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STUDY ON THE BREEDING PRACTICE OF SMALLHOLDER DAIRY FARMERS IN HOLETTA AREA, CENTRAL HIGHLANDS OF ETHIOPIA

BY
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ABBREVIATIONS

AFC	Age at first calving
AI	Artificial Insemination
ANOVA	Analysis of Variance
CI	Calving Interval
DMYBL	Daily Milk Yield at the Beginning of Lactation
DMYML	Daily Milk Yield at the Middle of Lactation
DMYEL	Daily Milk Yield at the End of Lactation
DNA	Deoxyribonucleic Acid
EARO	Ethiopian Agricultural Research Organization
ESAP	Ethiopian Society of Animal Production
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
ha	Hectare
HP/CL	high potential /crop livestock
HP/PL	high potential perennial crop/livestock
IAEA	International Atomic Energy Agency
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
LP/CL	low potential cereal/livestock
MoA	Ministry of Agriculture
NSPC	Number of service per conception
TLU	Tropical Livestock Unit
PA	Peasant Association
PRA	Participatory Rural Appraisal
QTL	Quantitative Trait Loci
SD	Standard Deviation
SDDP	Smallholder Dairy Development Project
SE^2	Standard Error Square
SPSS	Statistical Package for Social Scientists

ABSTRACT

This study was carried out in Wolmera Woreda of the West Shoa Zone of Oromia Regional State from October 2007 to April 2008. Simple random type of sampling was used to select 300 households from five peasant association for questionnaire survey and 37 smallholder farmers, who got at least 25% of their income from dairy and grouped in five groups each with 5 to 8 farmers, were included in the participatory method. Data were collected on socio-economic and farming system characteristics, livestock and cattle herd size and composition, dairy cattle management practices, different aspects of dairy cattle breeding practices and constraints associated with dairy cattle production. Data was analyzed using descriptive and differences between means was analyzed using one-way ANOVA. The results showed that the overall mean for family size was 5.7 person (SD=2.25). Cattle (37.3%) and sheep (27.8%) were dominated the livestock herd. The average cattle herd size in the study areas was 16.06. Shortage of grazing land was the most important constraint among the factors that hinder dairy development in the area (37.7%) followed by cattle disease (21.7%), shortage of concentrate feed (18.7%) and shortage of crossbred heifers (12.7%). This finding was also supported by the results of participatory methods. The average daily milk yield of diary cattle ranged from 0.91-2.50 liters in indigenous cattle and from 2.75-6.34 liters in crossbred cattle. The average lactation length was 5.82 months for indigenous cattle and 10.79 months for crossbreds. Breed effect on daily milk yield and lactation length was significant ($p<0.001$). The average age at first calving, calving interval and number of services per conception of indigenous cattle (5.45 years, 24.92 months, 1.43 respectively) were significantly higher ($p<0.005$) than the values for crossbreds (3.22 year, 16.55 months, 1.20, respectively). About 86% of the farmers obtained their establishment dairy herd from local market and 84% of farmers were not satisfied with the performance of their dairy animals currently owned. Friesian crosses were ranked top by total score (46.7) followed by Jersey crosses (43.7%) and indigenous cattle (31.2%). However, indigenous cattle were considered better in milk fat percentage, conception rate, visibility of oestrus signs and disease resistance. The sources of information regarding the performance of animals were individual performance (42.6%), dams performance (28%) and progeny performance (20.8%). Morphological appearance of animals was also mentioned as important source of information in the participatory method. The most important preferred trait was high daily milk yield (33.9%) followed by age at first calving (26.2%) and high milk fat percent (18.4%). Most of the farmers (92%) were using only natural mating while the remaining proportion of farmers, 3.3% and 4.7% were using AI and both AI and natural mating, respectively. It can be concluded that farmers in the study areas did not have a well organized breeding practice and dairying was constrained by a number of factors, which needs to be addressed properly.

Keywords: breeding, central highland, dairy, practices, smallholder

1. INTRODUCTION

Agriculture is the mainstay of the Ethiopian economy, employing approximately 85% of the total population. Livestock production accounts for approximately 30% of the total agricultural GDP and 16% of national foreign currency earnings (Degefe and Nega, 2000). Moreover, Ethiopia has diverse animal genetic resources and its relatively large livestock population (approximately 100 million) is well adapted to and distributed among diverse ecological conditions and management systems (Hizkias, 2000). The major farm animal genetic resources of the country include cattle, sheep, goats, donkeys, horses, mules, camels and chickens. As well, demand for livestock products in sub-Saharan Africa and in developing countries in general is likely to rise considerably as a result of rapidly growing human population, urbanization and income. This increase in demand for livestock products will have profound implications for food security, poverty alleviation, and the environment (Ehui, 2000).

There are two distinct ecological categories, highland and lowland, in Ethiopia. The highlands comprises 40% of the country's land area, holds 88% of the human and 74 % of the tropical livestock units (TLU). The main activity in the highland is a mixed farming system dominated by crop production and accounts for more than 90 % of the country's economic activity (Ahmed *et al*., 2006). The highland area based on the development potential and resource base is further defined under three zones, the high potential cereal/livestock (HP/CL), the low potential cereal/livestock (LP/CL) and the high potential perennial crop/livestock (HP/PL) area (Ahmed *et al.*,, 2000), which has distinct livestock production system. In contrast, the lowland has 78 million hectares land area (60% of total) and 12.2% of the total human population. Ecologically it has arid (64%), semi-arid (21%) and sub-humid (15%) area dominated by semi nomadic transhumance population whose economy is entirely dependent on livestock production (Benin *et al*., 2002). Seasonal migration and the tendency of overstocking in specific area are the major characteristics. Dairy production is an important part of the livestock production systems in Ethiopia, especially in the highland area. Cattle, camels and goats are the main livestock species in Ethiopia that supply both milk and dairy products.

Milk from cows constitutes 83.4 % of the total annual milk output of the country (FAO, 1993). Estimated total milk production ranged from 960, 000 metric tons for 1994 to about 1.2 million metric tons for 2000 showing meager growth (Getachew and Gashaw, 2001). This low production is reflected in the very low per capita consumption of animal protein. The average per capita consumption of milk in Ethiopia, Africa, developing world and the world is 19.2kg, 27.5kg, 36.6kg and 75kg, respectively (Ahmed *et al*., 2006), which shows the per capita consumption of milk in Ethiopia is 52.5% of developing countries and represents only 15-30% of that of the developed countries (Azage and Alemu, 1997). The consumption level has also decreased substantially during the last 25 years by 23.8% (Berhanu and Debrah, 1991).

Although cattle play significant social and economic roles in the subsistence production systems of the East African highlands, the productivity of indigenous breeds is relatively low, with milk off take rarely exceeding 300kg for a lactation period of about 7 months. This is mainly due to poor feeding, diseases, low genetic potential of indigenous breeds, which account for more than 98% of the total cattle population, and poor understanding of the dynamics of farming system. Currently indigenous cattle constitute more than 98% of the total Ethiopian cattle population. Improving the genetic potential of indigenous cattle breeds through crossbreeding with some European breeds has been considered as an alternative means of improvement in order to combine the hardiness and disease resistance of local zebu breeds with high productivity of European breeds. However, the complex nature of livestock production in Africa, particularly in Ethiopia coupled with a low technical base and long generation times have slowed down the progress in livestock production. Lack of maintaining the desired level of exotic blood, inbreeding, and the use of exotic breeds, which are not suited for the specific environmental condition, are the major responsible factors hindering breed improvement activities in developing countries like Ethiopia. It is essential thus to study the breeding practices of smallholder farmers and the associated constraints to come up with recommendations that would help the breed improvement strategies in the country.

Therefore, the objectives of the study were:

- To characterize the breeding practices of smallholder dairy farmers in Holetta area;
- To identify constraints in dairy production in smallholder dairy farmers in Holetta area.

2. LITERATURE REVIEW

2.1. Status of the dairy industry

In the developing countries, there are milk producers that practice traditional and non-traditional dairy productions. In areas that practice the non-traditional dairy production, the structure of dairying is more varied. In the traditional milk producing regions, especially those of Africa, small farms with not more than three or four animals characterize the structure of milk production. Dairying is nearly always part of a mixed farming system and livestock are fed principally on agricultural residues and are grazed on natural pastures of non-arable land. The agricultural by-products largely supported cattle husbandry and milk production (Schelhaas, 1999). The dairy cows produce food to the family, provide direct cash income, are capital assets, produce manure for use as fertilizers, fuel, and may be source of power for transport and cultivation. The highlands of Sub-Saharan Africa are the most productive in terms of milk per hectare in the traditional dairy production system, but production per head of cattle is lower than in the dry zone; this is because the majority of cattle are found in the Ethiopian highlands, where male stock used for traction comprise a high fraction of the herd (de Leeuw *et al*., 1999).

Over the last decade following the political changes in 1993, the dairy sector in Ethiopia has shown considerable progress (Samuel *et al.*, 2006). Total milk production grew at an estimated rate of 3% as compared to 1.8% during the period of 1975-1992, thus ending the long-time trend of declining per capita milk production in the country. The progress achieved is mainly due to technological intervention, policy reforms and population growth (Ahmed *et al*., 2006)

The dairy sector in Ethiopia is largely dependent on indigenous breeds of low-productivity native zebu cattle, which produce about 400–680 kg of milk per cow per lactation. The state dairy farms, now being privatized or in the process of privatization, use grade animals (those with more than 87.5% exotic blood) and are concentrated at a distance of 100 km around Addis Ababa (Alemu *et al*., 2000; Holloway *et al*., 2000).

2.2. Prospects of the dairy industry

In the next two decades, there will be globally an increment in demand for milk and milk products, fueled by population growth, urbanization and income growth (Degefe and Nega, 2000). The strongest growth in demand for milk and milk products is anticipated to come from developing countries, where it is projected to grow at the rate of 3 percent annually (Griffin, 1999). Sub-Saharan Africa is expected to register 3.3% increase in demand for milk and milk products in 2020 (Delgado *et al*., 2001). In addition, world production of milk is also forecasted to grow by an annual rate of slightly over one percent and the largest increment is expected in developing countries (Griffin, 1999). Delgado *et al*., (2001) projected the annual growth rate of milk production in developing countries between 1997-2020 to be 2.73% and a 4% annual growth in milk production was projected between 1993 and 2020 in Sub-Saharan Africa (Delgado *et al*., 2000).

In addition, internationalization and privatization are also among the forces that are acting towards change. A number of agreements have been signed that would represent a major breakthrough on the road towards a free world dairy market. These agreements have been aimed at a reduction of the level of domestic market protection and a lowering of export subsidies by the developed world and hence to an enlargement of the scope for imports (Schelhaas, 1999).

The dairy sector in Ethiopia is expected to continue growing over the next one to two decades given the large potential for dairy development in the country, the expected growth in income, increased urbanization, and improved policy environment. The shift towards market economy is creating large opportunity for private investment in urban and peri-urban dairying. However, the main source of growth is expected to be the growth in demand for dairy products (Ahmed *et al*., 2006).

The existing excess demand for dairy products in the country is expected to induce rapid growth in the dairy sector. Factors contributing to this excess demand include the rapid population growth (estimated at 3 percent annually), increased urbanization and expected growth in incomes.

In addition, the favorable climatic condition throughout the country supports use of improved, high-yielding animal breeds and offers a relatively disease free environment for livestock development. Given the high potential for dairy development and the ongoing policy reforms and technological interventions, success similar to that realized in the neighboring Kenya under a very similar production environment is expected in Ethiopia (Mohamed *et al.,* 2003). While the response of the private sector to the increased demand for dairy is expected to be significant, the small-scale household farms in the highlands hold most of the potential for dairy development (Ahmed *et al.*, 2003).

2.3. Dairy production system in Ethiopia

Livestock are raised in all of the farming systems of Ethiopia by pastoralists, agro-pastoralists, and crop–livestock farmers. According to Tsehay (2002), milk production systems can be broadly categorized into urban, peri-urban and rural systems, based on their location.

2.3.1. Lowland pastoralist dairy farming

About 30% of the livestock population in Ethiopia is found in the pastoral areas. These areas comprise 50% of the total land area of the country and have altitudes below 1500m.a.s.l. Pastoralism is the major dairy production system in the lowland. Livestock not provide inputs for crop production but are the very backbone of their owners providing all of the consumable and saleable outputs and are regarded as insurance against adversity. Milk production is dependent on season due to the rainfall pattern that influences feed availability (Ketema and Tsehay, 1995).

2.3.2. Rural highland smallholder dairy farming

There are two types of systems in the highland. The traditional system that is based on indigenous breeds and the market oriented system that is based on crossbred dairy cattle. The average lactation yield for indigenous cows is 524 liters for 239 days and the average age at first calving is 53 months and the average calving interval is 25 months (Azage *et al.,* 1981). Tesfaye (1995) reported that the average milk yield and lactation length for crossbred dairy cows ranges from 518.8-1448 kg and 110-300 days, respectively, depending on the breed type. The traditional system is not market-oriented and most of the milk produced were retained for home consumption. The level of milk surplus is determined by the demand for milk of the household and its neighbours, the potential to produce milk in terms of herd size, production season and access to a nearby market. The surplus is mainly processed using traditional technologies and milk products such as butter, ghee, *ayib* and sour milk are usually marketed through the informal market after the households satisfy their needs while most of the milk is sold to generate income in the market-oriented system. (Tsehay, 2002).

2.3.3. Urban and peri-urban small-scale dairy farming

This system is developed in and around major cities and towns located mainly in the highlands of Ethiopia. The main feed resources are agro-industrial byproducts and purchased roughage. The system comprises small and medium sized dairy farms that own crossbreed dairy cows. Farmers use all or part of their land for forage production. The primary objective of milk production is generating additional cash income to the household (Azage *et al*., 2000).

Both the urban and peri-urban systems are located near Addis Ababa and the regional towns and take advantage of the urban markets. The urban milk system consists of 5167 small, medium and large dairy farms producing about 35 million liters of milk annually. Of the total urban milk production, 73% is sold, 10% is left for household consumption, 9.4% goes to calves and 7.6% is processed into butter and *ayib* (cottage cheese). In terms of marketing, 71% of the producers sell milk directly to consumers (Tsehay, 2002). This sector controls most of the country's improved dairy stock.

2.3.4. Large-scale dairy farming

This system is a specialized market oriented dairy operation practiced by very few private investors and the state sector to some extent (now being privatized or in the process of privatization). Most of these farms are located in and around Addis Ababa and use grade animals and exotic dairy stock (Ketema and Tsehay, 1995)

2.4.The role of the dairy sector in the Ethiopian economy

At household level, dairying is important in one way or another in all the farming systems of Ethiopia. In pastoralist, farming system and the crop farming areas milk is the most important source of protein (Tilahun, 1995). In the mixed farming systems, milk is also used mainly as food to the household and to a lesser extent as a source of income (FAO, 1999). In the urban and peri-urban areas, dairy production is practiced mainly as a source of income. At macro-level, there is scarcity of information that estimates the share of the dairy sector in the GDP. However, the report of Azage and Alemu (1997) indicted that 800,000 metric tones of milk are produced every year. The very low per capita consumption of milk (20 kg Per annum) is lower than the average for Sub-Saharan Africa, and this indicates that the actual level of dairy productivity is extremely low.

Nationally, the livestock sector contribute about 12-16% of national GDP, about 30-35% of agricultural GDP, about 15% of export earnings and about 30% of agricultural employment. Livestock contribute to livelihoods of 60-70% of the population (Aklilu, 2002; Aytaged, *et.al*, 2003; and Belay, 2003). Dairy output accounted for about half of the livestock output (Getachew and Gashaw, 2001).

2.5. Major constraint that hinder dairy development in Ethiopia.

2.5.1. Animal health

Animal health and improved management is one of the major constraints of dairy development in Ethiopia, which cause poor performance across the productive system. Many of the problems result from the interaction among the technical and non-technical constraints themselves example: poorly fed animals develop low disease resistance and fertility problem. Many of the disease constraints, which affect supply, are also a consequence of the non-technical constraints example: insufficient money to purchase drugs or vaccines aggravates the effects of diseases on animal productivity (Tefera and Abaye, 1993). In addition, the trend of dairy development in Ethiopia, which is characterized by intensification, also favors the occurrence of diseases of intensification.

2.5.2. Feed and nutrition

In highland zones, high population growth and density are causing the shortage of grazing land on which livestock production by smallholders depends. In the lowland areas, the shortage of feed and water during the dry season forces animals and livestock keepers to travel long distances in search of food. The quality of feed also deteriorates during the dry season in both the mixed farming and pastoral systems (Tilahun, 1995).

2.5.3. Genetics

According to Tsehay (1997), about 99% of the cattle population in Ethiopia are indigenous that are adapted to feed and water shortages, disease challenges and harsh climates. The productivity of indigenous livestock is, however, believed to be poor even, although there is no practical recording scheme used to judge their merit. Crossbreeding has been practiced with encouraging results, however, a strictly controlled breeding program has not been practiced (Tesfaye, 1990) and there has been no dairy herd-recording scheme.

2.5.4. Policy and socioeconomic issues

Recent political developments in Ethiopia coincide with three phases of dairy development policy. These include the imperial regime, characterized by almost a free market economic system and the emergence of modern commercial dairying (1960–1974), the socialist (Derg) regime that emphasized a centralised economic system and state arms (1974–1991), and the current phase under the structural adjustment programme and market liberalisation (1991 to present). The principal rationale for following the political regimes in identifying phases of dairy development in Ethiopia is that during each of these three phases, the country followed a distinct political path and development policies that directly and indirectly influenced the dairy sector. These include land tenure and land policy, macro-economic policy and orientation of development efforts (Ahmed *et al.*, 2006).

Land ownership and land rights

The 1975 land reform legislation abolished all forms of private ownership of land and put land under state control (Samuel *et al.*, 2004). The issue of land ownership with respect to dairy production is particularly important in the urban and peri-urban areas. The land policy does not make individuals, who already have land, free and secure to invest more on the land and there is also scarcity and difficulty in acquiring new land. Land for investment purposes could be obtained by lease, with prices set by periodic auctions, which is beyond the capability of most of the small scale and medium scale dairy farmers. (Samuel and John, 2001).

Farmers' participation

Farmers have in general limited opportunity and authority to participate in decision-making processes for what is economically, socially and culturally good for them. Most obviously, government intervention is based on a top-down development approach, which has lead to the imposition of ideas (Tesfaye, 1990).

2.5.5. Institutional constraints

The institutional constraints include lack of coordinated research activities, absence of agricultural information system to document and disseminate information generated from research, lack of education, extension and consultation; shortage of qualified personnel, poor education and management expertise of farmers, misunderstanding of production systems, lack of extension works to transfer new technologies and knowledge gained through researches to farmers, ignorance of the experience and knowledge of local farmers and absence of forums for consultations and discussions with farmers (Sendros and Tesfaye, 1997).

2.6. Dairy cattle breeding methods

The present livestock breeds in the world are the results of both natural selection and human intervention. Natural selection operates to provide reproductive ability and continuity of the fittest while human intervention is to change one or more traits of animals that the owner thinks desirable under his environment (IAEA, 2005). The genetic variations available both within breeds and between breeds, has been used to accommodate interests and farmers wishes to make livestock more efficient in using available resources to produce human food and other agricultural products (Sendros and Tesfaye, 1997; Gamborg and Sandoe,2005).

2.6.1. Selection

The improvement of the average performance of a livestock population for any trait or traits by genetic means requires selection of animals for the specific trait or a combination of traits required (Olesen *et al.,* 2000). Selection acts by allowing selected individuals to contribute more traits to the next generation than other individuals in the same population (Miglior *et al.,* 2005). In fact, the unselected individuals will have no influence on the next generation, as they are not being allowed to breed.

Important considerations in selection

Heritability

The intensity of inheritance of a specific trait is known as the heritability of the trait (Lasely, 1978). It has been found that those parts of the animal that develop early in life tend to posses higher heritabilities than those parts that develop later, and that heritability estimates are least variable, if they are determined under standardized environmental conditions (Mark, 2004). According to Bulfield, (1996), heritability provides an index of the probable efficiency of selection. Where heritabilities are high, the most effective program for genetic improvement of the trait would be mass selection of those individuals exhibiting the desirable traits with little attention being given to ancestry, sibs and other collateral relatives and to progeny tests. Where heritabilities are low, selection should include some form of progeny test and be based on ancestry and the performances of close relatives. Heritability estimates are ratios expressed in percent and are usually designated by h^2. Heritability is the ratio of variations due to genetic differences from the total phenotypic variation (Falconer and Mackay, 1996). Heritability estimates of different traits of dairy cattle are presented in Table 1.

Table 1.Heritability of various traits in dairy cattle.

Trait	Heritability	Trait	Heritability
Milk yield	0.25	Reproductive efficiency	0.50
Milk fat yield	0.25	Calving interval	0.10
Protein yield	0.25	Life span	0.15
Total solid yield	0.25	Feed efficiency	0.35
Milk fat %	0.50	Mastitis resistance	0.10
Protein %	0.50	Overall type score	0.20
Persistency	0.40	Dairy character score	0.20
Conception rate	0.50	Peak milk yield	0.30

Source: Damron, 2000

In general, most reproductive traits tend to have low heritability (<0.2); yield traits tend to be moderately heritable (0.2-04); and composition traits and weights tend to have fairly high heritabilities (>0.4) (James, 2004). One can see that selection based primarily on improving reproductive efficiency will yield little progress where as rapid improvement may be made toward improving such traits as mature weight and wither height (Laurence, 2002).

Accuracy of selection

According to William *et al*., (1999), accuracy in selection depends up on how well the phenotype reflect the genotype and this can be improved by keeping as many records as is economically practicable. For example, the heritability of milk yield estimated from a single lactation record of a milking cow may be 0.25, whereas when two, three and four lactations are included in the estimate, the heritabilities may be 0.33, 0.37, and 0.40, respectively. Multiple and complicated records do not necessarily provide additional information as to how accurately the phenotype reflects the genotype. In addition, accuracy of selection can also be affected by selection intensity, which depends to a very large extent on suitable replacement animals being available (Miglior.*et.al.*, 2005).

The interval between generations depends up on the interval between birth and sexual maturity and the fertility rate. Any improvements in the age at first parturition and in overall fertility will help to decrease the interval between generations and thus increase selection pressure (Taylor, 1992).

Correlation among traits

Knowledge of the magnitude of the genetic correlation between various traits is useful in a selection program (Nielsen, 2004). According to Lasely (1978), the absolute value of the correlation indicates the strength of the association between the two traits. The magnitude of genetic correlation may vary between -1 and +1. A genetic correlation of zero indicates that different genes influence the two traits; thus, the traits are uncorrelated. For example, selection based on milk yield has little or no effect on front teat placement (Laurence, 2002). According to Damron (2000), the positively or negativity of correlation values indicate how selection for one affects the other. If the sign of the genetic correlation is positive, then the breeding value of the animals for the two traits tends to vary together. In cases when the two traits are desired, there would be no problem but when only one is desired the association of the two traits would have negative impacts. On the other hand, negative correlations between two desirable traits or positive correlation of desirable with undesirable traits have the same effect (Lasely, 1978; Bulfield, 1996). Thus, knowledge of the correlation between various characters should be a great help in avoiding mistakes in selection (First, 1990). Table 2 shows the phenotypic and genetic correlations between milk yield and other traits.

Table 2. Phenotypic and genetic correlation between milk yield and other traits.

Traits	Correlation with milk yield	
	Phenotypic	Genetic
Fat yield	0.85	0.70
Solid not fat yield	0.85	0.90
Protein yield	0.85	0.90
Fat percentage	-0.35	-0.35
Solid not fat percentage	-0.30	-0.25
Protein percentage	-0.35	-0.30
Dairy character	0.50	0.68
Fore udder attachment	-0.09	-0.47
Rear udder height	0.12	-0.13
Rear udder width	0.16	0.09
Udder depth	-0.27	-0.64
Front teat placement	0.02	-0.12
Productive life length	0.25	0.75
Mastitis susceptibility	-0.05	0.10

Source: James, 2004

Methods of selection

Phenotypic selection: consists of choosing parents of the future generation based on measurable performances. The characters under selection should be the ones that are most important for high production (Buchanan *et al*., 1993). Phenotypic selection is the method of choice for traits with high heritability and variability and when intensity of selection is high. According to Lin (2005), there are four major sources of information to carry out phenotypic selection: individual performance, pedigree and collateral relatives' performance and progeny testing.

Marker assisted selection: Genetic markers can be defined as any stable and inheritable variation that can be measured or detected by a suitable method, can be used subsequently to detect the presence of a specific genotype or phenotype other than itself, which otherwise is non-measurable or very difficult to detect. In animal breeding, we can have morphological markers, biochemical markers, chromosomal markers and molecular markers (Schrooten *et al*., 2005). The marker revealing variations at the DNA level are referred to us the molecular markers (Villanueva *et al*., 2005). Morphological and chromosomal markers show low degree of polymorphism and hence are not very useful for genetic markers. Biochemical markers are often sex limited, age dependant and are significantly influenced by the environment (Dekkers, 2004). The molecular markers are capable of detecting the genetic variation at the DNA sequence level. The molecular markers are numerous and distributed ubiquitously throughout the genome (Dekkers and Chakraborty, 2001). They remain unaffected by the environmental factors and generally do not have pleiotropic effects on the quantitative trait loci (QTL) (Abdel-Azim and Freeman, 2002).

In the application of marker assisted selection two steps are involved: the first step is identification of the marker loci that is linked to quantitative trait loci of economic importance, and the next step is utilization of linkage association in genetic improvement programs (Meumissen.and Van Arendonk 1992). Marker assisted selection is likely to complement rather replace the convectional breeding systems leading to increased rate of genetic improvement through higher selection intensity, reduction of generation interval and increased in the accuracy of prediction. The use of marker-assisted selection is predicted to be most beneficial for traits that have low heritability or are difficult or impossible to record like disease resistance traits (Stella *et al*., 2002).

2.6.2. Crossbreeding

Crossbreeding is the breeding of one recognized breed of animals to another recognized breed (Elmer and Dever, 2002). Each breed involved in crossbreeding is supposed to be generally more homozygous than the average of the population. By mating individuals from such different breeds, a breeder can take advantage of the homozygocity of the parents to ensure heterozygocity in the offspring; the resulting offspring is called a hybrid (White *et al*., 1981). Crossbreeding usually results in improved traits in the offspring (Mohadevan, 1976); dominant genes tend to mask undesirable recessive genes (James, 2004).

The basic objective of crossbreeding of high performing cattle breeds with tropical breeds is to produce crossbreds with an expected additive genetic merit being the mean of both parental breeds. The non-additive effect, which is observed as heterosis or hybrid vigor, is the amount by which merit in crossbreds deviate from the additive component and is fully exploited only when non-related breeds are crossed (Olesen *et al.*, 2000). Payne and Hodges (1997) indicated that hybrid vigor becomes greater when the differences in the parental genetic make-up are high and IAEA (2005) suggested the possibility of greater hybrid vigor in more stressful environments. The use of temperate dairy breeds for crossbreeding with indigenous breeds of the tropics has been widely accepted and aims at combining the superior performance of specialized dairy breeds with the superior adaptability of the local stock (Zumbach and Peters, 2000). According to Cunningham (1991), the crosses between the temperate dairy cattle breeds and local cattle in the tropics combined the milk producing ability of the temperate breeds with the climatic adaptability of the tropical breeds. However, the delicate balance between genetic performance ability and adaptability is determined by the degree of exotic inheritance (Zumbach and Peters, 2000). Many reports on the performance of crossbred cattle indicated that crossbreeding results in performance improvement only until 50% inheritance of *Bos taurus* genes. Syrstad (1996) analyzed 46 data sets from different tropical countries and concluded that there was a nearly linear improvement of milk yield, age at first calving and calving interval up to 50% *Bos taurus* inheritance and F_2 was inferior to F_1 in all the traits studied. Syrstad (1989) have also concluded that further upgrading more than 50% *Bos taurus* inheritance has negative effects on age at first calving, calving interval, herd life and survivability. Furthermore, Nielsen *et al.*, (2006) reported that performance declined in back crosses as the Holstein-Friesian gene fraction departed higher or lower than 50%. Cunningham (1991) indicated that the possible explanation for the low productivity of F_2 is the idea that blocks of genes giving favorable epistatic effects in the parental breeds and the F_1 may be broken up in the F_2 and subsequent generations.

2.7. Dairy cattle mating methods in Ethiopia

2.7.1. Natural mating

The use of bulls for natural service remains widespread even in areas where artificial insemination has proven to be very efficient. Many farmers believe that pregnancy rates are higher when a bull is used. The use of natural service may be indicated when personnel are inefficient to perform the tasks associated with heat detection and the techniques of AI, when long term genetic gain is of minor importance and when local conditions do not provide the infrastructure necessary for successful AI (Kaziboni *et al.,* 2004).

In undertaking natural mating, the bull must be morphologically and functionally sound. Testicles should have a distinct neck and should not be fibrotic or flaccid in consistency (Sprott *et al.*, 1998). This is essential because testicles must be at a reasonable distance away from the internal body temperature. A scrotal circumference of 30cm and 34 cm is recommended for 15 months old and 24 months old Friesian bulls, respectively (Jensen, 1997). Azage and Alemu (1997) indicated that there is a direct relationship between scrotal circumference and semen production. Bulls should also have good body condition and have morphologically sound feet and legs and healthy eyes to perform the service properly. A breeding bull is required also to have a good libido or serving capacity. IAEA (2005) reported that the serving capacity of a bull is positively correlated with the proportion of heat-detected cows. Differences in pregnancy rates were also associated with high, medium and low serving capacities of bulls (Ahuja *et al.,* 2000). If conditions allow, it is also essential to perform a rectal examination for abnormalities of accessory sex organs and to do semen evaluation tests

(Sprott *et al.,* 1997). Furthermore, farmers must be careful to select preferably a crossbred between the local and improved breeds for cows that are small and local type, which has a greater probability of siring small calves, which will not cause problems at calving time (Lee *et al*., 1999).

2.7.2. Artificial insemination

Artificial insemination (AI) in the broadest sense is the use of a technological process involving semen collection for the obtainment, processing, and deposition of male gametes in the female genitals to fertilize the oocyte(s) (Wattiaux, 1998). According to Dennis (2006), artificial insemination in several mammalian species and especially in dairy cattle has substantially contribution to the dissemination of superior genetic materials from the male, allowing acceleration of genetic selection at a much greater rate that could be hoped for with natural mating.

Successful insemination requires the acquisition of a quality sample of semen from a male, the detection of oestrus in the female, and the ability to properly place the semen in the reproductive tract of the female (Kaziboni *et al.*, 2003)

AI is an essential technique in breeding programs with progeny testing and it is the earliest reproductive technology. According to Mukasa-Mugerwa *et al.,* (1991c), AI provides the opportunity to choose sires that are proven to transmit desirable traits to the next generation and minimizes the risk of spreading sexually transmitted diseases and genetic defects. So far, artificial insemination using frozen semen has played an important role in increasing genetic progress by upgrading the reproductive rate of the male. It increases the selection intensity since less bull is needed and this is the basis for selection progress. Zumbach and Peters (2000) estimated that a bull using deep frozen semen could inseminate 1820 cows. Despite the wide application and success of AI throughout the developed world, the success rate in African and other developing countries is still low owing to a number of technical, system related, financial and managerial problems (Azage *et al*., 1995). Among the technical constraints are poor heat detection skills, communication and transport problems that hamper timely insemination, poor semen collection and storage technology and handling procedures that affect semen quality, and inefficiency of AI technicians (Kaziboni *et al.,* 2003). Other system related problems include small herds, disperse locations, limited production intensity and affordable cost. In addition, the pregnancy rate in AI scheme does not exceed 45% in Africa and the conception rate to first service was 48% in zebu cows kept at the Ministry of Agriculture Ranch in Ethiopia (Mukasa-Mugerwa *et al*., 1991a).

3. MATERIALS AND METHODS

3.1. Study area

This study was carried out in Holetta area, which is the administrative town of Wolemera Woreda and located 34km West of Addis Ababa at 38.5 ast longitude and 9.8^0 south latitude. It has an altitude of 2400m above sea level and is situated in the central highlands of Ethiopia (Figure 1.). The minimum and maximum temperature is $6.3^0{}_C$ and $22^0{}_C$, respectively. The area has bimodal rainfall pattern, with average annual rainfall of about 1200mm, and most of it occurring between June and October. The long dry season lasts from November to February followed by light showers in March and April. Mean annual relative humidity is 54%. The Woreda covers an extensive area of $809.27km^2$.The vegetation consists of annual legumes and perennial grass species. Major crops in the area include wheat, barley, lentil, teff (*Eragrostis teff*) and Maize. The natural pasture of the study area is predominantly composed of a*ndropogon, hyperrhenia, trifolium* and some species of the c*yperaceace* (Gifawosen *et. al.*, 2003).

In the highlands of Ethiopia, the agricultural scenario is dominated by a smallholder mixed crop-livestock farming system in which cattle husbandry mainly stands for traction and milk production. The majority of the farmers have exclusively local cattle breeds. Local cows are particularly needed to breed the oxen required for plowing. Crossbred cows are also found in the area. Most of crossbred cows and complementary feeding and management technologies were introduced to Holetta area through a collaborative dairy technology and cow traction project involving the Ethiopian Agricultural Research Organization (EARO) and International Livestock Research Institute (ILRI) (Zerbini *et al.,* 1996). According to the information obtained from Wolmera woreda Agricultural and Rural Development office, in the Woreda there were an expected livestock population of 170,077 cattle; 95,766 sheep; 14,532 Goat; 13,193 Donkey; 7,994 Horse 183 Mule and 145,147 poultry.

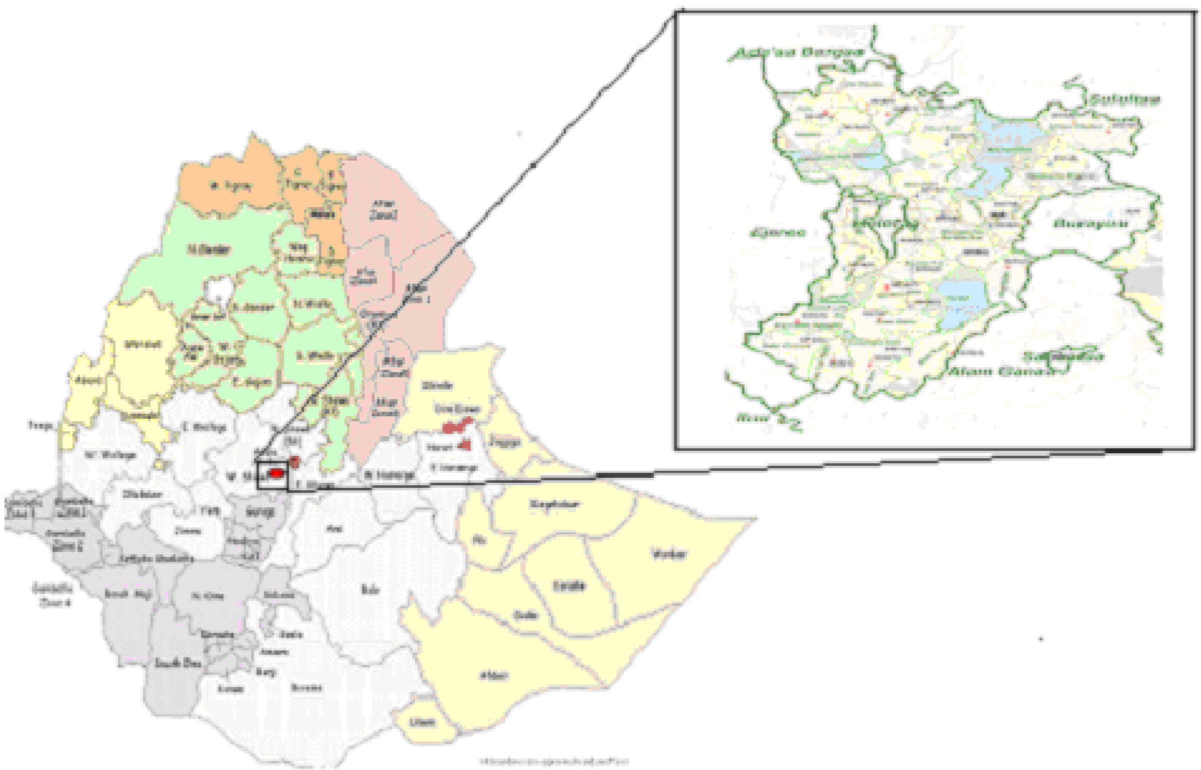

Figure 1. Map of Ethiopia (bottom) and (top) indicating the study sites Wolmera Woreda.

3.2. Study population

Smallholder farmers and dairy cattle owned by the farmers represented the study population.

3.3. Study design

A questionnaire survey and participatory methods were carried out from October 2007 to April 2008 to collect data on breeding practices of smallholder dairy farmers in Holetta area.

3.3.1. Sampling procedure and sample size determination

The sample size was determined by the formula recommended by Arsham (2007) for survey studies:

$$N = 0.25/SE^2$$

With the assumption of 3% confidence interval, a total of 278 households were required for the study. To increase the precision of the study the sample size was set at 300.

Welmera Woreda (Holetta area) was the study area, which contains 25 peasant associations. A simple random sampling method was employed to select 5 peasant associations. The selected PA's were Elala Gojo, Markose, Gefersa Gugi, Wagitu Harbu and Rob Gebia. Then, 60 smallholder farmers were selected randomly from each peasant association. The random selection was done from the list of PAs and farmers available at the Woreda Agricultural and Rural Development Office.

3.3.2. Data collection

Questionnaire survey

Detailed structured questionnaires (Annex 1) were prepared and used to collect information from smallholder dairy farmers in a one visit interview. The questionnaires were pre-tested to check clarity and appropriateness of the questions. Some of the information collected through interview were supported by observation. The data collected through interview were classified as follow: socio economic and farming system characteristics, estimated performance of dairy cattle owned by small holder dairy farmers, breeding practice by the farmers, heat detection and insemination, dairy cattle health, calf management, dairy extension service and major constraints of dairy production.

Participatory approach

Participatory methods were applied to triangulate and enrich the information collected by interviewing individual farmers. Checklist (Annex 2.) was prepared which contained points to be discussed in the PRA approach. The participatory methods were applied on groups of dairy farmers each comprising five to eight farmers, who got at least 25% of their total income from dairy cattle production. The following participatory methods were used in the study.

Matrix ranking

Farmers' perception of the different dairy cattle breeds available in the areas was studied by using a matrix ranking method. The participants first listed breeds of cattle they used for dairy farming in the respective PA's and the characteristics of dairy cattle, which they think are most important. They then assigned scores for the characteristics to each of the breeds. The maximum score for each characteristic was ten. Briefly, the names of the breeds were at the head of the columns and breed characteristics were in the first raw. The participants were provided with ten pieces of sticks, which they had to distribute based on the importance of the trait in each breed. The number of sticks (score) on the respective column of the breed was recorded. The participants then moved to the next character and repeated the exercise until the last character was covered. The scores given for different characteristics were summed to determine the composite score for individual breeds. After the exercise was completed in all five PA's, the breeds were sorted irrespective of the PAs concerning the breed characteristics and corresponding scores. An average of the scores was computed, if a character for breed was identified and scored by the farmers of more than one PA (Shamsuddin *et al.*, 2007).

System analysis diagram

Constraints limiting the dairy development were discussed using the system analysis diagram. A central circle was drawn around a model dairy house to indicate a dairy farm and around it different problems were mapped, scored and root causes were identified. Different colored markers, (Black, Red, Blue, Blue black, and Orange) were used to draw a map, which represent points of 5, 4, 3, 2, and 1, respectively. All the votes a particular constraint received were counted and multiplied by the respective point to obtain the score (Devendra, 2007).

Focuses group discussion

Participants were asked to reflect on the preferred traits of dairy cattle and major source of information to assess the performance of dairy cattle. For this purpose, group discussions were initiated. Farmers were encouraged to list a range of preferred traits and possible sources of information about the performance of dairy cattle and then advised to vote by raising their hands for the preferred traits and the source of information. Since the number of participants in the focus group discussion was 37 farmers, the maximum vote for each point was 37. However, each participant farmer was allowed to vote more than once.

3.5. Statistical analysis

Descriptive statistics like mean, standard deviation and frequency distribution were used to summarize data from the questionnaire survey. Differences in performance traits were analyzed using one-way ANOVA. SPSS (release 15, 2006) was used to run descriptive statistics.

4. RESULTS

4.1. House hold resource

The average age of the household heads was 46.6 years (SD=13.4) with dairying experience of 21.9 year (SD=12.8). About 87.6% of the household owners were males and the remaining (12.3 %) were females. Mean values for household resource in the study area are compiled in Table 3. The overall mean for family size was 5.7person (SD=2.25). The family size ranged from 1-12 persons. The average total land holding per household was 3.42 ha from which 55.2% was allocated for crop and 22.8% was grazing land. The remaining 11.1% was allocated for forestland and 10.8% was fallowland.

Table 3.Mean and standard Deviation of house holds resource in the study area.

Variables	Mean±SD
Family size (person)	5.71±2.25
Crop land (ha)	1.89±1.06
Grazing land (ha)	0.78±0.53
Forest land (ha)	0.38±0.29
Fallow land (ha)	0.37±0.13
Livestock number (TLU)	9.2±0.81
Cattle	8.38±4.53
Sheep	6.25±3.51
Goat	5.13±2.81
Donkey	1.40±0.68
Horse	1.28±0.73

ha= hectare, TLU= Tropical livestock unit, SD=Standard deviation

Regarding educational status, 43% of the farmers had basic education, 24.7% had elementary school education, 23% had secondary school education, 1% had college education and 8.3% were illiterate.

The livestock herd and composition in the study area shown in Table 3. Cattle (37.3%) and sheep (27.8%) were dominating the livestock herd. Next to cattle and sheep, goat comprised a significant portion of the livestock herd. Donkey stood next to goat in the livestock herd composition while horse comprised the least proportion of the herd.

4.2. Dairy cattle production

4.2.1. Objective of dairying

The main objectives of keeping dairy cattle in the study area were to obtain income, provide food for the family and for draft power. In the area, 44% of the farmers keep dairy animals for milk production as source of income and household consumption. The remaining 56% of the farmers kept dairy animals for milk production both for source of income and family consumption, production and source of draft and beef animals.

4.2.2. Dairy cattle herd size and composition

The cattle herd size and composition in the study area is indicated in Table 4. The average total cattle herd size in the study areas was 16.06. Cows account for the highest proportion of the herd(45.1%) followed by steers (22.3%). The proportion of cows in with different pregnancy and lactation was also share significant proportion (8-10%). The proportion of heifers, male calves, female calves and bulls was 10.7%, 9.5%, 8.8% and 3.61%. The breed composition of the cattle herd were; 91.1% indigenous and 8.9% crossbred cattle.

Table 4. Cattle herd size and composition in a household in the study area.

Variable	Mean± SD	Percent
Cow	7.24±4.11	45.1
Pregnant non lactating	1.39±0.64	8.7
Lactating non pregnant	1.61±0.88	10.0
Lactating pregnant	1.41±0.87	8.8
Dry pregnant	1.55±1.18	9.7
Dry non pregnant	1.28±0.54	8.0
Heifer	1.72±0.92	10.7
Bull	0.58±0.83	3.61
Male calves	1.53±0.79	9.5
Female calves	1.41±0.74	8.8
Steer	3.58±1.32	22.29

SD= standard devotion

In the 65.3% of the households, there was an increasing trend for the last ten years in the cattle herd size due to breeding (94.4%), purchasing of cattle (3%) and extension service (2.5%). In the 34.7% of households, there was a decreasing trend in cattle herd size due to disease (66.3%), feed shortage (17.8%) and grazing land shortage (24.7%).

4.2.3. Dairy cattle management

Dairy cattle feeding

The result of the study indicated that the predominant dairy cattle feeding system in the study areas was grazing and stall-feeding (87.7%). Cattle were allowed to graze on pasture for an average of 7 to 8 hours a day and are supplemented with native hay, crop-by products, green grasses, oil seed cakes and milling byproducts depending upon the availability and resources of farmers. Small proportion of farmers (12.3%) use only grazing to feed their animals.

Dairy cattle housing

In the study area, 38% and 32.3% of the farmers kept their dairy cattle mixed and separated in barn, respectively. The barns were well constructed from locally available materials. The remaining 24.7%, 4% and 1% of the farmers kept their dairy cattle in separate in corral, mixed in corral and in farmers' house mixed with people, respectively.

Calf management

Farmers rear all females born claves to reach puberty for breeding (67.4%), for sale (61.8%). Almost all (99.7%) of farmers rear all male born claves to reach puberty for the purpose of breeding and draft power (90.6%) and for breeding, draft power and beef (9.1%). About 94% of the farmers weaned their calves when the dam rejects (dry off) and 6% wean the calves when they start grazing. All the farmers provided calves with separate housing, which was well constructed from locally available materials, which can protect the calves from extremes of weather conditions.

Dairy cattle health

Cattle health problem were managed by farmers and taking to local veterinary clinic (36.3%), traditional healers (3.3%) and both local veterinary clinic and traditional healers (60.3%). In most farmer households, animals were vaccinated against anthrax, blackleg, pasteurellosis and contagious bovine pleuropneumonia. 94.3% of farmers in the area treat their animals against internal parasites with a mean value of 2.19 times a year (SD=0.63) when the animals were found in poor body condition at any time of the year.

4.2.4. Constraints of dairy production

According to the responses of sampled households, shortage of grazing land was the most important constraint in the area (37.7%) followed by dairy cattle disease (21.7%), shortage of concentrate feed (18.7%), shortage of crossbred heifers (12.7%). In addition, few farmers mentioned that low genetic potential of local breeds (4.6%) and inadequate AI service (4.4%).

4.2.5. Performances of dairy cattle

Daily milk yield and Lactation length

Table 5 shows mean daily milk yield at the beginning, middle and end of lactation and lactation length of the indigenous and crossbred dairy cattle in the study area. Milk yield at all stages of lactation and lactation length were significantly affected by genotype of cows ($p<0.001$). Crossbred dairy cows had better milk yield at all stages of lactation than indigenous ones. Crossbred cows gave 266.7-285.7% more milk during all stages of lactation than indigenous cows. The lactation length of crossbred cows was longer by an average of 4.97 months than that of indigenous cows.

Table 5. Mean and standard deviation of milk yields of indigenous and crossbred dairy cattle.

Breed	Mean± SD
Indigenous	
Milk yield (lit)	
Beginning of lactation	2.50 ±0.93
Middle lactation	1.59±0.70
End of lactation	0.91±0.51
Lactation length (month)	5.82±0.85
Crossbred	
Milk yield (lit)	
Beginning of lactation	6.34±2.48
Middle lactation	4.55±2.00
End of lactation	2.75±1.40
Lactation length (month)	10.79±1.63

SD =Standard Deviation, N=Number

The results of the analyses of variance for factors affecting estimated daily milk yield and Lactation length in the study area was genotype of dairy cows.

Reproductive performances

Table 6 shows mean values of age at first calving, calving interval and number of service per conception of indigenous and crossbred dairy cattle in the study area. Breed of cattle significantly ($p<0.001$) affected age at first calving and calving interval. There was significant difference ($p<0.05$) between breeds in number of services per conception. On average, age at first calving and calving interval were shorter by 2.23 years and 8.37 months, respectively in crossbred cattle than indigenous ones.

Table 6. Mean and standard deviation of age at first calving, calving interval and number of service per conception of indigenous and crossbred cattle.

Breed	N	Mean± SD
Indigenous		
Age at first calving (year)	505	5.45±0.64
Calving interval (month)	320	24.92±1.79
Number of service per conception	502	1.43±0.69
Crossbred		
Age at first calving (year)	48	3.22±0.74
Calving interval (month)	38	16.55±1.89
Number of service per conception	49	1.20±0.49

SD =Standard Deviation, N=Number

4.3. Dairy cattle breeding practice

4.3.1. Source of establishment dairy herd and level of satisfaction of farmers

The higher proportion of the farmers obtained their establishment herd from local market (86%). There were also some farmers who got their establishment herd from family as a gift (11%) and also from research and development institutions (3%). Most farmers (84%) were not satisfied with the performance of their dairy animals. The most important trait they were not satisfied with was milk yield (69%) followed by age at first calving (21%), milk fat percentage (11%) and calving interval (8%).

All the farmers who were not satisfied with the above performance traits had a plan to improve the performance of their animals. The higher percentage of farmers planned to improve the performance of their animals by cross breeding (60.7%), while others by selection within the herd (11%) and the combination of cross breeding and selection (17.7%).

4.3.2. Source of information for breeding decisions

Figure 2 illustrates the overall proportion of farmers that mentioned different source of information to know the performance of cows for the trait of their interest. In the study area, farmers mentioned one or a combination of sources of information. Most of the farmers (42.6%) used individual performance information to acquire dairy animals.

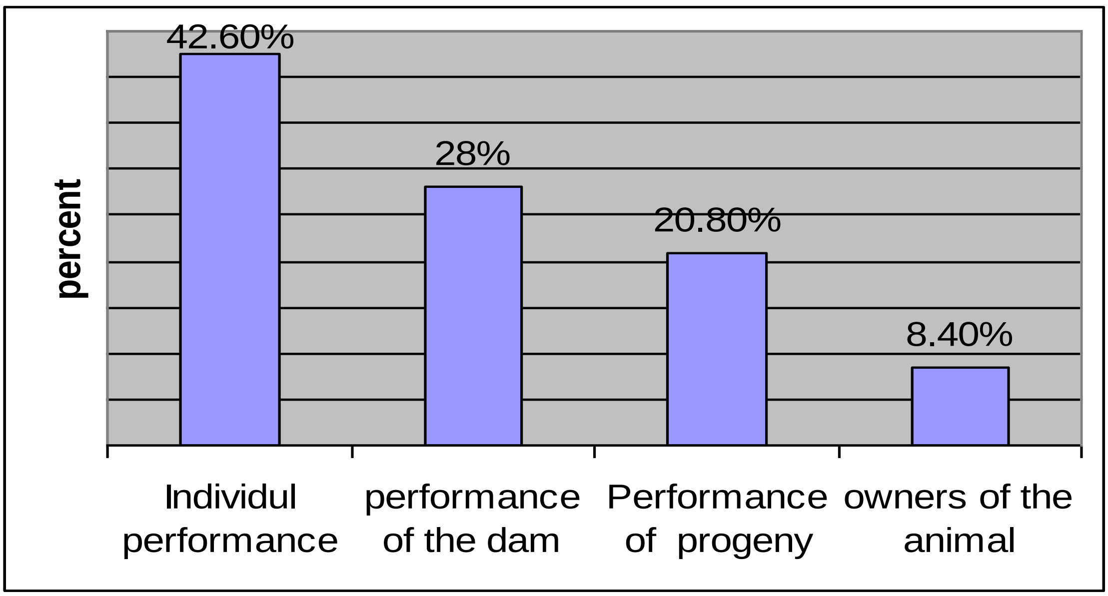

Figure 2. Farmers source of information to know the performance of cows for the trait of their interest.

4.3.3. Preferred performance traits by farmers

Figure 3 shows the proportion of farmers in the study area that mentioned different performance traits as their preference. The most important preferred trait mentioned by farmers in the study area was high daily milk yield (79%). Age at first calving was preferred by 10.5% of the farmers while high milk fat percentage and calving interval were considered as priority by 6.4% and 4.5%, respectively.

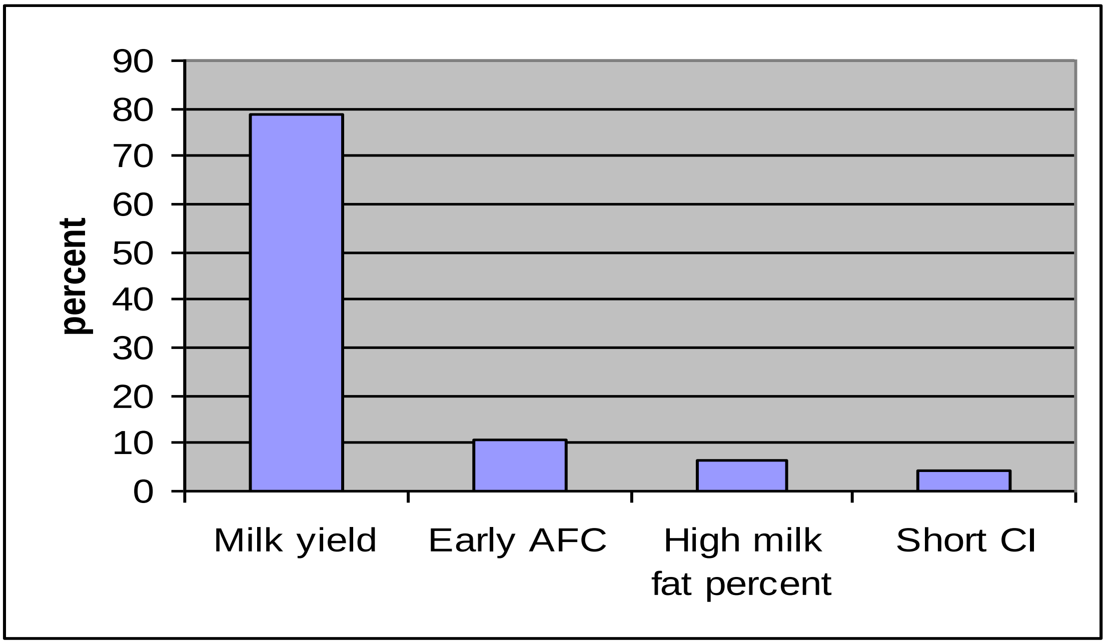

Figure 3.Preferred performance traits by farmers in the study area.

Morphological features that were considered related to dairy cows performance and mentioned by the farmers are shown in Table 7. Farmers in the order of importance mentioned triangular shape of the dorsum of a cow, large udder size of cow, long neck with small dewlap, short horn pointed forward and absence of hump as morphological features related to dairy cows performance.

Table 7. Morphological features considered related to dairy cows performance by respondents

Morphological features	Percentage of Farmers	Frequency
Triangular shape cow	45	170
Large udder size	26.4	99
Thin and long neck with small dewlap	12.4	47
Short horn with inclined forward	10	38
Hump less	9	34

4.4. Heat detection and mating practice

Table 8 shows the percentage of farmers in the study area that mentioned different heat signs used to detect cows or heifers in heat. The important heat sign used by farmers was standing to be mounted and mounting on bulls and other cows, mucous discharge from the vulva, Bawling, restlessness, redden and swollen vulva, disturbing the herd, isolation from the herd and reduced feed intake.

Table 8. Heat signs used by farmers to detect cows or heifers in heat in the study area.

Most important heat sign	Percentage	Frequency
Standing to be mounted and mounting on bulls or other cows	48.2	278
Mucous discharge from the Vulva	18	104
Bawling	12.3	71
Excitement (restlessness)	9.2	53
Redden and Swallow Vulva	6.2	36
Disturbing the herd	2.6	15
Isolated from the herd	1.7	10
Reduce feed intake	1.5	9

Regarding mating methods, most of the farmers (92%) were using only natural mating while the remaining proportion of farmers, 3.3% and 4.7% were using AI and both AI and natural mating, respectively (Figure 4). The most important reason for preferring natural mating by most of the farmers was availability (88.8%). About 63% of the farmers using natural service had a plan to change the bull they are using in the future. The reasons for changing bulls were to have better dairy breeds (to improve the performance of their herd) (90.7%), old age of bulls (3.1%) and castration of breeding bulls (6.2%).

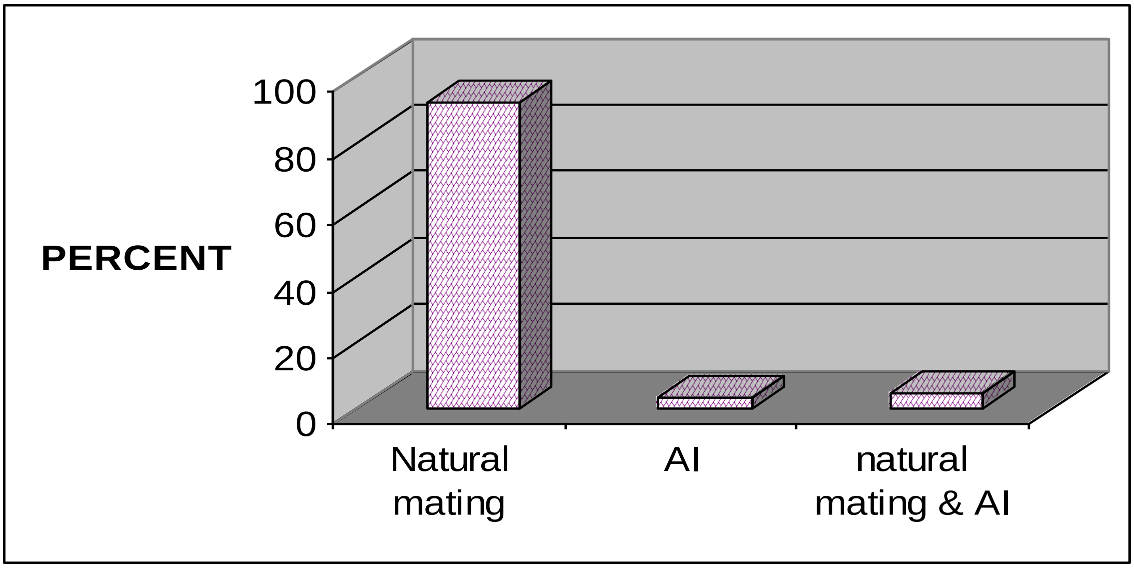

Figure 4. The existing pattern of mating practice in the study area

About 47.2% of the farmers detecting heats in the morning took their cows for service during the same morning, 19.7% of farmers did it in the afternoon. The remaining 15.4% and 11.4% of farmers took their cows to service in the next morning and any time of the day since the cows were left always together with bulls in grazing land, respectively.

When heat signs were detected in the afternoon, 67.7% of farmers took their cows for service in the next morning, while 20.6% took their cows in the same afternoon. The remaining 11.7% of farmers mentioned that since cows are together with bulls in grazing they were served at any time of the day.

4.5 Result of participatory methods

4.5.1. Farmers preference for dairy cattle breeds

Friesian crossbred cattle were ranked top by total score (45.2) followed by Jersey crosses (44.9) and indigenous cattle (29.2). Farmers' relative preference for Frisian crosses and Jersey crosses for high milk yield over hardiness was 2.5 and 2.4 times more when compared with preference for indigenous Zebu breeds respectively. The details of the characteristics of the cattle breeds and average scores given to them by farmers are shown in Table 9.

According to the results of matrix ranking, Friesian crosses were superior than Jersey crosses in visibility of oestrus signs, while Jersey crossbred cows were superior in milk fat percentage. There was not much difference between Friesian and Jersey crosses in milk yield, persistency in milk yield, maturity age, conception rate, maternal ability visibility of oestrus signs, calving interval, calmness during milking, milk letdown with out calf and diseases resistance. Indigenous cattle were considered better than the other two breeds in milk fat percentage, conception rate, and disease resistance. On the other hand, indigenous cattle were inferior to the other breeds in milk yield, persistency in milk yield, early maturity and easy milking.

Table 9. Characteristics of cattle breeds identified by farmers in the study area

Breed characteristics	Scores		
	Frisian crosses	Jersey crosses	Indigenous
Milk yield	4.5	4.3	1.8
Persistency in milk yield	4.2	4.1	1.7
Milk fat percentage	2.3	3.7	4.1
Maturity age	4.7	4.5	1
Conception rate	3.3	3.2	4.1
Short calving interval	4.7	4.3	1.3
Visibility of oestrus signs	4.7	4.2	3.5
Maternal ability	4.2	4.2	3.2
Calmness during milking	4.6	4.5	1.6
Milk letdown without calf	4.5	4.3	2.5
Disease resistance	3.7	3.6	4.4

4.5.2. Constraints of dairy production

Factors that hinder dairy development in the area, which were summarized by participant farmers are shown in Table 10. Shortage of grazing land was found to be a very important problem in the area. Inadequate AI service and scarcity of crossbred heifers were also important ranking second and third next to grazing land shortage.

Table 10. Farmers' views of the factors that hinder the development of dairy production.

Root causes	Score
Shortage of grazing land	164
Inadequate AI service	162
Scarcity of crossbred heifers	161
Concentrate feed shortage	157
Inadequate veterinary service	138
Inadequate support from the government	133
Lack of training	129
Lack of capital	120

4.5.3. Preferred performance traits by farmers

Figure 5 show the proportion of farmers in the study area that mentioned different performance traits as their preference. The most important preferred trait was high daily milk yield (33.9%) followed by age at first calving (26.2%) and high milk fat percent (18.4%). Shorter calving interval (10.8%), docile behavior of cows (5.8%) and fast growth rate (4.9%) were also mentioned by some farmers.

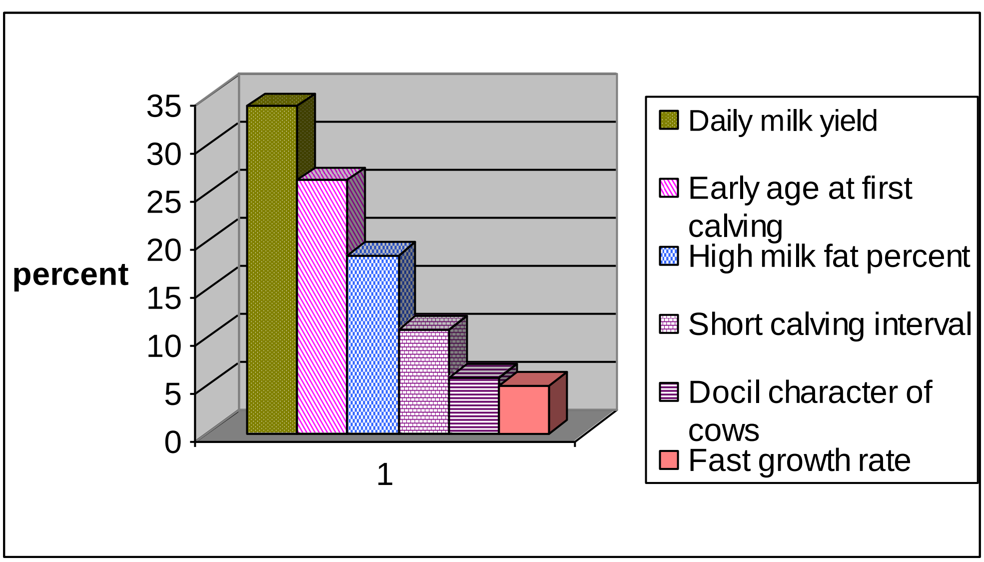

Figure 5. Preferred performance trait of farmers in focus group discussion

4.5.4. Source of information to assess the performance of dairy cattle

Table 11 shows the proportion of farmers mentioning different sources of information to assess the performance of dairy cattle used for breeding in the focus group discussion. The most important source of information was individual performance of the animal and the second was body conformation of the animal (morphological features) The third and the fourth were performance of the progeny and performance of the dam respectively. Woreda Agricultural and Rural Development Office, local knowledgeable persons and owners of the animals were also used as a source of information about the performance of dairy cattle.

Table 11. Farmers' sources of information to assess performance of dairy cattle

Source of information	Percentage	Frequency
Individual performance of the animal	27.6	27
Body conformation of the animal (morphological features)	24.5	24
Performance of the progeny	16.3	16
Performance of the dam	11.2	11
Woreda rural and agricultural development office	8.2	8
Local knowledgeable persons	7.1	7
Owner of the animal	5.1	5

6. DISCUSSION

6.1. Farming system characteristics

The result in this study indicated that the head of the sampled households had an average age of 46.6 year (SD=13.4) with dairying experience of 21.9 years (SD=12.8), indicating that dairying was generally in the hands of the old age with long dairying experience. This finding is partly in agreement with what has been reported by Bebe *et al.,* (2000)(the head of the sample households had an average age of 50.5 years (SD=14.2) with dairying experience of 16.3 yeas (SD=9.9) in central highlands of Kenya. The results of this study also showed that about 87.6% of the household owners were males and the remaining (12.3 %) were females which is in agreement with what has been reported by Chinogaramombe *et al.,* (2008) (80% were males in smallholder dairy farming in Zimbabwe) and Chagunda *et al.,* (2006) (79.1% males in Malawi smallholder dairy farmers).

The study also showed the mean values for family size in the study area (5.71 persons) were lower than the one reported by Kelay (2002) (7.54 persons) per household at *Selale* area and higher than the report of Niftalem (2000) (4.6 persons) at Debre Berhan. The average total land holding per household in this study was 3.42 ha from which 54.3% was allocated for crop and 22.4% for grazing land. This finding is in line with what has been reported by Yosef (1999) for the same study area, and stated that the average farm size of farmers was about 3.44ha of which 71.2% was cultivated and 28.79%was reserved for pasture and haymaking. The finding is also very close to the report of Kelay (2002) for Selale area (average total land holding per household was 3.78 ha from which 56.6% was allocated for crop and 43.4% was grazing land) and higher than what has been reported by Musalia *et.al.,* (2007) for Mumias and Kakamega districts in Western Kenya (the average land size was 2.4ha with only 30.3% being allocated to pasture or fodder crops).

Cattle (37.3%) and sheep (27.8%) dominated the livestock herd in the study area. Kelay (2002) reported the same result for Selale area, but the proportion was higher than our finding, (58.3% cattle and 30.3% sheep).

6.2 Dairy cattle production

The result of this study showed that 44% of the farmers keep dairy animals for milk production as source of income and household consumption. The remaining 56% of the farmers kept dairy animals for milk production both for source of income and family consumption and production of draft animals. This finding is in agreement with what was reported by Bebe *et al.,* (2003) in the Kenyan highlands and Kelay (2002) in Selale area in Ethiopia. Mwacharo and Drucker (2005) also found a result emphasizing the multiple importance of keeping cattle South-East Kenya.

Cows dominated the cattle herd compositions found in the study area (45.13%) most of which were indigenous. This is partly in line with what was reported by Yosef (1999), who stated that the majority of mixed crop-livestock farmers have exclusively local cattle breeds, and also Kelay (2002) for Selale area where cows comprised 38.7%-44.7% of the cattle herd, of which 37.3% were indigenous and 62.7%were crossbreds**.** According to the report of Ahemed *et al.,* (2006), the large cattle population of Ethiopia has relatively limited numbers of exotic dairy cattle and their crosses. Indigenous cows are particularly needed to breed the oxen required for plowing in mixed crop-livestock production systems (Yosef, 1999). Oxen (steers) in this study, which were used mainly for traction in the present study area, also comprised a significant proportion of the cattle herd (22.29%), which is considerably lower than the report of Kelay (2002) (31.4%).

6.3. Dairy cattle management

The predominant dairy cattle feeding system in the present study areas was grazing and stall-feeding (87.7%). Cattle were allowed to graze on pasture for an average of 7 to 8 hours a day. Small proportion of farmers (12.3%) use only grazing to feed their animals. The same result was reported by Bebe *et al.,* (2008); smallholder dairy farmers in the Kenya highlands follow a feeding practices including grazing of forages from common properties (communal grazing land) and feeding of crop residues supplemented with purchased forages and concentrates.

Shortage of grazing land was the most important constraint mentioned in the present study followed by cattle diseases, shortage of concentrate feed, shortage of crossbred heifers, low genetic potential of local breeds and inadequate AI service in the order of their importance. This is partly in agreement with what has been reported by Bebe *et al.,* (2008) where feed problem was ranked as the most important constraints to the development of dairy production in smallholders in the Kenya highlands followed by poor animal performance and shortage of capital to purchase inputs. And the result was supported by the finding of PRA result in the same study, which states, shortage of grazing land was found to be a very important problem in the area.

6.4. Breeding practices

The result of this study shows that 86% farmers obtained their establishment herd from local market and 11% got their establishment herd from family as a gift and 3% from research and development institutions. This finding is partly in agreement with what has been reported by Bebe *et al.,* (2000), who indicated that over 80% of the smallholders purchased their first dairy cow and less than 10% actually upgraded their stock.

The results of PRA in the study shown that Friesian crossbred cattle were ranked top by total score (46.7) followed by Jersey crosses (43.7%) and indigenous cattle (31.2%). There was not much difference between Friesian and Jersey crosses in milk yield, persistency in milk yield, calmness during milking and milk letdown without calf. The same result was reported by Bebe *et al.,*(2003) that smallholder farmers give high priority to exotic dairy breeds for milk production in the Kenya highlands. According to farmers' rankings, the major objectives for keeping cattle were milk production for feeding the family and for generating cash income.

The results of both questionnaire survey and PRA in this study showed that high daily milk yield was the most important preferred performance trait by individual farmers in the study areas. The introduction and distribution of crossbred dairy cows and complementary feeding and management technologies through a collaborative dairy technology and cow traction project involving the Ethiopian Agricultural Research Organization (EARO) and International Livestock Research Institute (ILRI) and the increasing in the demand of milk and milk products are the main driving forces for farmers to consider milk yield as the most important trait at Holetta area. In view of its ability to generate significant amount of daily cash income and its contribution to the improvement of the livelihoods of very poor people, dairy production is becoming increasingly important in many developing countries including Ethiopia (Ergano and Nurfeta, 2006).

Age at first calving was also one of the preferred performance trait mentioned by farmers in both questionnaire survey and PRA in the study areas. Breed of cattle significantly affected age at first calving. On average, age at first calving was shorter by 2.23 years in crossbred cattle than indigenous ones. This finding is in agreement with the reports of many authors. Age at first calving was higher in indigenous animals than crossbreds in Ethiopia (McDowell, 1972; Albero, 1983; Mukasa-Mugerwa, 1989; Mekonnen and Goshu, 1987; Mukasa-Mugerwa *et al.,* 1989; Mattoni *et al.,* 1988).

The study also indicated that the other preferred performance trait by farmers was high fat content in the study area. Thus, the lack of infrastructures (e.g. milk collection centers, road to deliver liquid milk to market site etc.) for liquid milk changes the attention of farmers on butter and cheese production to optimize the utilization and the market value and storage life of liquid milk produced in the area. This finding is in agreement with has been reported by Kelay (2002) who stated that high fat content was also considered as a preferred performance trait by a significant proportion of farmers at

Mulo-Sululta that is located closer to Addis Ababa than Degem area in Selale. This finding is also in agreement with what has been reported by Almaz *et al.,* (2001), fermented milk products fulfill multiple purposes in the rural smallholder dairy farmers in Ethiopia. They are consumed as food and the market value and storage life are improved over that of raw milk.

The results of this study showed that most of the farmers (42.6%) used individual performance information to acquire dairy animals. This shows that farmers in the area depended on unreliable information on cows' individual performance in conditions that had no production and reproduction record activities. The finding agrees with the report of Kelay (2002), which found out that farmers in Selale area depended on performances of individual dairy cows to acquire dairy animals. The accuracy of indirect information not based on official recording of performances is difficult to access and farmers, thus, are exposed to high transaction costs whenever cows are purchased. Selection by individual performance is a most valuable method where a trait is highly inherited and where it can be observed in both sexes (Dickinson, 1985). In general, most reproductive traits tend to have low heritability (<0.2) and yield traits tend to be moderately heritable (0.2-04) (James, 2004).

The study also indicated performance of the dam was second most important source of information mentioned by farmers. This type of selection is a method of selection based on the performance of ancestors (James, 2004). This method can be of value only if the pedigree information is complete (Syrstad, 1998). According to Laurence, (2002) today, pedigree information is most useful when no data are available for the individual animal, either because it is too young or because the expression of a trait is sex-linked.

Most of the farmers in this study did not practice any sort of record keeping. According to the report of Chagunda *et al.,* (2006), the main reason for farmers not participating in recording activities in highlands of Malawi was that farmers were busy with other activities. This is basically a reflection of the production system, which is a crop-livestock mixed system in highland smallholder farmers.

Regarding mating practice, the result of this study showed that most of the farmers (92%) were using only natural mating while the remaining proportion of farmers, 3.3% and 4.7%, were using AI and both AI and natural mating, respectively. The bulls used for mating may mated with their close relatives, potentially increasing the inbreeding levels in the population. Furthermore, most of the bulls would be of unknown pedigree although generally of known genotype, implying that systematic selective breeding is lacking. This is in agreement with the report of Yosef (1999) for Holetta area. This finding is also partly in agreement with what was reported by Baltenweck *et al*., (2004) (81.44% used natural service) in Kenyan smallholder farmers and higher than the report of Bebe *et al*. (2000) (62%) in smallholders in the central highlands of Kenya.

7. CONCLUSION AND RECOMMENDATION

The smallholder farmers in the present study dairying in mixed crop-livestock farming system with the objectives of producing milk and milk products for household consumption and sales and also other purposes. Dairy production in the study area was based on grazing and stall-feeding and the performance of dairy cattle with regard to milk yield, age at first calving and calving interval was poor while the number of services per conception was good. The constraints of dairy production in the study areas included shortage of grazing land, cattle diseases, shortage of concentrate feed, inadequate AI service and shortage of crossbred heifers.

Jersey and Holstein crosses were preferred by farmers in the study area for milk yield and behavioral characteristics while indigenous cattle were preferred for their milk fat percentage, conception rate, visibility of oestrus signs and disease resistance. The preferred performance trait in the study area was milk yield. Shorter age at first caving and high milk fat content were also considered as important to some extent. The breeding decisions of smallholder dairy in the study area conform to producers' multiple objectives. Farmers in this study depended on various sources of information to determine the performance of animals including individual performance, dam's performance, progeny performance and body conformation of animals (triangular shape of cow, large udder size and thin and long neck with small dewlap). The most important mating method in the study area was natural service mainly for its availability.

In line with the above conclusions, the following points are recommended:

- Efforts should be made by government and non-government organization to improve the productivity and availability of grazing land, concentrate feeds and improved breeds of cattle;

- Herd recording schemes which are suitable for the prevailing production system situations should be instituted and sustained so that farmers can get reliable source of information for selection of replacement stocks;

- The smallholder farmers in the study areas should be encouraged to form cooperatives which can facilitate input acquisitions and product marketing and also influence policy makers;

- In the short term, bull services should be very well organized and controlled and the health status of bulls should be monitored regularly. In the long term, the availability of AI in the area should be improved.

- Large scale private investors should be encouraged to be involved in the introduction of new technology in the sector such as improved genotypes, feed and processing;

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9. ANNEX

Annex 1. **Questionnaire**

GENERAL INFORMATION OF THE AREA

I. Survey site (Location)

Region: __________ Zone___________ Woreda _______________ Kebele ________Altitude (m a.s.l.) __________________________

II. Socioeconomic and farming system characteristics

1. Name of farm owner: _________________________________
2. Age of farm owner: ________________
3. Sex of farm owner: ________________
4. Educational status: _________________
5. Family size: ________________
6. Land holdings (ha)

   Crop---------, Pasture -----------, Fallow------------------ Forest--------------- Others------

7. Livestock herd size and composition

Livestock species	Herd size	What is the trend in the last ten years (Increase or decrease)	Reason for the change in the trend
Cattle			
Sheep			
Goats			
Donkey			
Horse			
Mule			
Camel			
Poultry			

8. Cattle herd size and composition

Cattle type	Status	Number			
		Indigenous	Crossbred	Exotic	Total
Cows	Pregnant non-lactating				
	Lactating non-pregnant				
	Lactating pregnant				
	Dry pregnant				
	Dry non-pregnant				
Heifers					
Bulls					
Male calves					
Female calves					
Steers					
Total					

9. What are the objectives of cattle keeping?

Milk_____ Meat _______ Draught ________ Other (s): _______

10. When did you start keeping dairy cattle in your farm?

Breed of dairy cattle % of exotic blood	Year of establishment

11. How do you house your dairy cattle?

a) Separately in corral   b) Mixed in corral   c) Mixed in barn

d) Separately in barn   c) In the farmer's house mixed with people

e) Other (specify)

12. What type of feeding do you practice for dairy cattle?

a) Based on only grazing

b) Based on only stall feeding (concentrate + hay and/or crop residue+ agro industrial byproducts + cut and carry) please underline the combinations

c) Based on grazing and stall-feeding (concentrate + hay and/or crop residue+ agro industrial byproducts + cut and carry) please underline the combinations

d) Any other system (specify)

14. Dou practice culling of dairy cattle? If yes why

a) Yes   b) No   if yes, why

III. Dairy cattle breeding practices

1. What was your source of establishment herd?
2. How long have you used the current dairy herd?
3. How long are you intending to use the herd in the future?
4. Are you satisfied with the performance (milk yield, age at first calving, calving interval, number of services per conception etc) of your animals currently?
5. If not, in which traits are you not satisfied?
6. How are you planning to improve the performance of your herd in the traits in which you are not satisfied? (Cross breeding or selection within the herd owned by the farm currently)
7. Are planning to replace your dairy herd in the future? If yes, when, why and how?

8. Which traits of dairy production are you interested in while selecting your replacement stock?
9. What is your source of information to know the performance of animals you are selecting for the traits of your interest?

10. Do you know any sort of morphological features, which you think is associated with the trait of your interest? If yes, please specify.

11. Once you selected animals with good performance in the preferred trait, how do you introduce these animals into your farm (purchasing the animals, purchasing the daughters or using the son of the animals as a breeding bull or others)?

12. Is there any genetic relationship between your cattle herd and the source of your replacement stock?

13. Do you think there is problem in breeding very closely related animals (sisters and brothers, dam and son or etc) for dairy production?

14. If yes, what do you think is the problem?

15. Do you keep the performance and service records of your dairy cattle?

16. If yes, what are the records you are keeping?

IV. Heat detection and insemination

1. How do you detect a heifer or cow in heat?

2. If you are using heat signs, what are the most important heat signs you use to detect a cow in heat?

3. If you see a cow in heat in the morning, when do you take the cow for service?

4. If you see a cow in heat in the afternoon, when do you take the cow for service?

5. Are you using AI or Bull or Both to mate your dairy cows?

6. What is your primary reason for preferring AI, bull or both?

7. If you want your cow to get service (AI or Bull), how long would it take you to reach to the service site?

8. Do you have any preference for seasons while breeding your dairy cattle with either AI or Bull? If yes, why

9. How do you confirm weather a cow/heifer gets pregnant or not?

10. Have you ever considered your trait of interest (breeding objective) while using bulls or AI semen for breeding?

16. If you are using bull service, how long have you used the bull(s) for breeding?

17. Do you have any plan of using another breeding bull in the future?

If yes, when and why?

18. If you are using AI, do you mind to ask/check for the identity of the bull whose semen you are using for breeding?

V. Dairy cattle health

1. What are the major health problems of cattle that are of economic importance in the area? List in the order of importance
2. Do you see any difference in susceptibility to disease problems among the different breeds of cattle you own? If yes, which ones are highly susceptible and for which disease?
3. How do you manage cattle health problems?
   a) Taking to local veterinary clinic
   b) Taking to a traditional healer
   c) Any other way (specify)
4. Do you give vaccines to your cattle? If yes, against which diseases?
5. Do you practice deworming of your cattle? If yes, how frequent per year and when?

VI. Performance of dairy cattle

1.What was the age of your cows when they gave their first calf?

Cow ID/Name	Breed/level of exotic blood	Age at first calving

2.When did your cows give their recent birth? When did your cows give birth before the recent birth?

Cow ID/Name	Breed/level of exotic blood	Date/month/year of recent calving	Date/month/year of previous calving

3.How many times did you take your cow for service before it got pregnant last time?

Cow ID/Name	Breed/level of exotic blood	Type of mating (AI, Bull or Both)	Number of services per conception

4.What is the average daily milk yield of your cows at the beginning, middle and end of lactation? And how long do you milk your cows?

Cow ID/Name	Breed/level of exotic blood	Daily milk yield			Lactation length (months)
		Beginning	Middle	End	

I. Calf management

1. Do you feed newborn calves with colostrums? If yes, for how long?

2. For how long new born calf stay with their mother?

Local ______ Cross _________ Exotic_________

3. For how long new born calf stay at house until they start grazing?

Local ______ Cross _________ Exotic_________

4. Do you provide supplementary feed to newborn calf till they start grazing?

a) Yes b) No

5. If yes, mention the type of feed and form of feeding?

	Type of feeds	Form of feeding
Local	___________________________	___________________
Cross	___________________________	___________________
Exotic	___________________________	___________________

6. Do you rear all females born to reach puberty?

Yes, explain reason____

No, explain reason_______________________________________

6. Do you rear all males born to reach puberty?

Yes, explain reason____

No, explain reason____

7. When and why do you wean your calves?

When?

Why?

8. Are you providing your calves with separate housing? If yes, is it protecting the calves from extremes of temperature and humidity?

VII. Dairy extension service

1. What are the major sources of information for dairy production?

2. Have you ever participated in dairy production trainings?

a) Yes b) No

If yes, specify the training type and the organization organized the training.

3. Have you ever got, extension services for dairy production?

a) Yes b) No if yes, specify the type of service

4. Have you ever been supported in any means by an organization for dairy development in this area?

a) Yes b) No if yes, specify the type of support

5. Is there any credit program that support dairy development in this area?

Yes b) No If yes, type of credit, source and its performance?

VIII. Constraints

1. What are the major constraints of dairy production in your locality?

2. What are your suggestions to alleviate the above-mentioned constraints?

Annex 2. Checklist for points to be discussed in the PRA approach

- The most common breeds of dairy cattle found in the area
- Comparison of the different breeds with regard to different performance traits (milk yield, persistency in milk yield, fat yield, maturity age, fertility, disease resistance, feeding behavior and longevity).
- Morphological features believed to be associated with performance traits (selection criteria) and their relative significance
- The major sources of information to assess the performance of dairy cattle used for breeding purpose and their relative reliability

Annex 3.ANOVA Table for daily milk yield, Lactation length, age at first calving, calving interval and number of service per conception of indigenous and crossbred airy cattle

		Sum of square	df	Mean Square	F	Sig.
AFC	Between Groups	249.64	1	249.64	643.04	.000
	Within Groups	213.91	551	0.38		
	Total	463.56	552			
CI	Between Groups	2830.48	1	2830.48	20.27	.000
	Within Groups	49710.88	356	139.63		
	Total	52541.36	357			
NSPC	Between Groups	2.44	1	2.44	5.34	.021
	Within Groups	251.54	549	0.45		
	Total	253.99	550			
DMYBL	Between Groups	640.39	1	640.39	465.44	.000
	Within Groups	689.32	501	1.376		
	Total	1329.72	502			
DMYML	Between Groups	379.73	1	379.73	455.90	.000
	Within Groups	415.62	499	0.83		
	Total	795.36	500			
DMYEL	Between Groups	146.48	1	146.48	345.98	.000
	Within Groups	210.00	496	0.42		
	Total	356.49	497			
Lactation length	Between Groups	1072.42	1	1072.42	1174.09	.000
	Within Groups	458.52	502	0.91		
	Total	1530.95	503			

AFC=Age at first calving, CI=Calving Interval., NSPC=Number of Service per Conception, DMYBL=daily milk yield at the beginning of lactation, DMYML= daily milk yield at the middle of lactation, DMYEL= daily milk yield at the end of lactation.

SIGNED DECLARATION SHEET

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

Name	Nebyu Baye
Signature	________________
Date of submission	________________

This thesis has been submitted for examination with our approval as university advisor

Dr.Kelay Belihu	___________________
Prof.Merga Bekekana	___________________