Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.7, No.13, 2017

Smallholder Dairy Production Technology Transfer and Adoption Constraints in Mixed Farming System in Girar Jarso Woreda of North Shoa Zone Oromia Regional State, Ethiopia

TOLERA DEBELLA BOBOSHA
Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit

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 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.
Keywords: Dairy technology, reproduction performance, adoption, market oriented, constraints

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 tons 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 output 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. With this, the study was initiated to fill this gap.

2. 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.

2.1. Study procedures

2.2.1. 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.

2.2.2. 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.

2.3. 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

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 1). 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 1. Total numbers of smallholders that participated in the study

District	Sample Kebele	No HH	Sample Size	Proportion of the tota l(%)
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

Source: Data obtained from Girar-Jarso District MoARD* office (2006) , * Ministry of Agriculture & rural Development

2.4. Methods of data collection

2.4.1. 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.

2.4.2. 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.

2.4.3. 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 2 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 2. Parameters assessed by groups of smallholder dairy farmers using PA method

Parameters	Change of an indicator to be measured	Methods applied
Disease control	Effects of improved health service	Before and after proportional piling
Animal health sevices	Preferences for service providers	Pereference proportional piling
Production	Benefits derived Milk usage	Before and after proportional piling
Breeding	Preference	Pereference proportional piling
Feeding	Preference	Pereference proportional piling

2.5. 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 release11.5, 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.

2.6. 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).

3. Results

3.1. Results of questionnaire survey and farm visit

3.1. 1. Description of household characteristics

Some demographic characteristics of the smallholder dairy farmers are summarised in Tables 3 and 4. 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 3. 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 Holding(inhectares)	≤ 2	35	17.5
	2.1 - 4	126	63
	>4	39	19.5
Farm Experiences	≤ 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	Illitrate	79	39.5
	Basic Education	43	21.5
	Praimary level	43	21.5
	Junor &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 1male to 0.12 female (Fishers' Exact Test = 0.068), which is statistically not significant at ($p>0.05$).

3.1. 2. Description of livestock holding characteristics

Table 4 illustrates 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. 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 4 Livestock herd size and composition in TLU (N= 200) smallholder dairy farmers, 2006/2007

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

1TLU = 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 5. 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 5. Cattle herd composition breed, sex and age groups,(200 smallholder dairy farmers, 2006/2007)

Category	Breed			
	Indigenous	Crossbred	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.

3.1.3. Dairy cattle production and reproductive performance

Table 6 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 7. 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 6. Summary of reproductive and milk production performance of cattle, (200 smallholder dairy farmers, 2006/2007)

Performance Parameters	Breed				P-values
	Local		Crosses		
	Mean	SD	Mean	SD	
Age at first calving(years)	4.7	0.62	3.4	0.56	0.000
Average milk yield(lit/day/cow)	2.5	0.42	6.7	2	0.000
Average lactation length(months)	219	56.8	314	56	0.000
Average milk yieldper lactation(lit)	565.4	233.7	2216	1081.8	0.000
Average weaning age(months)	5.9	0.95	5.7	2.26	0.510*
Calving Interval(months)	24	1.82	21	2.46	0.000

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

3.2. Dairy technology adoption

Table 7 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 than11 dairy technologies of which 17% were female respondents. This trend indicates the technology uses by female were increased.

Table 7. 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		
Crossbreeding	183	91.5
Maitain breeding Bull	14	7
3. Reproductive technonolgy(AI)		
Pregnancy test	73	36.5
Artificial insemination(AI)	73	36.5
4. Management		
Castration(tradition)	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 mastities	190	95
Vacination	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 8 shows list constraints of technology uptake as indicated by smallholder farmers.

Table 8. Constraints of technology up take in the study area (200 smallholder dairy farmers, 2006/2007)

Constraints	Frequency	Percentage
Land Shortages	188	94
Labor shortages	167	83.5
Feed shortages	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

3.3. 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%.

3.3.1. Animal diseases status

Table 9 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 9. Results of animal disease status scoring by smallholder farmers using preference proportional piling (200 smallholder dairy farms, 2006/2007)

Medical Name(Lacal Name)	Group of informants(N= 4)	
	Before/After	FC
Anthrax(*Abbasenga*)	70/30	-0.6
Blackleg(*Abbaagorba*)	125/95	-0.2
Mastitis(*Dhukkuba mucha)*	15/60	3
Foot and Mouth Disease/FMD(*Kebenecha*)	35/38	0.1
Foot rot(*O'echo*)	10/15	0.5
Reproductive problems	18/30	0.7
Leech(*dhulaandhula*)	45/72	0.6
Ticks(*Silmii*)	22/15	-0.3
Liver fluke(*Dodoo*)	50/35	-0.3
Pasteurolosis	5/5	

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

3.3.2. Benefits obtained from dairy production

Eight items were identified as indicators to assess benefits obtained from dairy farming. Table 10 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 10. Benefits of dairy production as scored by groups of smallholder farmers using proportional piling method (200 smallholder dairy farms, 2006/2007)

Indicators	Group of respondents(N= 4)	
	Sores "Before"/"After" situations	FC
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

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

3.3.3. Breeding and feeding systems

Table 11 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 11. Breeding and feeding systems as identified and scored by groups of smallholder farmer using proportional piling method (200 smallholder dairy farms, 2006/2007)

Indicators	Group of informants(N= 4)	FC
	Sores "Before"/"After" situations	
Breeding		
Natural breeding	350/330	-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

AI* Artificial Insemination

4. 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 + 0.62 years (56.4months) and 3.4 + 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 + 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) and3.4years (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 to27 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 income 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. Furthermore, 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. Another study 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. Furthermore, 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. Furthermore, 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 otherwise 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.

5. 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, and 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 and Further detailed studies encompassing wider areas and production systems should be conducted in order to substantiate and consolidate the findings of the present study.

6. References

Aaron, I. (1981): Modernization of Agriculture in Developing Countries Resource Potential and Problems. A Wiley – Inter Science Publication, New York.

Ababu, D. (2002): Evaluation of Performance of Boran Cows in the production of Crossbred Dairy Heifers atAbernosa Ranch, Ethiopia. M.Sc.Thesis. Alemaya University of Agriculture. Alemaya, Ethiopia.

Abdnasir, I.B. (2000): Smallholder Dairy production and Dairy Technology Adoption in the mixed farming in Arsi highlands, Ethiopia. PhD, Thesis. Humboldt University of Berlin, Department of Animal Breeding in Tropics and Sub tropics, Germany.

Agriculture and Rural Development Office of the North Shoa zone (2006): Basic data for the zone. Un published Document, Fitche, Ethiopia.

Agyemang, K., and Nkhonjera, L.P. (1990): Productivity of crossbred cattle on smallholder farms in Southern Malawi. Trop. Anim. Hlth., 22: 9 – 16.

Ahmed, M. M., Ehui, S. and Yemesrach, A. (2006): Dairy Development Ethiopia Socio Economic and policy research working paper 58 ILRI (International Livestock Research Institute), Nairobi, Kenya, Pp 1-42

Aiumlamai, S. (1999): Dairy management and animal health. In: Falvey, L. and Chantalakhana, C. (eds.), Smallholder Dairying in Tropics. ILRI (International Livestock Institute), Nairobi, Kenya. Pp 226.

Albero, M. (1983): Comparative performance of F1 Friesian x Zebu heifers in Ethiopia. Animal Production, 37: 247 – 252

Alemayehu, M. (1998): The Borana and the 1991-92 Drought: A Rangeland and Livestock Resource Study,

Intitute of sustainable Development, Addis Ababa, Ethiopia.
Alemu, G.W., Aemayehu, M., Sendros, D., Seyoum, B., and Alemu, T. (2000): Status of dairy research in Ethiopia. In: The role of village Dairy co-operatives in dairy development: prospects for improving dairy in Ethiopia. In: Proceeding of a workshop SDDP, MoA, Addis Ababa, Ethiopia.
Azage, T. (1981): Reproductive performance of Zebu cattle and their crosses with temperate breeds in Ethiopia. MSc. Thesis. College of Agriculture, Alemaya, Addis Ababa University, Ethiopia.
Azage, T., Tsehay, R., Alemu, G.W. and Hiskias, K. (2000): Milk Recording and Herd Registration in Ethiopia: an essential step toward genetic improvement for milk production. In: Proceedings of 8th annual conference of ESAP 24-26, August 2000. Addis Ababa, Ethiopia. Pp 91-104.
Azage, T. and Alemu, G.W. (1998): Importance of herd recording in improvements of reproduction in dairy cattle. ILRI, Addis Ababa, Pp 12.
Bachman, M. (1987): Products and processes, Possibilities and limitations of decentralized milk processing as quoted by Brokken R.F. In: Brokken R.F. and Senait Seyoum (eds), Dairy marketing in sub Saharan Africa. In: Proceedings of a symposium held at ILCA, Addis Ababa, Ethiopia. 26-30 November 1990. Pp 20.
Baltenweck, I. A. and Staal, S. J. (2000): Determinants of Adoption of Dairy Cattle Technology in the Kenya Highlands: A SPATIAL AND dynamic Approach. International Livestock Institute. Nairobi, Kenya. Pp 1-7.
Bauman, D. E. (1987): The experience in proceedings of the National invitational workshop on Bovine Somatotropine. Washington, Dc, USDA, Extension service
Bebe, O. B., Udo, and H. M. J., Thrope, W. (2002): Development of smallholder dairy systems in Kenya high lands: Adoption and impact studies.
Berhanu, B. (2001): Analysis of factors affecting the adoption of Crossbred Dairy cows in the Central highlands of Ethiopia: The cases of two districts in Salale Zone Ethiopia. MSc.Thesis. Alemaya University of Agriculture, Alemaya,Ethiopia.
Bulale, A.A. (2000): Smallholder dairy production and dairy technology adoption in the mixed farming system in Arsi High land, Ethiopia. PhD.Dissertation,Humboldt University, Berlin, Germany.
Catley, A. (1999): Monitoring and impact assessment of community-based animal health projects in southern Sudan, A Report for Veterinarians Sans Frontiers Belgium and Veterinarians sans Frontiers, Switzerland, London, IIED.
Catley, A. (1999a): Monitoring and impact assessment of community based animal health projects in Southern Sudan. A report for veterinaries sans frontiers Belgium and veterinaries sans frontiers Switzerland, London: IIED.
Central Agricultural Census Commission (CACC). (2003): Ethiopian Central Agricultural Sample Enumeration, 2001/2002, Statistical report on livestock and farm implements, Addis Ababa. Ethiopia.
Chambers, R. and Ghildyal, B. P. (1985): agricultural Research for Resource Poor Farmers: the farmer first-and-last model. Agricultural Administration, 20: 1 – 30.
Chantalakhana, C. (1999): Research Priorities for Stallholder dairying in tropics. In: Smallholder dairying in the tropics: ILRI, Nairobi, Kenya, Pp 403-416
Daniel, K. (1988): Role of crop residues on livestock feed in Ethiopia and Extensive livestock production.In: proceedings of the third PANESA Work shop held in Arusha, Tanzania, April27-30, 1987, Arusha, Tanzania, Pp 430-439.
De Leeuw, P. N. and Thorpe, W. (1996): Low input cattle production system in tropical Africa: An analysis of actual and potential cow- calf productivity In: All African conference on Animal Agriculture, Pretoria, South Africa.
De Leeuw, P. N., Omore, A., Staal, S. and Thorpe, W. (1999): Dairy Production Systems in Tropics. Flavey, L. and Chantalakhana, C. (eds.). In: smallholder Dairying in the Tropics. ILRI. (International Livestock Research Institute). Nairobi, Kenya. Pp 19-37.
DeBoer, A. J. (1981): Socio-economic aspects of dairying in developing countries. Journal of Dairy Science, 64:2453-2462.
EARO (2001): Recent Developments in Dairy cattle research. A Training Manual for Agricultural expert. Addis Ababa, Ethiopia.
EARO–HARC (Ethiopian Agricultural Research Organization-Holleta Agricultural Research Center) (2004): Recent Development in Animal Feeds and nutrition Training organized for Agricultural experts in West, Southwest and North Shewa Zones.Ethiopian Agricultural Research Organization, Holetta Agricultural Research center, Ethiopia.
Enyew, N., Brannang, E. and Rottaman, O. J. (2000): Reproductive Performance and herd life of dairy cattle with different level of European inheritance in Ethiopia. ESAP 7th Conference. Addis Ababa, Ethiopia. Pp 65-90.
Falvey, L. and Chantalakhana, C. (eds.) (1999): Smallholder Dairying in Tropics. ILRI, (International Livestock Research Institute), Nairobi, Kenya. Pp 19-340.

FAO (1999): Livestock, environment and development (lead) initiative.Livestock and Environment Toolbox.http://www.fao.org/lead/toolbox/homepage.htm.

FAOSTAT (2003): FAO statistics database on the World Wide Web http://apps.fao. Org/ (accessed February, 2003)

Feder, G. R., Just, R. E. and Zilberman, D. (1985): Adoption of Agricultural innovation in developing countries: A survey on Economic Development and cultural change: Smallholder Dairy technology in coastal Kenya: An adoption and Impact study.ILRI, Addis Ababa, Ethiopia.

Frederico, M. and Hansen, P. J. (2003): Pregnancy diagnosis in the cow: Department of Animal Sciences, University of Florida.

Getachew, A., Hailu, B., Workneh, N. and Gezahegn, A. (1993): A survey of farming systems of vertisol areas of the Ethiopian high lands. In: Improved managements of vertisols for sustainable crop-livestock production in Ethiopian high lands.Synthesis Report. Addis Ababa, Ethiopia.

Getachew,F. and Gashaw,G(2001): The Ethiopian dairy development policy: Draft Policy Document. Ministry of Agriculture /AFRDRD/ AFRDT/ Food and Agriculture organization/SSFF, Addis Ababa, Ethiopia

Girar-Jarso District Agriculture and Rural Development (2006): Baseline Data for the District. Un published Document. Ficthe, Ethiopia.

Haile-mariam, T. (1995): Whole Farm Evaluation of Improved Management and Feeding Strategies for Crossbred Dairy Cows in Selale Area, Central Highlands. MSc.Thesis, Alemaya University of Agriculture, Alemaya, Ethiopia.

Holloway, G., Nicholson, C., Delgado, C., Staal, S., and Ehui, S. (2000): How to make milk Market: A case study from Ethiopian high lands. Socio- economic and policy research working paper 28 ILRI (International Livestock Research Institute), Nairobi, Kenya, Pp 2.

Kaitho, R. J., Eddleman, B. R., Chen, C. C., McCarl, B. A., Angerer, J. and Stuth, J. W. (2001): Policy and Technology Options for Dairy Systems in East Africa: Economic and Environmental Assessment. A paper presented to the SANREM CRSP Research Scientific Synthesis Conference. November 28-30, 2001. Athens, G.A., Pp 4-5.

Kelay, B. (2002): Analysis of dairy cattle breeding practices in selected areas of Ethiopia. PhD, Thesis, Humboldt University of Berlin,Department of Animal Breeding in the Tropics. Berlin, Germany.

Ketema, H. and Tsehay, R. (1995): Dairy Production System in Ethiopia. In: Proceedings of the workshop entitled: Strategies for market orientation of small-scale milk producers and their organizations 20-24, March, 1995.Morgono, Tanzania.

Kirsopp-Reed, K. (1994): A review of PRA methods for livestock research and development.RRA. Notes. 20:11-36.

Kiwuwa, G. H., Trail, C. M., kurtu, M. Y., Worku, G., Andeson, F. D.and Durkin, J. (1993): crossbred Dairy cattle productivity in Arsi Region, Ethiopia.International Livestock Center for Africa (ILCA) Research Report No.11. Addis Ababa, Ethiopia.

Mahadevan, P. (1966): breeding for milk production in tropical cattle.Technical Bulletin No. 17.Commonwealth Agricultural Bureaux, Edinburgh.

Mahanta, K .C. (1987): Handbook of Animal husbandry.First edition.Published by Omsons publications.Printed by united printing Co., Maujpur, and Delhi-53. Guwahati, New Delhi.

Masama, E., Kusina, K.T., Sibanda, S. and Majoni, C. (20030: Reproduction and Lactation
performance of cattle in smallholder dairy system in Zimbabwe. Trop. Anim. Hlth. Prod., 35:117 – 248.

McDowell, R. E. (1972): Improvements of livestock production in worm climates, W.H. Freeman and Co, San Francisco.

Mekonnen, H. .M. and Goshu, M. (1987): Reproductive performance of Fogera cattle and their Friesian crosses. Eth. J. Agric. Sci., 9:95-114.

Mekonnen, H. M., Asmamaw, K, and Courreaw, J. F. (2005): Husbandry Practices and Health in smallholder dairy farms near Addis Ababa, Ethiopia, Preventive Veterinary medicine, 74:99-107.

Metz, T., Kiptarus, J., and Muma, M. (1995): diffusion of Dairy Technologies in six Districts of Kenya: A Survey of Smallholder Dairy Farmers in Kakameya, Uasin Gishu, Nandi, Kiambu, Nakuru, and Nyeri Districts. Monitoring and Evaluation unit, National Dairy Development Project, Mistry of Agriculture, Livestock Development and Marketing, Nairobi, Kenya.

Microsoft Office Excel (2003): Microsoft Corporation 2003 (11, 5892, 5606).

MOA and FINNDA (1996): Selale peasant dairy development and rehabilitation project, Ethiopia report of evaluation study in blue series. Addis Ababa, Ethiopia.

Mogga, N. K. (2001): A description of primary animal health programme in selected area of Southern Sudan and Ethiopia and first assessment of programme impact. Freie. Universsitat Berlin and Addis Ababa University, MSc., Thesis. Berlin, Germany.

Moriner, J. C. (1996): Participatory Epidemiology: Methods for the collection of Action Oriented

Epidemiological Intelligence, FAO Animal Health Manual No 10. Rome: Food and Agriculture Organization, Rome.

Mukosa – Mugerwa, E. D, Ephraim, B. and Tadasse, T. (1989): Type and Productivity of indigenous cattle in central Ethiopia. Trop. Anim. Hlth., 21:120.

Muriuki, H. G. and Thorpe, W. (2002): Smallholder Dairy product and Marketing in Eastern and Southern Africa. In: the proceedings of a symposium Held at International livestock center for Africa (ILICA). Addis Ababa, Ethiopia.

Negussie, E., Bran nag, E., Banjaw, K. and Rottman, O. U. (1998): reproductive performance of dairy cattle at Asella Livestock farm. Arsi. Ethiopia. I: Indigenous cows versus their F1 crosses. J. Anim.Breed. Genet, 115:267 – 280.

Nftalem, D. (2000): Sheep production on smallholder farms in the Ethiopian highlands.A Farming Systems Approach. PhD, Thesis.Humboldt University of Berlin,Department of Animal Breeding in Tropics and Sub tropics, Berlin, Germany.

Nicholson, C. F., Thornton, P. K., Mohammed, L., Muinga, R. W., Mwamachi, D.M., and Elbasha, E.H., Staal, S.J.and Thorpe, W. (1999): Smallholder Dairy Technology in Coastal Kenya. An Adoption and impact study. ILRI, (International Livestock Research Institute), Nairobi, Kenya, Pp10-42.

Otchere, E. (1983): The productivity of white Fulani (Bunajii) cattle in pastoralist herds on the Kaduna plains of Nigeria. ILCA, Programme Document. Kahadu, Nigeria.

Perera, B. M. A. O. (1999): Management of reproduction. In: Falvey L. and Chantalakhana C. (eds.), Smallholder Dairying in Tropics. ILRI (International Livestock Institute), Nairobi, Kenya. Pp 242 – 263.

Preston, T.R. (1977): A strategy for cattle production in the tropics. Wld. Anim. Rev. (FAO): 21:11-15.

Pulan, N. B. (1979): Productivity of white Fulani cattle on the Jos plateau, Nigeria. I. Herd structure and reproductive performance. Trop. Anim. Hlth. Prod., 11:231-238.

Pulan, N. B. (1980): Productivity of white Fulani cattle on the Jos plateau, Nigeria. II.nutritional Factors. Trop. Anim. Hlth. Prod., 12:17-24.

Ramish, B. (1995): Trend, Pattern and Effect of Diffusion and Adoption of Cross Breeding Technology: An Assessment in the context of Kerala. Indian Journal of Agriculture Economics.3: 294 – 298

Ranjhan, S. K. (1993): Animal Nutrition and Feeding Practices. 4th ed. Vikas Publishing House, Pvt.Ltd, India, Pp 156-157.

Risstrom, I. (1999): Herd recording. In: Falvey L. and Chantalakhana C. (eds.), Smallholder Dairying in Tropics. ILRI (International Livestock Institute), Nairobi, Kenya, Pp 269 – 274.

Roberts, S. J. (1986): Veterinary Obstetrics and General Diseases.Second edition.Lithographed by Edwards Brothers In c. Ann. Arbor, Michigan, Pp 60-86 and 500-505.

Samuel, C., Jutzi, (2005): Application of gene based Technologies for improving animal production in developing countries Published by Springer, Dirdrecht, The Netherlands, Pp 28.

Sastry, N. S. R. and Thomas, C.K(1981): Farm Animal Management, Vikas publishing House Pvt. Ltd. India. Pp 46-115.

SDDP (Smallholder dairy Development Project) (1998): The role of village Dairy cooperatives in dairy development: prospects for improving dairy in Ethiopia.Organized by Smallholder Dairy Development Project. Addis Ababa, Ethiopia.

Shapiro, B. I., Haider, J. Alemu, G.W. and Abebe, M. (1998): Crossbred cows and Human Nutrition and Health: Evidence from Ethiopia.

Shapiro, B. I., Mohamed-Saleem, M. A. and Reynolds, L. (1994): Socio-economic constraints tostrategic sheep fattening: evidence from the Ethiopian highlands. In: Proceedings of the2nd biennial conference of the African Small RuminantResearch Network. Lebbie, S.H.B.,Rey, B., E.K. Irungu (eds.).Published jointly by the International Livestock Centre for Africa (ILCA), Addis Ababa (Ethiopia) and Technical Centre for Agricultural and Rural Co-operation, Wageningen, The Netherlands, Pp 9–14.

Shapiro, K., Jerse, E. and Foltz, J. (1992): Dairy marketing and development in Africa: Dairy Marketing in sub-Saharan Africa. In: proceedings of a symposium held at, ILCA, and Addis Ababa, Ethiopia.

Shiferaw, Y, Bekana, M. and Kassa, T. (2003): Reproductive performance of crossbred dairy cows in different production systems in central highlands of Ethiopia. Trop. Anim. Hlth Prod, 25:551– 561.

Simmonds, N. W. (1985): Farming System Research: A Review.World Bank Technical Paper No. 4.The World Bank, Washington.

SPSS (2002): Statistical packages for social Sciences.Version 11.5. SPSS Inc., 1989-2002.

STATA (2001): STATA soft ware, Stata Corporation, Texas, 77845. Texas,USA.

Swensson, C., Schaar, J., Brannang, E. and Meskel, L. B. (1981): Breeding Activities of the Ethio- Swedish integrated rural development project III: reproductive performance of Zebu and crossbred cattle. Wld. Anim. Rev., 38: 31 – 36.

Tekalign, M., Abiye, A., Srivastava, K. L. and Asgelil, D. (1993): Improved management of vertisols for

sustainable crop-livestock production in the Ethiopian highlands. Synthesis Report 1986-92.Technical Committee of the Joint vertisol project, Addis Ababa, Ethiopia.

Tesfaye, Z., Legesse, D. and Dawit, A. (2004): Agricultural Technology evaluation adoption and marketing. Proceeding of the workshop held to discuss the socio-economic research result of1998-2002.EARO, Addis Ababa, Ethiopia.

Thrusfield, M. (1995): Veterinary Epidemiology, Black Well Science Ltd., Pp 180-186.

Tsehay, R. (1998): Prospects of the Ethiopian Dairy Development. In: The Role of village Dairy Cooperatives in dairy development: Prospects for improving dairy in Ethiopia. SDDP (Smallholder Dairy Development Project), MOA, Addis Ababa, Ethiopia, Pp 149- 159.

Variko, T. (1991): Development of appropriate Feeding Systems for Dairy cattle in the Ethiopian High lands.Research and Development Project Final Report.ILCA, Addis Ababa, Ethiopia.

Walshe, M. J., Grindle, J., Nell, A. and Bachman, D. (1991): dairy Development in Sub-Saharan Africa: A Studyof Issue and Options.World Bank Technical Paper 135. World Bank,Washington DC, USA. Pp 94.

Workneh, A. and Rowland, J. (2004): Design, Execution, and Analysis of the livestock Breed Survey in Oromia Regional State, Ethiopia. OADB (Oromia Agricultural Development Bureau) and ILRI, (International Livestock Research Institute). Nairobi, Kenya. Pp 260.

Yefat, D. (2005): A Study on Reproductive Performance of Crossbred Dairy cows in Smallholder Dairy Farms in South East Shoa Zone of Oromia Region, Ethiopia. MSc.Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre-Zeit, Ethiopia.

Yoseph, M. (1999): Impacts feed resources on productive and reproductive performance of dairy cow in the urban and peri-urban dairy production system in the Addis Ababa milk shed and evaluation of non conventional feed resources using Sheep, Msc. Thesis. Alemaya University of Agriculture, Alemaya, Ethiopia, Pp 171.

Zelalem, Y. and Yohannes, G. (2002): On-farm efficiency evaluation of smallholder and improved butter making techniques around Hollota and Selale in central high lands of Ethiopia. Holleta Agricultural Research center, Addis Ababa, Ethiopia

Zumbach, B. and Peters, K. J. (2000): Sustainable Breeding Methods for smallholder Dairy production under unfavorable conditions in the tropics Deutscher Tropentag, International Agricultural Research, A contribution to crisis prevetion. October 11- 12,2000Hohenm, Pp 2.