between the breeds, which almost corroborates with studies of various researchers. The implications of this study is that the longer the calving interval means the longer the time to get more calf crop, which influence the herd productivity and off take, which in turn have influence on overall in come of farmers and food security.

As far as the study area is concerned, productivity of cattle has been hampered primarily by genetic component, shortage of feed, disease and management factors. On the top of these technical, policy and institutional problems were also mentioned. Maximum return from dairy operation depends on the use of animals with high milk output. Thus production of milk depends heavily on reproductive activity (Kiwuwa *et al*., 1983).

This study revealed that, to improve the productivity of cattle, different development partners have introduced modern dairy technologies. Of these technologies the use of crossbred dairy cows has been popularized in the area during the last decades. Crossing local breed with improved breeds has been done via artificial insemination (AI) and natural bull services. The purpose of crossing local breed with improved breeds is to increase milk production. Further more, the study area has a project intervention that promoted dairy technology through credit provision. All the farmers who owned dairy and dairy related technologies had a better ground to develop good experience regarding livestock management.

The present study identified 21 dairy related technologies and practices in the study areas. Anther studies have examined the use of 20 dairy technologies and practices associated with smallholder dairying in six districts of Kenya (Metz *et al*., 1995), but the latter did not assess factors associated to their adoption. In the past, smallholders adopted technologies at a very low rate. Rates of adoption of technologies by small-scale farmers who raised bovine animals in Thailand was studied by Chantalakhana (1999); This author who examined about 23 well known animal technologies found different adoption rates, a result comparable with the present study findings.

The ownership of crossbred dairy cows is a key element in the development of intensive dairy production. Grade and crossbred cows require more feed than local cows to produce milk up to their potential. Because seasonal feed shortages have been identified as constraining milk production, the development of improved feeding systems should constitute a focal point for future research. Introduction and adoption of dairy technologies in the highland areas were the logical alternative to increase the smallholder farmers' income and to minimize the risk of crop failure due to rain shortage and recurrent drought (seasonal variation). Results of these study show 26% of the farmers received credit last year for crop and animal production. Out of this the credit provision for dairy production was only 10%. These credit facilities for animal production and reproduction can be useful in diversifying the income of smallholder households. Such intervention increases household disposable income while improving children and household's access to nutrition.

Finding of this study indicated that adoption of crossbred dairy cows and complementary technologies by smallholder farmers all owed to improve the standard of living of smallholders through the sale of milk and home consumption. This observation is in agreement with the results of Baltenweck and Staal (2000) and Kelay (2002). The cost of crossbred dairy cow was relatively high, and the dairy enterprise is risky. Scarcity of livestock feed, shortages of grazing land, livestock disease, low genetic potential and lack of livestock development services were stressed as constraints by most of the households in the area. Further more, production constraints vary among respondent farmers and this agreed with the findings of Kelay (2002). On the contrary, result of this study indicate that farmers had access to an organized milk collection center and dairy processing facilities managed by smallholder farmers to sell their fresh milk, which is bulky, highly perishable, and sold daily in the four study 'kebeles'. Baltenweck and Staal (2000) reported inaccessibility of fresh milk market in Kenyan highlands. Though, marketing risks to sale fresh milk is not a common problem in the area, the price of milk and other dairy products were the serious concerns indicated by smallholder producers. Access to credit was also found to play a role in the adoption of dairy and dairy related technologies, which was agreed with the reports of Baltenweck and Staal (2000) in the determination of adoption of dairy technology in the Kenyan highlands.

The main reasons for keeping crossbred dairy cows compared to indigenous breeds are their higher milk potential, milk that is both consumed at home and sold. These were in agreement with the reports of (Baltenweck and Staal, 2000; SDDP, 1998). Farmers with crossbred cows are usually market oriented since the higher milk production level enables them to sell the surplus milk.

For many smallholders, adoption of dairy cattle and their related technologies were a promising way to increase their income. Yet, the production constraints are high, which were comparable with the result of Baltenweck and Staal (2000). Dairy cooperatives have been created to organize the milk collection and to facilitate the marketing of the milk in the area since 1997. Some dairy cooperatives offer other services, like veterinary services (drugs) and animal feeds on credit basis to members of their cooperatives. Availability of marketing channels in the study area and elsewhere in the highland was thus one of the important factors to foster the adoption of dairy and dairy related technologies.

In this study, participatory appraisal (PA) was conducted in the study area to have a better understanding of the prevailing dairy and dairy related technologies in the area, to identify problems and set priorities.

The PA study revealed that livestock benefits such as milk, draft power, manure, sale of animals and products increase it in this study sites. In contrast, milk use such as milk for home use and cosmetics decreased. Benefits of livestock have increased with considerable amount in the study area. More over the incidence of livestock disease status reduced because the increment of milk produced to generate income and to improve the revenue of smallholder households in the area. Further more, in this study, improved livestock management including regular disease treatment and disease prevention has increased productivity of animals in the area. This is in agreement with the reports of (Mogga, 2001).

In the study area, the uses of private veterinary services were increased. Income from daily milk sell also contributed to the increased general livelihood of the smallholder dairy producers. The present study showed that service provided by government is cheaper than the private veterinary service provider, but in contrast, the drugs are not available as private service providers in the area.

As per the PA results cattle diseases such as anthrax, black leg, ticks, and liver fluke are significantly decreased. On the other hand, cattle diseases especially production diseases such as mastitis, foot rot, and reproductive diseases have increased while pasteurolosis have remained still static similar to the before the interventions. Even though some parts of the area is water logged which harbor liver fluke the informant groups confirmed that the parasite infestation is decreasing. In the contrary, leech (*Limnatis* and *Dinobdella*), the two genera of aquatic leeches with veterinary importance in domestic animal, were/are a serious problem.

Among the many use types, milk for cosmetics was decreased in the study areas. This might be due to the availability of other body lotions available in the market especially for the younger females. This survey results showed that only improved feeding in the form of concentrates has been adopted by 3.5 FC in the study area. This implied that concentrates might then substitute for land that would other wise have to be used for forage production. Improved feeds would lessen the reliance on grazing land and makes stall-feeding possible with more productive animals (crossbred cows). Concentrate feeding is a land and labor saving technology.

6. CONCLUSIONS AND RECOMMENDATIONS

In Girar Jarso "wereda" dairy cows represented the highest proportion of the herd followed by draft oxen, calves, heifers and bulls. The system of production was semi-intensive, nearly in two third of the farms. Feed shortage, small land size and health problems were the three top livestock production constraints identified by the smallholder dairy farmers. The land use pattern showed that the highest proportion of land was used for crop production and grazing land was very limited. Feeding, selling of livestock and handling of animals against diseases are mostly the responsibilities of the male household members whereas their female counterparts are responsible for milking, barn cleaning, butter making, and selling of livestock products. A total of twenty-one available dairy technologies with different degrees of adoption were identified. Cross breeding, vaccination/veterinary services, and checking for mastitis were the most adopted technologies, while record keeping, straw chemical treatment and pasture improvement were the least adopted ones. Factors influencing adoption of dairy and dairy related technologies often focus on characteristics of the household head, the nature and source of information before adoption, the characteristics of the farm to adopt new technology, and location of the household, in that order.

Sex, age, farm experience and level of education were found factors that favored the likelihood demands for dairy technology. These suggest the important role of factors in stimulating demand for technology use. The utilization of the available technologies increases milk production performance of dairy cows five folds compared to the traditional technologies. Smallholder farmers appreciated technology use to be economically worthwhile. However, there are production and adoption constraints to sustain production of crossbreds under; one of which was the absence of a reliable milk market. Technologies adapted by the smallholder sector could, therefore, be considered of crucial importance in improving the dairy sector.

In line with the above conclusion the following recommendations are forwarded:

- Feed shortage is the principal constraints for livestock and technology uptake in the area. Therefore, it is important to improve the existing feed resource through management and establish an integrated approach to overcome feed shortages.

- Instead of purchasing improved dairy breeds from different sources it is advisable to establish natural bull stations under small-scale level.
- Expansion and promotion of dairy technological packages targeting to reach very large number of smallholder farmers should get due attention to increase milk production.
- Promotion of dairy cooperatives' role in planning, implementation and dissemination of dairy technologies to small-scale dairy farmers should be initiated.
- Developing and applying appropriate dairy production technologies that allow smallholder farmers to secure their livestock assets and that could lead to specialization and commercialization should be sought.
- Further detailed studies encompassing wider areas and production systems should be conducted in order to substantiate and consolidate the findings of the present study.

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8. ANNEXES

Annex 1. Conversion Factors used to estimate Tropical Livestock Unit (TLU)

Types of animal (species)	Indigenous breed		Crossbred	
	Live weight (kg)	TLU	Live weight (kg)	TLU
Cow	250	1.0	380	1.5
Heifers	125	0.5	150	0.6
Oxen/Young bull	250	1.0	300	1.2
Calve	50	0.2	50	0.2
Sheep & Goats	22	0.1	-	-
Horse & Mule	200	0.8	-	-
Donkey	90	0.4	-	-

Source: Variko, T. (1991)

Annex 2. Questionnaire sample

Instruction: -

The questionnaire should be filled after you have introduced your self and discussed all the points with the selected farmers.

For closed questions circle the letter(s)

For open questions, write farmers' responses clearly and shortly

Use only pencil

Questionnaire Number ____________________Date of Interview ____________

Name of the enumerators ___________________ Name of the Woreda____________

Peasant Association (PA) ______________Village Name ___________________

Farmers Name _________________

Socio-economic characteristics

Please tick (√) the appropriate answer in the box or give short answers in the space provided.

1.1. Sex Male ☐ ☐ Female

Age ___________ Years

Marital status

Unmarried ☐ Married ☐ Divorced ☐ Widowed ☐

If married number of children ☐

Did you participate in the literacy program Yes No? ☐

Can you read and write? Yes ☐ No ☐

Level of education ___________________________

Number of years since started farming __________years

Family status (level of wealth) Poor farmer ☐ Medium ☐ Wealthy ☐

Labour utilization in dairy production

2.1 How many of your family members are working full time on your farm? _____________Male___________ Female _________Total_____________

2.2 Number of family members working part- time on farm_________ male______Female_____ Total___

2.3 For which activities do you allocate more working hours per day?

a) For dairy production_____hrs/day

b) For crop production _____hrs/day

2.4 How many days do your work on your farm per week?

During peak period_____Hours/week

During slack period_____hours/week

2.5 Do you have family labor shortage? Yes ☐ No ☐

2.6 If yes, for which part of the farming activities do you face shortage of labor.

Land preparation (sowing, weeding, and harvesting threshing ☐

Livestock management (feeding, keeping, milking, cleaning) ☐

Other specify____________

2.7 In your opinion, is a labor a major problem? Yes ☐ No ☐

2.8 If yes, how do you solve the problem during peak period?

Hiring ☐ Labor exchange (debo) ☐

Other (specify)___________

2.9 How much do you pay per day for hired labor? ____Birr/day

2.10 What are the factors that limit number of working days in your area?

School ☐ Home making ☐ Disabled ☐ Old age ☐

Religious or public holydays ☐ Others (please specify)__________

2.11 Do you do other income generating activity (off- farm employment)?

Yes ☐ No ☐

2.12 If yes, specify the level of contribution of this activity to your total income:_________%

2.13. Share of responsibility in dairy management (rank form 1-5)

Description	Husband	Wife	Children	Hired labor	Other (specify)
Feeding					
Herding					
Milking					
Barn cleaning					
Butter Making					
Watering					
Selling Livestock					
Selling of Livestock products					
Handling diseases/Health care					
Others (specify)					

2.14. Management system

Extensive ☐ Semi-intensive ☐ Intensive ☐

Other (specify)___________

2.15. How is milk produced on the farm partitioned for different uses?Home consumption________% Sold as liquid milk______% Processed to butter and cheese for sale _____________% Others (please specify) ________%

2.16. If you sell milk, what is the price of one liters of milk?

During wet season ________birr during fasting periods______birr

During dry season _________birr

Land holding (ha)

3.1 Land use pattern and holding (ha)

Description	Own
Total land holding	
Crop land	
Fallow land	
Grazing land	
Other (specify)	

3.2 Do you use communal grazing land? (Tick one)

Yes ☐ No ☐

3.3 Types of grazing land and owner ship (indicate the area in ha.)

Description	Own	Communal
Open grazing land		
Tree covered improved Forage		
Swamps/water logged		
Other (Specify)		

3.4 If Q. 3.2 is yes which animal given priority (rank 1-4)

Description	Own	Communal
Cattle		
Sheep and Goats		
Equine		
Other specify		

3.5 Is there grouping of animals during grazing Yes ☐ No ☐

Utilization of grazing system

Description	Dry season	Wet season
Un herded		
Herded		
Paddock		
Zero grazing		
Semi zero grazing		

Crop production

Crop type(major)	Wet season		Dry season	
	Area in ha 2005/6	Yield in Qt. 2005/06	Area in ha. 2005/06	Yield in Qt. 2005/06

Farm characteristics

3.1.1. What is your main farming activity?

Livestock production only ☐

Crop production only ☐

Mixed farming ☐

Source of in come (pleas rank 1-4, (1 representing highest income and 4 least income)

Lives stock sale ☐ crop sale ☐ off farm activity ☐

Other (specify)

Production system characteristics (mostly computed after observation**)**

Livestock population

Livestock type	Number of livestock	TLU	Breed type		
Cattle			Local (number)	Crossbred	Exotic
Calves <1 yrs					
Heifer					
Bulls					
Oxen					
Cows					
Small ruminants					
Sheep					
Goat					
Equines-Horses					
Donkey					
Mules					
Poultry					
Beehives					

Major live stock purposes (use)

4.2.1. Describe the reasons why you keep livestock

Purpose	Cattle		Sheep and goats		Equine		Others	
	1	2	1	2	1	2	1	2
Meat								
Milk								
Work power								
Social prestige								
Ceremonies								
Hide								
Manure								
Transportation								
Threshing								
Other specify								

Note: 1* Tick the purpose 2** Rank according to priority 1 to 10, 1 representing highest use and 10 least use

Housing condition

Types of animals	Type of housing				
	Open without enclosure	Corrals	Separate barn	In family house	Other specify
Calves					
Dairy cows					
Local					
Crossbred					
Small ruminants					
Equines					

Constraints of livestock production (put in rank 1-8)

Constraints	Cattle	Equines	Small ruminants
Shortages of feed			
Shortages of grazing land			
Health problem			
Low productivity			
Predator			
Water scarcity			
Scarcity of labor			
Other specify			

If you use cow for milk production, fill the table

Breed type	Age at first calving	Frequency of milking day
Local		
Cross		

4.6. What are the major constraints of dairy production technology in your area?

What is the means you use for cattle reproduction?

a. AI b. Breeding bulls (cross) c. Local bull

Do you have crossbred dairy caws at present?

a. Yes b. no

-Specify the year you obtained____________________

Have you ever used AI services?

A. yes B. no

Have you ever used bull services? A. yes B .No

Have you received crossbred bull? A .yes B. no

-Specify the year you Obtained_______________

How you were Obtained Crossbred caws/bulls?

Purchased from FINNIDA project

Purchased from local market

Taken as credit from MOA/SDDP

Used AI/Bull services

Breeding practice

Breed and Age of dairy cow owned mark with "x" staricks.

Cow number	Indigenous (Native)	Crossbred				Exotic	Age
		<25%	25.5-50%	50.5-75%	Unknown		

What was the average quality of milk you got from your cow last time an

Haw long did you milk you cow? _______________________________

Cow number	Daily milk yield			Lactation length (months)
	Beginning lactation	Middle of lactation	End of lactation	

Do you have any plan to improve the milk productivity of dairy herd?

A. Yes B .No

If yes how do you want to improve the milk productivity of your herd?

_____________ _____________ ___________ _____________

4.17. What was the age of your cows when they gave birth to their first calf?

Cow number	Local	Cross

4.18 When did your cows give their last calving and previous calving?

Cow number	Last calving date	Previous calving date

4.19 Do you have any plan to improve the reproductive performance of your dairy herd?

A. Yes B. No

If yes how do you want to improve reproductive performance of your herd?_____________

___________ _______________ ________________

Are you selecting the bull serving your cow? A. yes B. No

What is the breed of the bull (semen) for AI users you are using for making? ___________

________________ ____________________

If you are not deciding in the selection of bull, who is deciding? _________ ____________

Do you need or keep the performance of your breeding cattle?

A. Yes B. No

5. Livestock diseases/parasites found in the area

5.1 What are the major diseases /parasites of livestock in your area? (mention according to order of occurrence)

a____________ b____________ c___________d__________

5.2 Types of disease and animal attached (put1-11 in order of importance for each class of livestock)

Types of disease parasite	Live Stock Close							
	Calves	Heifer,	Cow	Bull	Oxen	Small ruminants	Equines	Other
Internal parasites								
Lumpy skin disease								
CBPP								
CCPP								
External parasite								
FMD								
Anthrax								
Sheep Pox								
AHS								
Black leg								

5.4. Describe types of disease(s) that is /are/ s serious problem (s) to the area._______

____

5.5. Which one of the bread highly susceptible and less resistant to disease?

A. Local B. Crosses

5.6. At what season does high death of cattle have been observed to diseases in your area?

____

5.7. Have you ever got animal health services? A. Yes B. No

5.8. If yes, who has given health services for livestock in your area?

A. MOA B. NGOs C. Other (Specify) ______________________

5.9. Animal health service during 2005/6.

Types of Livestock	Types of diseases/ parasites	Number of Live stock served (2005/6	Types of Vet-service given during 2005/6 and their frequency		
			Treatment	Vaccination	Total Cost
Calves <6m					
Heifers					
Cows					
Bulls					
Oxen					
Sheep					
Goats					
Horses					

5.9. Measure taken (Way of treatments) or prevention of theses diseases

5.9.1. Modern A. Yes B. No

5.9.2. Traditional A. Yes B. No

5.9.3. Traditional Way Why?

A. It is more healer B. Lack of veterinarian C. Lack of money

D. Drugs not available E. Other (Specify) _________________

For What Diseases Vaccination are given____

Feeding dairy cattle

A. Grazing (hrs) ___________

B. Hay (kg) ______________

C. Crop residue (kg) ______

D.Concentrate (kg) _______

E. beverage by products (lit) ___________

F. Mineral salts (mg) ________________

G. fodder beet (kg) __________________

6.1. What are the major Livestock feeding systems?

A. Free grazing (full time)

B. Grass from cut and carry /free grazing)

C. Rotational grazing D. stall-feeding

6.2. What was your source of feed for cross bred cows last year? _________________

6.3. Do you grow tree Lucerne and fodder beet? A. Yes B. no

6.4 Do you grow vetch/oat last year? A. Yes B. no

6.5 Do you feed concentrate feed for dairy cows? A. Yes B. No

Income

7.1 What is the main source of your income?

A. Crop production B. livestock production C. both

D. Other (specify)___________________

What is your monthly income? ________________EB

Credit provision

8.1 Do you get credit lat year? A. Yes B. No

8.2 If yes, who did provide you? A. AID bank B. MOA C. NGOs D. Other (specify)__________

8.3 For What development activities did you get credit during last year? (Specify the amount)

to purchase form in puts ______birr

To livestock (sheep, goat, poultry, other) _________birr

To purchase crossbred cow/bull ______birr

Other (specify) ___________ birr

8.4 On what basis did you get credit?

A. Yes B. No

Specify the year: ___________ Amount obtained__________________

8.6 Who have more responsibility to make decision on the credit taken? A. husband B. wife C. both

If you have not got credit/specify the reasons__________________________________

____

If you have not used credit so got, what are the main reasons?

A. Due to high interest rate

B. Shortage of down payment

C. Have no capacity to repay the loan

D. Inaccessibility to credit e. other specify_____________ ________________

Extension services

9.1 Do you have awareness a bout dairy technology? A. Yes b. No

If yes which of the following have you heard so for?

A. Crossbred cow B. AI service C. bull service D. Forage development E. other (specify) ________________

How frequent did the development workers visit you and your form last year?__________ times per month. A. Once B. Twice C. Three times D. If more, specify_______

How many times did you receive extension advice on dairy cow Husbandry? __________ Times per month A. once B. twice C. three times D. if more specify __________

What are the problems that you have faced in using crossbred dairy cows?

A. Land shortage B. labor shortage C. feed shortage D. lack of government assist once E. health problem F market problem G. The forming land is too small to under take animal rearing H. lack of credit regarding crossbred dairy cows I. It costs much for its management J. Other (specify) ______________________

If not used, have you heard / observed about anyone of dairy technologies or when other farmers were using crossbred technologies? A. Yes B. No

If yes, what was source of information? A. Farmers B. extension agent C. other (specify) _____________

If yes, what was source of information? A. Farmer s B. extension agent C. other (specify)

If yes, why have you not used it so far? A. ___________B.____________

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

a. Reduction of risk b. crossbred cows too expensive c. shortages of feed d. no accessibility to crossbred cows e. high cost involved

If you used, what advantage do crossbred cow over local bred cows? A. To reduce aver stocking B. to increase milk yield C. to prolong lactation length D. other (specify)________________

. Institutional support and Technology Options

10.1 Is there any government, private, NGOS etc, work area? A. yes b .no

If yes, which organizations are working on dairy development? a.________________ b._____________________

Have you been supported by any of these organizations to improve dairy development activities? A. Yes B. No

If yes, specify the supports you have got so far? A. __________ B. _________

Year of adoption of dairy technology? ____________

Source of acquire of dairy cattle /G/C/ A. purchasing B. Assistance of development project on credit basis C. AI D. Natural service

Do you currently own any of the following assets (radios, tape etc) a. yes b. no

Please, mention all adoption constraints associated with dairy production in your area? ____

Annex 3. Questionnaires sample of participatory Appraisal Check List formats

Form 1;

Benefits Obtained from improved production

Date_____________ Group____________ Area_____________

Number of respondents/Participants____________

Method: Proportional piling, Scoring: before and after adoption of dairy Technology

Benefits	Before period (Score)	After period (Score)	Comment from participants
1			
2			

Checklist questions

Think of eight (8) benefits, which can be obtained from healthy dairy animals, If 100 pile of stones / seeds represents the benefits before the dairy technology was established in the area, divided this pile according to the mentioned benefits.

Why this one has the smallest or why is that one are the bigger pile?

Now with the presence of dairy production technology in the area is there increase, decrease or remains the same of the benefits, increase, decrease or let the pile remains the same and make the scoring again or the same mentioned benefits?

Form 2; Milk production

Milk use categories

Date___________ Group__________ Area___________ Number of participants_________

Date of establishment of Dairy technology /milk unit/ in the area_________

Method: Proportional piling, Scoring: before and after adoption of dairy Technology.

Uses of milk in the area	Before period (Score)	After period (Score)	Comment from participants
1			
2			
3			

Checklist questions

What are the different uses of milk in this area?

If 100 seeds represent the daily quantity of milk produced in the herd, divide this seeds/stones to the mentioned uses.

Has this increased, decreased or remained the same after the adoption of dairy technology. Reduce increase or leave the heap, as it is then score the uses.

Form 3: Disease status before and after starting use of modern veterinary services

Date_______________ Group______________ Area_______________

Number of participants______________

Method: Proportional piling, Scoring: before and after starting use of modern veterinary services

Disease	Before period (Score)	After period (Score)	Comments from participants
1			
2			

Checklist questions;

What are the major diseases that kill Livestock in your area?

If 100 stones/seeds are the animals that died from these diseases which disease killed what number of animals before the adoption of technology in the area.

Why do you put more stones/seeds on this disease than that?

Why do you choose this as the most important disease and that is the least?

Has the death increased, decreased or it remained the same, adds to the heap decrease or remains the same and scores for the situation after the adoption of dairy technology.

Observational/Comments____

Form 4 Breeding systems used to obtain improved animals.

Date_______________ Group_____________ Area______________

Number of respondents/_______________

Method: Proportional piling, Scoring: before and after adoption of modern breeding technologies

Breeding system	Before period (Score)	After period (Score)	Comment from respondents
1			
2			
3			

Checklist questions

What are the major breeding systems (s) that you use in your area? If this pile of stone/seeds represents the caws obtained service /method/ before dairy technology was established in the area, divided this pile according to the mentioned breeding systems.

Now with the presence of dairy production technology in the area is there increase, decrease or let the pile remain the same and mark the scoring again on the same mentioned breeding systems?

Form 5 Feeding systems

Date_________________ Group________________ Area_________________

Number of respondents___________________

Method: Proportional piling, Scoring: before and after adoption of modern feeds and feeding technologies

Grazing System	Before period (Score)	After period (Score)	Comments from respondent
1			
2			

Checklist questions

What are the different uses of feeding/grazing/ systems in this area?

If 100 seeds represent the feeding system (s) in your area, divide this seeds/ stones to the mentioned uses/systems.

Has this increased, decreased or remained the same after the adoption of dairy technology.

Reduce, increase or leave the heap, as it is then score the uses.

Observations/ comments____

____

Form 6 Use of different types of veterinary services before and after the dairy technology transferred to the area.

Date____________ Group__________ Area___________ Number of respondent________________

Method: Proportional piling, Scoring: before and after adoption of modern animal health technologies

Animal Health Services	Before period (Score)	After period (Score)	Remark
1			
2			

Checklist question

Think of six (6) uses of different types of veterinary services in your area.

If 100 piles of stones/seeds represents the veterinary services before the dairy technology was/ were transferred in the area, divided this pile according to the mentioned services.

Now with the presence of dairy technology in the area is there increase, decrease or let the pile remains the same and make scoring again on the same mentioned veterinary services

9. CURRICULUM VITAE

1. Personal data

Name	Tolera Debella Bobosha
Date of birth	October 21, 1971
Places of birth	Oromia, West Wollega zone, Nedjo district
Nationality	Ethiopian
Martial status	Married
Children	Two
Religion	Christian (protestant)
Membership	___________________________
Contact address	Oromia Region, North Shoa Zone, Girar-Jarso Rural and Agricultural Development Office P.O. Box 144, Fitche North Shoa Zone, Oromia, Ethiopia E-mail: _saratolera@yahoo.com Tele 251-1- 911775059/0111351585/0114336480

2.Educational background:

Elementary school- 1979- 1984/85

Junior secondary school - 1885- 1988/89

Senior secondary school -1989/90 -1992/93

Achievement: ESLCE

Higher education

Alemaya University of Agriculture, Departments of Animal sciences

Sept, 1993- July, 1996

Achievement: BSc degree in Animal Sciences

3. Work experience: October, 1996 to August, 2004 in District level in different position at Ministry of Agriculture

A brief account of my job experience is described below:

In year 1996- 1997:- Livestock expert at district level

In year 1997-2000:- Smallholder Dairy Development Project Coordinator at district level.

In January 2001-April 2001:-Deputy head of Agricultural Extension Department at district level.

In year November 2001-June 2002 and October 2002 to 2005:- Head of Girar-Jarso district Agricultural development Department.

September 2005 to June 2007 study at Addis Ababa University, Faculty of Veterinary Medicine.

4.Paper writing:

A review on smallholder dairy production technology transfer and adoption constraints. Seminar on current topics (2006) FVM, AAU

Study on Smallholder Dairy Technology Transfer and Adoption Constraints in mixed farming system in Girar Jarso Woreda North Shoa Zone of Oromia Regional State, Ethiopia, Debre Zeit. MSc Thesis (2007)

Additional Training:

1. In year 1999 a three weeks (21days) training course on dairy technology and milk unit management held at ILRI, Debre Zeit station and Asella dairy farm, Ethiopia.
2. In year 2000 a five days training course on feed resource and forage development held at International Research Institute, Ethiopia.
3. In year 2002 a nine days training course on dairy processing and marketing held at held at International Research Institute, Ethiopia.
4. In 2004 a six days training course on a result based monitoring and evaluation held at Nazareth, Ethiopia.

Languages: Afan-Oromo, Amharic and English: Listening, Speaking and writing.

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10. SIGNED DECLARATION SHEET

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any University and that all sources of material used for the thesis have been duly acknowledged.

Name: Tolera Debella: ____________________________

Date of submission: June 2007.

This thesis has been submitted for examination with our approval as University advisors:

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