COMPARATIVE PERFORMANCE EVALUATION OF DAIRY COW BREEDS AND FARMERS' TRAIT PREFERENCE IN ANGOLELANA TERA DISTRICT, NORTH SHEWA ZONE, ETHIOPIA.

M.Sc. Thesis

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COMPARATIVE PERFORMANCE EVALUATION OF DAIRY COW BREEDS AND FARMERS' TRAIT PREFERENCE IN ANGOLELANA TERA DISTRICT, NORTH SHEWA ZONE, ETHIOPIA.

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A Thesis Submitted to the Department of Animal Sciences, College of Agriculture and Natural Resource Sciences, postgraduate studies

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In Partial Fulfillment of the Requirements for the Degree of Master of Science in Animal Sciences

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This is to certify that the thesis entitled "***Comparative performance evaluation of dairy cow breeds and farmers' trait preference in Angolelana Tera district, north shewa zone, Ethiopia***" submitted in partial fulfillment of the requirements for the degree of Masters of Science with specialization in Animal Production of the Graduate Program of the Animal Science, College of Agriculture and Natural Resource Sciences, Debre Berhan University and is a record of original research carried out by ***Beshah Agune ID. No DBU1400534*** under my supervision and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during this investigation have been duly acknowledged. Therefore, I recommend that it to be accepted as fulfilling the thesis requirements.

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As members of Boards of Examiners of the final Masters open defense, we certify that we have read and evaluated the thesis prepared by ***Beshah Agune Mulat*** under the title "***COMPARATIVE PERFORMANCE EVALUATION OF DAIRY COW BREEDS AND FARMERS'TRAIT PREFERENCE IN ANGOLELANA TERA DISTRICT,NORTH SHEWA ZONE,ETHIOPIA*** "and recommended that it be accepted as fulfilling the thesis requirement for the degree of Master of Science in *Animal science* with specialization in ***Animal Production.***

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I hereby that all the correction and recommendation suggested by the Board of Examiners are incorporated in to the final thesis**.** ***COMPARATIVE PERFORMANCE EVALUATION OF DAIRY COW BREEDS AND FARMERS' TRAIT PREFERENCE IN ANGOLELANA TERA DISTRICT, NORTH SHEWA ZONE, ETHIOPIA***. *By*

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DEDICATION

This thesis is dedicated to my lovely wife Mrs. Mekdes Zike and my daughters Samrawit, Ristetsiyon, Meklit and Wuhibt Beshah.

STATEMENT OF THE AUTHOR

I declare that this thesis is my genuine work, and that all sources of materials used for this thesis have been profoundly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for Master of Science (MSc) at Debre Berhan University and it is deposited at the University library to be made available for users under the rule of the library. I intensely declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate. Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgement of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the School of Graduate Studies when in his judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author and advisors of this thesis.

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ABBREVIATIONS AND ACRONYMS

AI	Artificial Insemination
ANOVA	Analysis of Variance
CBJ	Crossbreds Jersey
CBHF	Crossbred Holstein Frisian
CI	Calving Interval
CSA	Central Statistics Agency
DHIA	Dairy Herd Improvement Association
DMY	Daily Milk Yield
DO	Days Open
DRDP	Dairy Rehabilitation and Development project
FDA	Food and Drug Administration
HH	Household
IB	Indigenous Breed
LL	Lactation Length
MY	Milk Yield

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ABSTRACT

*The objectives of this research were to assess the productive and reproductive performances, and crossbred Jersey traits preferences by farmers in Angolelana Tera district. A total of 158 smallholders holding crossbreed Jersey recruited from seven Kebeles were interviewed face to face using a semi structured questionnaire. Index for traits preferences and one-way analysis of variance for reproductive and productive performances differences of dairy breeds were employed using SPSS version 25. In addition, the data were summarized in mean, frequency and percentage. The faming household headed by males with the mean age and family size of 46.09 years and 2.72, respectively besides an average dairy farming experience of 20.13 years. The sample farmers currently own an average number of 5.65 cattle including 2.97 crossbred Jersey sourced entirely from Mercy project in calf heifer free provision. Improved bull is the dominant means of mating dairy animals in the study district, which is sourced from neighbor (93.06%) with mean price per service of 38.61 ETB. Crop residues (0.18), grazing natural pasture (0.17), hay (0.13), wheat bran (0.13) and treated crop residues (0.11) are among the most ranked feed resources available for crossbreed dairy animals. Milk yield, growth and traction in crossbreed Holstein Friesian, while milk fat, fertility and growth in crossbred Jersey were the most valued traits by farmers in the study district. The overall mean of most reproductive and productive performance parameters of crossbreed Jersey namely age at first calving (30.56 months), daily milk yield per cow (5.02 liters), lactation length (241.32 days), calving interval (441.79 days), number of services per conception (1.55) and longevity (16.53 years) were significantly better than its counterpart crossbreed Holstein Friesian with the corresponding values of 32.91 months, 7.36 liters, 227.28 days, 447.59 days, 1.86 and 15.03 years. However, no significant variations were observed between the two crossbreeds on age at first service and days open. Adoption of improved Jersey breeds because for increased income (100%), milk production (100%), milk consumption (97.5%), demands for inputs and services such as AI service (100%), veterinary service (100%), concentrate feed (70.9%) and improved forages (72.8%). The higher content of chemical compositions of milk from the study animal results was 13.12%, 4.65%, 4.71%,*8.53%, 3.16% and 0.67% *for total solid, lactose, fat, SNF, protein and ash, respectively. In conclusion, although some parameters are antagonistic with the standards recommended for dairy farming, crossbreed Jersey performed well in the district. It indicates that the project looks targeted on the right breed in the right place with necessary training approaches on caring for animals and milk processing. Therefore, the wide use of crossbreed Jersey must be promoted in the district together with necessary improved management packages.*

Key words: Crossbred; Jersey; Performances

1. INTRODUCTION

1.1. Background and Justification

Ethiopia holds the largest cattle inventory in the region, which account for 70 million with the female cattle constituents for about 56%. Livestock contributes to 16.5 and 40% of the national and agricultural Gross Domestic Product, respectively. The numbers of dairy and milking cows are estimated to be15 million and 7.5 respectively (CSA, 2021).The country produces over an estimated amount of 4.69 billion liters of cow milk. Livestock products in general are not only rich sources of protein and essential amino acids but also globally contribute 13% of the world calorie intake (CSA, 2021).

The increasing population growth coupled with increased income, changes in nutritional and dietary needs and desires, and increased urbanization are the most potent drivers of increasing demands for livestock products in Ethiopia. Dairy sector is dominated (97.4%) by indigenous cattle breeds with low average productivity of 1.48 liters per day per cow (CSA, 2021), which is about 10-fold below the levels routinely achieved in Europe. Breed improvement generally provides key entry points for increasing productivity in dairy cattle. Exotic dairy cattle breeds could perform at much higher levels, but often do not express their full genetic potential in African production systems due to shortage quality feeds, poor breeding and fertility management, high pests and diseases prevalence and poor housing conditions (Shiferaw *et al.*, 2003).

Crossbreeding of indigenous breeds with high producing exotic dairy cattle breeds combined with improved management system has been the primary intervention to improve milk production and enhance other performance traits in Ethiopia. Over the past many years, Ethiopian government has been attempting several initiatives intended to improve the productivity of dairy animals on farm and research conditions with the support of development partners. Consequently, promising results on productive and reproductive performances of crossbred dairy animals have been recorded under the existing smallholder's management system besides positive outcomes on the livelihoods of poor farmers. But still Ethiopia is unable to satisfy its own demand for milk and dairy products (Tadesse, 2002).

Crossbreeding could be realized with Jersey and/or Holstein Friesian but identifying the right animal in the right place and fit for purpose have often been paramount. Jersey breed cattle consume less feed, which is 80% of Holstein because of smaller stature, and the breed has a higher content of milk solids than that from its counterpart, Holstein. The Jersey breed also match with African poor nutrition and feed quality, high pest and disease prevalence, heat stress and sub-optimum husbandry practice than Holstein (Bland *et al.*, 2015).

To increase milk production sustainably and effectively respond to the increasing demand for animal source foods in general, and milk and milk products in particular, it is important that crossbreeding programs focus on dairy cattle breeds suitable for specific agro-ecological zones, culture, and production systems. The Jersey breed, for instance, is more economically efficient due to its higher milk solid content, which generates more return per kg of milk, higher fertility rate, and feed efficiency, which increases income over feed cost (~30%) compared with Holstein-Friesian. The chemical composition of milk can be determined by several factors such as breed of cattle, environmental temperature, stage of lactation, and animal feed (Kalac and Samkova, 2010). Generally milk is the most widely consumed food in the world and composed of 87.7 % water, 3.3% protein, 3.4% fats, 4.9% lactose and 0.7% minerals (Haug*et al.*, 2007; Poulsen *et al.,* 2012). Fat and protein contents are important economic traits for the milk particularly for butter making and cheese industry (IDF, 2012). In this regard, Jersey is preferable and top ranked breed interims of milk solid content.

Considering the comparative advantages of the Jersey dairy cattle breed, Project mercy established in 2010 in Chacha towan with 350 acre dairy farm to cross breed Ethiopia indigenous cattle with the jerky breed to increase milk reproduction. The project starts by distribution 5 six month in calf cross breed jersey heifer for 10 family members in 2013 e.c. The project mercy beneficiaries have got with need necessary training animals caring and milk handling.

The project mercy a non-profit charity organization based in Addis Ababa, Ethiopia and operating in several areas in the country, has been crossbreeding three local cattle breeds, namely Borana, Fogera, and Begait, with Jersey at Chacha, Angolelana Tera district of the North Shewa zone. Project Mercy produces F1 local Jersey heifers, breeds them with pure Jersey, and distributes 50% of Jersey cross pregnant heifers to the surrounding resource-poor farmers. Thus far, Project Mercy has distributed over 188 pregnant heifers to the surrounding farmers that are expected to give birth to 75% of Jersey blood crossbred calves. However, data on the on-farm production and reproductive performance, and milk composition of these Jersey crossbred cows under the smallholder farmers' management system are not available, which is essential for determining the productivity and profitability of their dairy operations. This study was therefore conducted to evaluate the reproductive and productive performance of farmers-owned and managed Jersey crossbred cows along their preferred traits by farmers in comparison with those of indigenous breeds and Holstein-Friesian crossbred dairy cows under smallholder farmers' management conditions. Such efforts should be encouraged as they provide important information that helps to decide which breed/crossbred cattle can be introduced and scaled for a specific agro-ecology as well as production system and objective.

1.2. Objectives of the Study

1.2.1. General Objective

To evaluate Comparative performance of dairy cow breeds and farmers' trait preference in Angolelana Tera district, north shewa zone, Ethiopia under smallholder farmers' production systems.

1.2.2. Specific Objectives

1. To assess productive and reproductive performances of crossbred dairy cow breeds under smallholder management levels;
2. To assess farmers' trait's preferences of crossbred dairy cow breeds in the study area.
3. To evaluate the chemical composition of milk of crossbred dairy cow breeds in the study areas.

1.3. Significance of the Study

This study will be used as reference material for those who need to conduct research related to performance and farmers preference traits of crossbred Jersey cows. The results of the current study will also support the decision or policy makers in providing valuable information with regard to productive and reproductive performance of crossbred Jersey cows.

1.4. Limitation of the Study

The study is limited to single district instead of covering the country where highly Jersey breed intervention areas like Holleta and Wolayita to get comprehensive information for better decision. This is due limitation of resources required to conduct a research such as budget and time.

2. LITERATURE REVIEW

2.1. Dairy Production Systems in Ethiopia

Dairy production is essentially practiced as an important share of agrarian duty in Ethiopia since ancient period (Asrat *et al*., 2013). Based on their location rural dairy production, pre-urban and urban dairy productions are the three main dairy production system classifications in Ethiopia (Ayalew, 2017).Ethiopia have a huge potential for dairy development. The large and diverse livestock genetic resources, existence of diverse agro-ecologies suitable for dairy production, increasing domestic demand for milk and milk products, improved market opportunities and proximity to international markets all contribute to the growing potential and opportunities for dairy development in the country. However, the development of the sector has been hampered by multi-faceted, production system-specific constraints related to genotype, feed resources and feeding systems, access to services and inputs, and low adoption of improved technologies (Asrat *et al*., 2016).

Therefore, any breed improvement program should be designed in accordance with the production systems. The different types of production environments need different types of dairy cattle breeds that are fit for the purposes. This right breed for right environment has special meaning for low input tropical production systems where all components of the production environments may not be changing shortly. In Ethiopia according to management practices, marketing situations, feed source and feeding system, herd type and size, land use type and objective of keeping animal, dairy production systems categorized into three production systems namely urban, peri-urban and rural production systems (Kassahun *et al*., 2015; Ayalew,2017)..

2.1.1. Urban Dairy Production System

This system is developed in cities located in the different agro-ecology of Ethiopia. It comprises medium to large sized dairy farms which are capable of keeping improved dairy cattle breeds. Cattle are housed in improved shelters made of locally available materials (Desta, 2002). The farmers have limited or no access to farming or grazing land, they are often based exclusively on livestock under stall feeding conditions (Ayenew *et al*., 2008). The main feed resources are agro-industrial by-products and purchased roughages. The primary objective of milk production is generating additional cash income (Ketema and Tsehay, 1995; Desta, 2002; Aneteneh *et al*., 2010). This production system serves as the main milk supplier to the urban market (Ayenew *et al.,* 2008). Milk is either sold to dairy cooperatives, on the local informal market or directly to consumers from the farmers' gates.

2.1.2. Peri -Urban Dairy Production System

This system is located around major cities and towns. It comprises of small sized to medium dairy farms which are also capable of keeping improved and local dairy stock. Cattle are housed in improved shelters made of locally available materials (Desta, 2002). The farmers have small size of grazing land; they use semi-grazing systems and also practice under stall feeding conditions for improved animals (Ayenew *et al.,* 2008). The main feed resources are agro-industrial by-products, purchased roughage and in addition they use crop residue and pasture land. The primary objective of milk production is also generating additional cash income (Ketema andTsehay1995; Desta; 2002; Anteneh *et al*., 2010).

2.1.3. Rural Dairy Production System

Most parts of the highlands are used for both crop and livestock production (mixed farming) with subsistence smallholder farming systems (Ketema and Tsehay, 1995; Anteneh *et al.,* 2010). Livestock is mainly grazed on natural pastures of non-arable or fallow land between crop fields and additionally fed crop residues (Desta, 2002). During wet season an increase of animal weight and milk production is achieved. There are two types of dairy systems in the highlands: the traditional and the market-oriented system. The traditional system is based on indigenous breeds which have low production performance (Ketema and Tsehay, 1995; Desta, 2002). The milk produced is mainly used for home consumption and feed requirements are entirely satisfied from native pasture, crop residues, stubble grazing or agricultural by products (Falvey and Chantalakhana, 1999). The market-oriented system is based on improved crossbred dairy cattle where milk is an important source of additional cash income (Ahmed *et al*., 2003).

2.2. Introduction of Exotic and Crossbred dairy cattle in Ethiopia

Ethiopia received its first exotic cattle (Holstein Friesian and Brown Swiss) in the 1950's from the UN Relief and Rehabilitation Administration and since then started commercial liquid milk production on government stations (Ahmed *et al.,* 2004). Crossbreeding itself did not start until 1967/1968 when the Chilalo Agricultural Development Unit (CADU) was formed at Asela station. Wolayta Agricultural Development Unit (WADU) established the farm in 1971, and in 1987 with the financial aid of Dairy Rehabilitation and Development project (DRDP) 90 Jersey breed heifers and Jersey bulls were imported from Zimbabwe and Kenya, respectively as initial foundation stock for the farm (Habtamu *et al*., 2010).

2.3. Historical Development in Cross breeding and Crossbred Cattle in Ethiopia

Crossbreeding could be realized with Jersey and/or Holstein Friesian but identifying the right animal in the right place and fit for purpose have often been paramount. Jersey breed cattle consume less feed, which is 80% of Holstein because of smaller stature, and the breed has a higher content of milk solids than that from its counterpart, Holstein (Bland *et al.,* 2015). The Jersey breed also match with African poor nutrition and feed quality, high pest and disease prevalence, heat stress and suboptimum husbandry practice than Holstein.

With the aim of improving milk production and growth performance, the crossing of indigenous cattle breeds with different exotic breeds was conducted since the 1950s. Bulls and semen of Holstein Friesian, Jersey, Simmental, Angus, Brahman, Hereford, Charolais, and Santa Gertrudis were imported to Ethiopia in different years. Most of the exotic breeds were not found currently, only Holstein Friesian and Jersey breeds are being utilized partially. In Ethiopia, dairy cattle genetic improvement program was started in the early 1970s. Initially, two imported exotic sire semen sources, namely Friesian (F) and Jersey (J) were used to cross with local Boran (Bo) dam to produce the first generation (F1) crossbred dairy calves. Secondly, F1 bulls were selected based on dam milk yield and physical appearances to produce second generations (F2) crosses Thirdly, semen from pure exotic breeds was used to produce high-grade cows whose level of exotic gene further rose to 75%.

In Ethiopia, the genetic improvement of dairy cattle is mainly based on crossbreeding and adoption of improved exotic breeds. Even though there is a concern about adaptation of pure exotic dairy cattle to tropical environment (climate, feed and disease challenge), pure Friesian and Jersey dairy breeds have been raised by large scale private and state dairy farms in Ethiopia. Crossbred cows have been reported to be more productive than purebred cows in the tropics.

Despite the promising productive performance of crossbred dairy cattle, high demand for milk and efforts to multiply in Ethiopia, well-organized and successful crossbreeding programs could not generate significant number of improved crossbred dairy cattle compared to the proportion of indigenous breeds and remains few. This could be associated with less efficient service delivery and lack of suitable breeding program to generate adaptive and productive generations. A long-term crossbreeding program initiated in 1974 at Holetta Agricultural Research Centre has been produced several generations of crosses between the indigenous Boran and Holstein Friesian breeds with the aim of combining productivity and adaptability in the crossbreds. This crossbreeding effort resulted in the development of various genetic groups (50% F1, F2, F3, and 75% first and second generations) which intervened for improving the breeding program (Cunningham and Syrstand, 1987).

Shorter calving intervals and calve at a younger age than the indigenous stock (Galukande, 2010). Calf mortality and health costs of calves are lower in F1generation compared to other crossbred grades (Madalenaetal.1995; Teodoro *et al.*, 1994). Further upgrading through producing second generation crosses (F2) by inter mating of F1 generations, or backcrossing (B1, B2) through crossing F1 to one of its parent breeds, results in serious deterioration of performance compared to F1. This effect is cribbed to reduction in heterozygosis and loss of beneficial epistatic effects (Cunningham and Syrstad, 1987; Syrstad and Ruane, 1998).

2.4. Reproductive and Productive Performance of Pure and Cross breed Jersey Cattle in Ethiopia

There is limited information on reproductive and productive performance of pure Jersey breed in Ethiopia. Research reports in the tropics revealed that Jersey cows are characterized by small body size, hardy and adaptable, low maintenance requirement, high feed conversion efficiency, high milk fat content, and good reproductive performance and has been selected for tropical research and development programs (Cunningham and Syrstad 1987; Njubi *et al* 1992). According to African Jersey Forum 2021 report, in the tropical highlands of Ethiopia, F1 Jersey x Boran crosses studied for longevity traits by Effa *et al*. (2012) showed significantly longer mean total life (4270 days (± 135)), herd life (3108 days (± 147)) and productive life (2387 days (± 126)) when compared with F1 Friesian x Boran crosses with a mean total life of 4200 days (±

135), mean herd life of 2877 days (± 148), and mean productive life of 2145 days (±127). F1 Jersey x Boran crosses also showed higher mean lifetime milk yield (MY) in litres (13547 (± 812), compared to 12817 (± 817) for F1 Friesian x Boran), though mean total milk yield in terms of litres per day of total life was broadly comparable at 3.04 litres (± 0.2)3 in F1 Jersey x Boran crosses vs. 3.00 litres (± 0.2)4 in F1 Friesian x Boran crosses.

In addition to pure Jerseys, the performance of Jersey x Horro (local) and Jersey x Arsi (local) crossbreds have been reported in Ethiopia: Kebebe *et al*. (2011) showed that Jersey X Horro indigenous crosses raised in the sub-humid area of Bako, Ethiopia had slightly improved estimates of 1.97 for the number of services per conception (NSC) compared to an NSC of 2.0 for the local Horro breed. Similarly, Njubi ***et al.*** (1992) reported that environment and diverse management systems had a significant negative impact (P<0.0).

2.5. Crossbreeding Systems and their Impacts

In the starting phase of a crossbreeding programme there is a significant improvement in performance due to the heterotic superiority of the first cross generation (F1) compared to the mean value of both origin breeds (Cunningham and Syrstad,1987).

Crossbreeding strategies can be basically classifying in to four different categories (1) present of exotic breeds among national breed populations by Species (multipurpose),(2) present of exotic and local breeds with genetic evaluation implemented, by species (exotic breeds), (3). Per cent of exotic and local breeds with breeding methods including cross-breeding, by species (local breeds) and (4) present of exotic and local breeds with breeding methods including cross-breeding, by species (exotic breeds) that differ according to whether or not hybrid animals will be used for breed in and the number of purebreds that contributes other breeding program (Thorpe *et al*., 1994; Kahi *et al*., 2000). With terminal crosses, hybrids are marketed. With the other categories, hybrids are reproducers and are subsequently mated with animals from one (breed substitution/upgrading), at least two (rotational crossing) or no (synthetic breed creation) continuously available pure breed(s). Each category has different merits or weakness (Debir and Bereket, 2021).

2.6. Crossbred versus indigenous Dairy cattle breeds

2.6.1. Productivity

Well-designed crossbreeding programs may lead to exploit desirable characteristics of the breeds or strains involved, and to take advantage of heterosis for traits of economic relevance (López-Villalobos, 1998). Milk productivity in Ethiopia is low; the indigenous zebu breed produces about 400-680 kg of milk/cow per lactation period compared to grade animals that have the potential to produce 1,120-2,500 lifters over 279-day lactation (Kefena *et al*., 2011).Moreover, mating of different genotypes increases efficiency in animals, and the improvement of reproductive and fitness traits such as fertility, survival, and calving ease, seems to be an important. Another study conducted in North Showa zone indicates that 50% cross breeds (1511.5 L) produce more amount of milk than local breeds (457.89 L) per lactation (Mulugeta and Belayneh, 2013). Belay *et al*. (2012) reported that mean milk production per lactation of Horro and Holstein Friesian crosses was 2333.63L.

2.6.2. Calving Interval

Calving interval is a time elapsed between two consecutive successive parturitions. Average calving interval of indigenous cattle breeds and their 50% crosses were 431.5 and 429 days respectively. Likewise, Yifat *et al.* (2012) reported that cross breeds have slightly shorter calving intervals than indigenous (622.6 days).Another study supporting this judgment reported in North Showa zone indicated that indigenous breeds have larger calving interval (748.2 days) than crossbreds (660 days) (Mulugeta and Belayneh, 2013). In order to maintain optimum economic benefits under modern intensive dairy systems, it is generally accepted that the CI should be around one year. However, under many dairy systems in tropical countries a one-year CI is often difficult or impossible to achieve and, in some situation, even undesirable.

2.6.3. Lactation Length

Lactation length (LL) of indigenous cattle increased in correspondence of exotic blood level. For example, the average lactation length of indigenous Arsi, Zebu and Boran breeds was 203.75 days while the average lactation length of their 50, 75 and 87.5% cross were 262.25, 284.25, and 294.25 days respectively. Similarly, another study conducted in Soddo Zuria District, Wolaita

Zone, Ethiopia indicated that local breeds (273.9 days) had shorter lactation length than cross breeds (333.9 days) (Mulugeta and Belayneh, (2013).

2.7. Chemical Compositions and Physical Properties of Milk

Milk compositions vary between Boran and Boran- Friesian crosses. Fat % in milk, protein, lactose and total solids in Boran-Friesian crossbred cows ranges from 3.80 to 15.32% and in Borana cows ranges from 4.00 to 16.02 % (Mesfin and Getachew, 2007), respectively. The per cent of fat in milk (6.01%), protein (4.05%) and total solids (16.02%) contents for Boran cows were higher than that of Friesian crossbred cows whereas Boran Friesian crossbred dairy cows have higher content of milk lactose (4.18%) than Boran cows (Mesfin and Getachew, 2007). Gonthier *et al*. (2005) reported that the type of breed affects milk composition. According to Mesfin and Getachew (2007) indicated that the difference in milk composition between the two breeds (Borana and crossbred dairy cows) may be due to the influences of breed differences in feed conversion efficiency to specific feed type.

Table 1. Milk constituents (%) of different dairy cattle breeds

Breed	**Fat%**	**Protein%**	**Lactose %**	**Total solid%**	**Solid nonfat %**
Holstein-Friesian	3.7±0.03	3.14±0.06	4.6±0.04	12.16±0.14	8.48±0.1
50%JerseyxHorro	3.8±0.18	3.8±0.18	4.67±0.023	13.24±0.23	9.29±0.23
50%HolsteinFrisianx25Jerseyx25Horro	4.7±0.08	4.7±0.09	4.17±0.04	13.68±0.02	8.98±0.09
Ogaden	4.69±0.01	4.69±0.01	4.57±0.19	14.03±0.39	9.28±0.5
Unknown	3.76	3.1	5.08	12.24	8.56
Local	5.46±0.51	3.07±0.56	5.47±1.25	14.71±1.51	9.26±1.38
Crossbred	4.04±0.29	2.76±0.37	5.52±1.71	13.03±1.24	9.01±1.16
Mean	14.06	3.61+0.9617	4.87+2.08	13.30.+2.49	8.98+0.57

Mesfin and Getachew (2007)

2.8. Factors Affecting Milk Composition of Lactating Cows

Generally, breed, age and the health condition of the animals, lactation period (early, mid, and late), feeding (type and quality), season, method of milking (manual or automatic), and the number of lactations, individual cows and environmental factors are the main determinant of milk composition (Alganesh, 2016). Milk is composed of approximately 87% water, 5% lactose or milk sugar, 3 to 4% milk protein and 3 to 5% milk fat. Milk lactose concentration does not vary and is known to determine the overall amount of milk produced. Milk protein concentration does vary some but not as widely as milk fat concentration. The question then becomes: what factors impact the concentration of milk fat from dairy cows? These factors can be loosely divided into genetic, environmental, and nutritional factors.

2.8.1. Genetics Factors

Yields of milk, fat, protein and total solids are not easily impacted by genetics; Heritability estimates for yield are relatively low at about 0.25. Meanwhile, heritability estimates for milk composition are fairly high at 0.50. Jersey cows produce milk of higher butterfat content than Holsteins. Milk fat percentage is moderately to highly heritable. Thus, relatively quick progress can be made if selecting sires for higher or lower milk fat percentage. Third although not a genetic factor per se, higher producing cows generally have a lower milk fat percentage.

Table 2. Breed averages for percentages of milk fat, total protein, true protein and total solids

Breed	**Fat %**	**Protein %**	**Lactose %**	**Ash %**	**Total solids %**
Holstein	3.55	3.42	4.86	0.68	**12.50**
Brown Swiss	4.01	3.61	5.04	0.73	**13.41**
Ayrshire	4.14	3.58	4.70	0.68	**13.10**
Jersey	5.18	3.86	4.94	0.70	**14.09**
Guernsey	5.19	4.02	4.91	0.74	**14.87**

Differences among individuals within a breed are often greater than differences among breeds (O'Connor, 1994) such differences are due to partly genetic factors and partly to environmental. For instance, Jersey breed gives milk of higher fat content than Friesian cattle, while Zebu cows can give milk containing up to 7 percent fat (O' Mahony, 1998). The milk from indigenous cows contains 6.1 percent fat, 3.3 percent protein, 4.5 percent lactose and 0.7 percent ash (Alganesh, 2002).The milk from various species of mammal has different composition (Table 2). This variation in milk composition is due to species effect.

2.8.2. Non-Genetic Factors Affecting Milk Composition

The length of time between milking, the stage of lactation, the age and health of the cow, the food regimen, the carefulness of milking, and microbial activities like the degradation of milk proteins and fats can all affect the content of milk (O'Connor, 1994).

2.8.2.1. Stage of lactation

The fat, lactose and protein contents of milk vary according to stage of lactation. In temperate type cows, the fat and SNF percentages tend to be higher in the early weeks of lactation, dropping by the third month then rising again as milk yield gradually declines (O' Manhony, 1998). The milk immediately after calving contains a very high percentage of total solids (up to 19 percent) mainly due to the very high fat and milk protein contents (O' Connor, 1993).The concentration of milk fat and protein is highest in early and late lactation and lowest during peak milk production through mid-lactation. Normally, an increase in milk yield is followed by a decrease in the percentages of milk fat and protein, while the yields of these constituents remain unchanged or increase (Rogers and Stewart, 1982).

2.8.2.2. Environmental factors

Heat stress does tend to decrease milk fat content. Often times, this is related to a decrease in feed intake and especially when intake of the forage component of the diet is reduced. Conversely, environmental factors such as nutrition and feeding management will impact yield more than the actual percent composition of the major milk constituents (Kroeker *et al*., 1985).

2.8.2.3. Nutritional factors

Nutrition has major effect on milk composition. According to O'Connor, (1994) under feeding cows reduces milk production, the fat and SNF contents of milk produced. As a general rule, any ration that increases milk production usually reduces the fat percentage of milk. The composition of milk varies considerably with breed type, stage of lactation, feed, season of the year, and many other factors (Charles, 1998). The cow's diet is the ultimate source of most of the material used in milk synthesis. The condition of feeding and the rations fed to the cow influences the percent and yield of milk composition. The nutritional status of cows in relation to optimization of milk constituents can be adjusted through proper grazing and feeding management (Robinson, 1997).

2.8.2.4. Disease

Although other diseases can affect milk component content and distribution, mastitis has been the predominant disease studied. The compositional changes in milk constituents associated with elevated somatic cell counts (a measure of severity of the disease). Mastitis results in a reduction in fat and casein content; and an increase in whey content of milk (Fernando *et al*., 1985).

2.8.2.5. Age (Parity)

The age of the cows has slight but definite effect on the composition of their milk. O'Connor (1994) suggested that as cow grows older, the fat content of their milk decreases by about 0.02 percentage units per lactation while the fall in SNF is about 0.04 percentage units. The decrease in SNF content seems to be due to a decline in casein content. Both fat and SNF contents can be reduced by disease, particularly mastitis. While milk fat content remains relatively constant, milk protein content gradually decreases with advancing age.

3. MATERIALS AND METHODS

3.1 Description of the Study Area

This study was conducted in Angolelana Tera district of the North Shewa administrative zone of the Amhara region. Chacha is the capital town and administrative center of the district, which is located approximately 112 km Northeast of Addis Ababa along Mekelle road. The district comprises 19 rural and two urban Kebeles[1]. The district is located between $9^0$36'40.756" to $9^0$14'32.4672"N and $39^0$15'48.7116" to $39^0$38'15.252"E. The altitude of the district ranges from 1700 to 3245 m.a.s.l, with an annual temperature range of 6.18 to 19.8^0C. The rainfall pattern of the district follows a bimodal annual distribution of a long/main rainy season that extends from early June to mid-September and a short rainy season that occurs between February and April. Barely and vegetables during *Belg*, and barley, wheat and bean during *Meher* season are the principal crops grown in the district. With mean annual minimum and maximum rainfall of 925 and 1240 mm, respectively, the district has an annual average precipitation of 1078 mm.

The total land size of the district is about 78,248.67 ha with 40664.7 ha of cultivable land, 2616.78 ha bareland5985.82ha forest and shrub land and 26406.7 ha of land allotted for natural pasture (grazing), and 615.29 ha water body. The average landholding per household ranges from 0.75 to 1.25 ha. Almost all (99%) inhabitants of the district are engaged in agriculture. The district is home to a total of 100,919 (48.8% women and 51.2% men), with most (86.9%) of them dwelling in rural *Kebeles*, while the difference (13.1%) lived in urban *Kebeles*. The district is endowed with 168,313 cattle heads, of which cows and heifers comprise 25%, 194,823 sheep, 17,980 goats, 48,671 equines, 233,120 poultry, and 1,853 bee colonies, respectively (2022 Angollena Trara district Agricultural and Livestock Production and Promotion office annual report).

[1]*It refers to the smallest classification of administrative unit in Ethiopia*

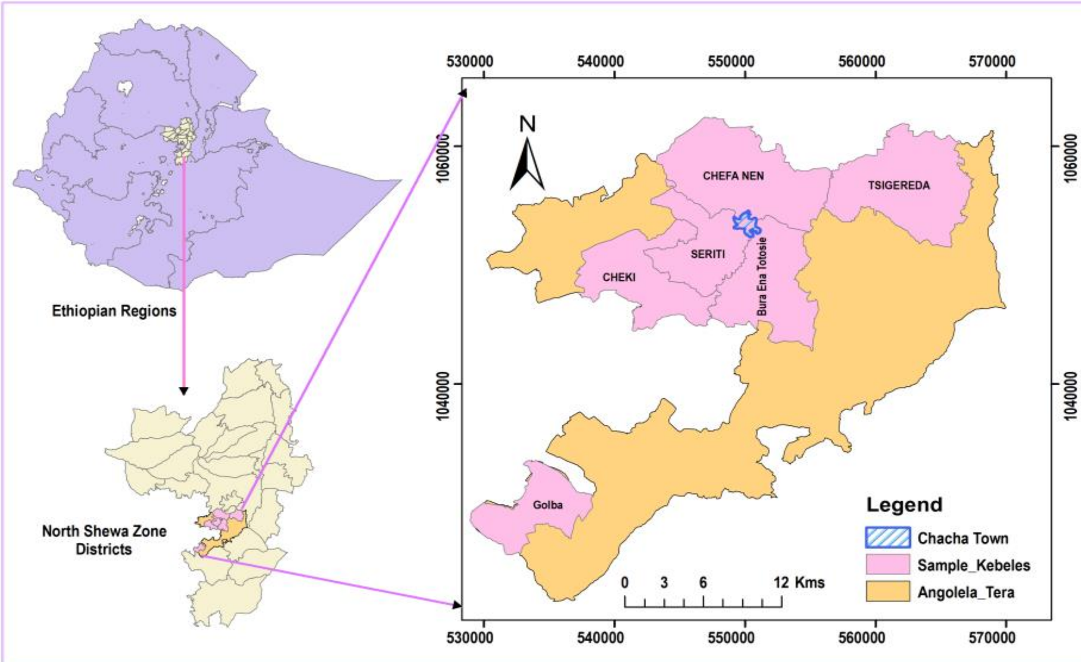

Figure 1 Map of the study district showing sampling *Kebeles*

3.2 Study Design and Sampling Procedures

For the present study, a cross-sectional survey design was employed. A purposive sampling procedure was done to select all *Kebeles* that involved in Mercy project[2]Jersey crossbred intervention. Accordingly, seven *Kebeles* namely *Cheki, Seriti, Chefanen, Golba, Tsegereda, Bura* and *Chacha* were selected purposively (Fig 1). Among them five of them belong to rural *Kebeles*, while the two's namely *Cheki* and *Chacha* representing urban *Kebeles*. All households who benefited from the project to improve indigenous breeds using Jersey breeds were considered as a sampling unit of the study. Lists of farmers who owned CBJ were obtained from the *Kebeles* and district offices and then triangulated with Mercy farm project, smallholders' intervention follow-up document. The results of CBJ performances compared to CBHF and IB, and the traits preferences by farmers were compared with its counter parts, CBHF. Eventually, a total of 158 households/beneficiaries of the project from seven *Kebeles* were identified and with whom formal survey questionnaire were administered as described in Table 3.

[2]*Project Mercy established in 350-acre dairy farm in Chacha town to crossbred Ethiopian indigenous cattle with the Jersey breed to increase milk production. A six-month in calf crossbred Jersey heifers have distributed to farmers who in need with necessary training packages of animal caring and milk processing*

3.3 Sample Size Determination and procedures

The district was purposively selected based on Jersey crossbred potential and high number of cows which have given at least one calf.Then Kebeles also were selected purposively based on potential of Mercy project activity (i.e. based on who have lactating cow of households).Based on this a total 158 (Table 3) household (HH) farmers who have a Jersey crossbred lactating dairy were selected based on mercy project Jersey crossbreed intervention.

Table 3.Kebeles and household number involved in survey study

No	*Kebeles*	Total no. of HH in the *Kebeles*
1	Chacha	14
2	Cheki	15
3	Seriti	42
4	Chefanen	30
5	Tsegereda	15
6	Golba	32
7	Bura	10
	Total sample size	**158**

3.4 Data Collection and Sources

A pre-tested semi structured questionnaire employed for household face-to-face interview. The questions used for household interview include socio-economic data, feed resources, health, breeding practices, housing, productive (LL and DMY) and reproductive (AFS, AFC, DO, CI, NSC) performances, and dairy animals traits preferences of farmers. To ensure accuracy and/or trustworthiness of the data the face-to-face interview of the questionnaire were managed by the first author (Researcher) and facilitated by animal production development agents who deployed each study Kebele. Complementary information about Jersey breeds were collected from the reports of North Shewa zone and Angolelana Tera district livestock office besides Mercy dairy farms record sheets and other relevant development partners offices in the study area.

3.5. Milk Sample Collection for Chemical Composition Analysis

A total of 45 milk samples (about 300 ml each) were taken from a chosen breed (15 milk samples were taken for chemical composition analysis from each breed). The samples were collected in sterile bottles, put in an icebox, and transported to Debre Berhan University, dairy microbiology laboratory for analysis. The sample was collected in the morning from individual household farm before providing to milk collectors. The samples were analyzed within 4 hours of collection.

Table 4 milk sample for physicochemical properties to analysis

No	Breed type	No. of milk samples of milk
1	CBJ	15
2	CBHF	15
3	Local/indigenous breed	15
	Total	**45**

3.6. Statistical Analysis

The data generated from the study were analyzed by using Statistical Package for Social Sciences (SPSS version 25.0). A one-way analysis of variance (ANOVA) and SAS was also used to determine for differences in the reproductive and productive performances of dairy breeds and chemical composition of milk. The tests were done at 95% level of confidence ($\alpha = 0.05$). Duncan means comparison procedure was used to test mean differences. Rank index was determined to get the overall priority of farmers on traits preferences of farmers in district. The trait preference with the highest rank index value corresponds to the highest priority, and the rest follow in order of importance. Formula used by Kosgey *et al*. (2008) was adopted to calculate the indices.

$$\text{Index} = \frac{Rn*C1+Rn-1*C2\ldots. +R1*Cn}{\Sigma Rn*C1+Rn-1*C2\ldots+R1*Cn}$$

Where;

Rn = Value given for the least ranked level (if the least rank is 5th, then Rn = 5, Rn-1 = 4, R1 = 1) Cn = Counts of the least ranked level (in the above example, the count of the 5th rank = Cn, and the count of the 1st rank = C1).

Statistical model=yij = μ + Ci + εij

Where,

Y_{ij} = the dependent variable, μ = Overall Mean, C_i = Effect of production system (i=1-2), E_{ij} = Experimental error

Or

$Y_{ij} = \mu + C_i + \varepsilon_{ij}$

Where,

Y_{ij} = the dependent variable, μ = Overall Mean, C_i = Effect of breeds (i=1-3), E_{ij} = Experimental error.

$$Index = \frac{\Sigma = [(r * No\ of\ HH\ in\ rank\ first + (r-1) * No\ of\ HH\ of\ in\ rank + (r-2) * No\ of\ HH\ in\ rank\ third + \ldots + 1 * No\ of\ HH\ rank\ last) for\ single\ factor]}{\Sigma = [[(r * No\ of\ HH\ in\ rank\ first) + (r-1) * No\ of\ HH\ of\ in\ rank\ second) + (r-2) * No\ of\ HH\ in\ rank\ third + \ldots + 1 * No\ HH\ in\ rank\ last)\ for\ all\ factors]}$$

4. RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Households

Most (82.3%) of the respondents in the study area were male headed households (Table 5). The current result matches with Medhint *et al.* (2019) who reported male headed household comprised 98.6%. The majority (52.4%) of the household have never been school, while 25.3% are literate with formal schooling ranging from elementary to college levels (Table 5). The level of illiteracy in the present study is higher than 44.1% reported in Dilla Zuriya district, 16.25% in central zone of Tigray and 28% in Oromia region (Gebrekidan *et al*., 2012; Deriba *et al.*, 2016; Sara *et al*., 2022). Illiteracy and low level of schooling have negative impact on dairy improvement efforts through slow adoption rate of dairy production technologies (Sara *et al*., 2022), however farmers in the study district introduce improved Jersey breed regardless of their educational background. It is the fact that education can also limit provision of extension services using various extension media such as production manuals, leaflets and pamphlets (Diriba *et al.,* 2016).

As indicated in Table 5 the average family size reported for this study was 2.72 with minimum and the maximum family size of 1 and 5, respectively. The over mean family size observed in the current finding is considerably lower than the reports of Abebe *et al.* (2017), Mekete *et al*. (2018) and Sara (2022) who reported 4.4, 5.86 and 8.79, respectively. It is cognized that farming households largely rely on family labor for routine dairy operations such as feeding, feed collection, herding, milking, marketing and cleaning. The average family size observed in the current study seems to be low to accommodate all the activities dairy farming by own family labors.

The age of the household head ranged from 22 to 74 years with an average age of 46.09 years. This indicates that the sample farmers are fall under productive age and they can actively manage their own dairy cows. The sample famers had an average of 20.13 years of dairy farming experiences. Experience in dairy farming is a signal that the vast majority of the farmers started cattle rearing in their early age. Sara *et al.* (2022) strengthens that starting dairy farming in young age is good opportunity to intensify, modernize and optimize economic use. In addition, the experience of farmers is accompanied by education, skill-based trainings, and experiences sharing visits may contribute to improve farming. Mixed crop-livestock production system (91.8%) is the dominant farming system in the study district.

Table 5 Household characteristics of the respondents (N=158)

Parameters	**Category**	**N**	**Percentage**
Sex (%)			
	Male	130	82.3
	Female	28	17.7
Educational level (%)			
	Illiterate	83	52.4
	Read and write	35	22.4
	Elementary	16	10.1
	Secondary	16	10.1
	College and above	8	5.1
Farming types (%)	Livestock dominant	13	8.2
	Mixed crop and livestock	145	91.8
Mean (SE) (N=158)	Minimum	Maximum	Overall mean
Age of HH head (yrs)	22	74	(46.09±0.83)
Family size (No.)	1	5	2.72±(0.08)
Dairy farming experiences (yrs.) (N=158)	12	52	20.13 ±(0.57)

Picture **1**. Focus Group Discussion

4.2 Livestock Population

The number of cattle owned by individual farmer on average was 3.28 and the crossbred HF comprised 1.26 during establishment, with the corresponding total current numbers of cattle are 5.65 (including 2.97 CBJ) (Table 6). The study indicates that unlike establishment, the current crossbred dairy animals comprise the highest proportion of the herd. This is in agreement with the reports of Solomon *et al*. (2009) in North-eastern Amhara region due to the favorable climatic conditions and the good milk market linkage. The average number of crossbred animals reported in the current study was lower than the reports of Abebe *et al.* (2017) and Derese (2008) who reported 4.7 and 4.3 in the central highlands of Ethiopia in the west Shewa zone of Oromia, respectively. The variation in the number of crossbred dairy cattle in different production systems could be due to available land size, market, feed source and inputs. Sheep and cattle are the most populous livestock species in the present study district. This is due to the fact that the crucial roles of farming society where milk and draft power are entirely produced from cattle since the farmers practiced mixed crop-livestock agriculture. Sheep are also important to sale and meet wherever the cash demand of the households arises

Table 6. Mean and standard errors of livestock composition/HH

Cattle breeds	During establishment: mean (SE)	Current number: mean ±SE
Cattle		
Local (N=158)	2.03(0.09)	1. 18±(0.07)
Crossbred HF (N=157)	1.26(0.09)	1.49±0.09
Crossbred Jersey (N=158)	0 (0.0)	2.97±0.14
Total	3.28(0.15)	5.65±0.19
Sheep		9.13±0.56
Goat		3.25±0.45
Equine		3.19±0.17
Poultry		5.01±0.35

4.3 Sources of Dairy Cattle Breeds

Farmers have been acquired initial stock from diversified sources. Smallholder farmers in the study district possessed CBJ entirely from Mercy project in calf heifer free provision, while the majority of CBHF were initially the farmers purchased from markets by their own capital or pocket (54.4%) followed by donation of World Vision Ethiopia (42.4%) to increase productivity of dairy cattle and thereby improving the livelihoods of smallholder dairy farmers in the study district (Table 7). On the other hands, high numbers of farmers owned local breeds' cattle were inherited from parents (23.4%), bought from market (27.2%) and World Vision Ethiopia (8.9%) during the establishment of the dairy farm. Donation of local and crossbreed animals by development partners were not as such common in Ethiopia, like the current study district. Foundation and replacement stocks of crossbreed animals in Ethiopia were mainly obtained by gift from family, market, inherited from parents and born from their farms (Godadaw *et al*., 2014; 2018; Amare *et al*., 2019; Demeke and Biruh, 2022).

Table 7. Source of dairy cattle breeds frequency (%)

Sources	IB	CBHF	CBJ
Mercy project	0.0	0.0	158(100)
World vision Ethiopia	14(8.9)	0.0	0.0
Inherited from parents	37(23.4)	0.0	0.0
Market	43(27.2)	86(54.4)	0.0
World vision Ethiopia and market	20(12.7)	67(42.4)	0.0
Inherited from parents and markets	31(19.6)	5(3.2)	0.0
Others	13(8.2)	0.0	0.0

IB – Indigenous breed, CBHF – Crossbred Holstein Friesian, CBJ – Crossbred Jersey

Picture 2.Borena and fogera parent stock at chacha dairy cattle multiplication center with their 50 % JCB calves

4.4 .Land Utilization

The overall mean of land size reported in the study area was 1.45 hectare per household with the minimum and maximum size of 0.25 and 4.25 hectare, respectively (Table 8). The average land size obtained in this study was similar with the findings (1.2) reported in the central highlands of Ethiopia (Abebe *et al.*, 2017). The largest share of land (0.78 ha) is allocated for rain fed crop production. On average land per household allotted for grazing and forage production were 0.34

and 0.10 hectare, respectively. Large proportion of land is allocated for crop cultivation than other land use types including grazing and improved forages, which is in agreement with the reports of Asefa *et al.* (2013) and Mekete *et al*. (2018). The average land allocated for grazing and improved forages production (0.44 ha) is lower than area of land in North Shewa (1.1 ha) and Arsi (1.1 ha) zones but higher than 0.2 ha in West Hararghe (Agajie *et al.*, 2016). Although adequate land size is a crucial pre-requisite for dairy farming specially to produce feed, the land size owned by farmers was very small in size to expand their farms. This could be a challenge for smallholder farmers to increase number of animals.

Table 8. Land size (hectare) and utilization

Variables	**Minimum**	**Maximum**	**Land size (Hectare)**
Total land size	0.25	4.25	1.45(0.62)
Crop land			
Rainfed	0.25	2.25	0.74(0.34)
Irrigable	0.0	0.63	0.05(0.01)
Fallow land	0	1	0.11(0.01)
Grazing land			
Private	0	1	0.34(0.02)
Communal	0	1.5	0.12(0.02)
Improved forages	0	0.5	0.10(0.01)
Land covered by tree/forest (Example eucalyptus)	0	1	0.1(0.01)

Picture 3. Land covered by Improved Forage

4.5 Role of Gender for Different Routine Activities of Dairy (2)

Dairy production creates jobs for all family members besides regular daily income, vital to household food security and family wellbeing. Gender differences were observed on the involvement of routine dairy activities in the study district (Table 9). The contributions of sons on dairy farming activities were nil or insignificant compared to others family members whereas, herding (40.5%), barn cleaning (40.5%), and feeding and watering (27.8%) were managed by daughters. Wives were mainly engaged on milking and processing (92.4%), feeding and watering (39.9%), heat detection and breeding (39.9%) in addition to other routine activities, while their respective spouse control income generated from dairy since the husbands were more responsible to perform selling and buying of animals (70.3%), milk and milk products marketing (65.2%) and animal health care (67.1%). Hired labor also participated in different dairy activities such as herding, feeding and watering, health care, and heat detection and breeding management with equal proportion of 40% due to shortage of family labour (Table 9). Similarly, in Southern Ethiopia dairy product marketing (86.7%), and buying dairy animal (62.6%) dominated by men, while milking (93%), milk processing (76%) and feeding and watering (40.8%) were performed by women (Berhanu, 2012).

Table 9.Lab our division different dairy routine dairy activity (N=158)

Activities	Daughter	Wife	Husband	Hired labour	Son and daughter	Wife and Husband	Daughter and wife
Herding	64(40.5)	0.0	54(34.2)	40(25.3)	0.0	0.0	0.0
Milking and processing	0.0	146(92.4)	0.0	1(0.6)	6(3.8)	0.0	5(3.2)
Feeding and watering	44(27.8)	63(39.9)	0.0	40(25.3)	0.0	0.0	11(7.0)
Selling and buying animals	1(0.6)	40(25.3)	111(70.3)	0.0	1(0.3)	0.0	5(1.4)
Health care	0.0	7(4.4)	106(67.1)	40(25.3)	0.0	0.0	5(3.2)
Heat detection and breeding	1(0.3)	63(39.9)	43(27.2)	40(25.3)	0.0	6(3.8)	5(3.2)
Barn cleaning	64(40.5)	40(25.3)	0.0	0.0	43(27.2)	6(3.8)	5(3.2)
Milk and its product marketing	0.0	42(26.6)	103(65.2)	1(0.6)	0.0	1(0.6)	11(7)

Picture 4. Dairy house facilities

4.6 Farmers 'Traits Preferences of Crossbred Jersey

The ranking of traits perceived by smallholders being primary importance are described in (Table 10). In the present study, milk yield (0.12), growth (0.11), traction (0.11) and fertility (0.11) in CBHF, whereas milk fat (0.16), fertility (0.16), growth (0.14) and adaptability to the local environment (0.11) in CBJ were mentioned to be the major traits preferred by farmers. In the current study, milk yield in CBHF and milk fat in CBJ were the most valued traits, which are not unexpected because HF and Jersey breeds are world known for highest milk yield and milk solid contents, respectively. In consistent with current finding of CBHF, previous studies in Ethiopia milk yield were the primary production trait in the selection of breeding females (Ftiwi and Tamir, 2015; Girma *et al.,* 2016; Belay and Zeleke, 2021; Demeke and Biruh, 2022). The current findings are also aligned with Amare *et al.* (2019) who reported the preferred traits of HF pure and CB cows were milk yield, growth, and reproductive efficiency. Besides, in Ethiopia place where fluid milk markets are accessible regardless of the scale operations farmers preferred HF and related crosses over Jersey and related crosses (Amare *et al*., 2019; Demeke and Biruh, 2022).

Farmers perceived that Holstein Friesian produces the highest volume of milk this help to achieve the primary objectives of dairy farming and thereby income. Milk yield could have an impact on mothering ability traits. Godadaw *et al*. (2014) reported that more milk supplied to calves reduce pre and post weaning mortality. Famers in the current study district are distant from main roads and milk market due to this fact they preferred to keep Jersey breeds which gives high milk solid contents to diversify milk into different milk products that are relatively shelf stable and fetch better price. The current study showed that longevity, temperament and color were the less preferred traits of cattle by farmers irrespective to the breed types, similar reports were observed by Amare *et al.* (2019). Indigenous farmers' knowledge and breeding objectives are important for designing breeding programs (Bayou *et al*., 2018). This could be due to famers make conscious decision to genetically improved cattle breeds to the next generation based on their performance traits in relation to parent generation (Wondossen and Tesfaye, 2017). The traits preferences of farmers could be one or more, which are determined by the cost of production and the revenue from product sales related to a genetic alteration in the target trait.

Table 10 Traits preferences of farmers for crossbreed animals (rank)

CBHF(N=158)	**Index**	**Rank**	**CBJ (n=158)**	**Index**	**Rank**
Milk yield	0.12	1	Milk Fat	0.16	1
Growth	0.11	2	Fertility	0.16	2
Traction	0.11	3	Growth	0.14	3
Fertility	0.11	4	Adaptation	0.11	4
Diseases	0.10	5	Milk yield	0.11	5
Milk fat	0.10	6	Diseases	0.10	6
Adaptation	0.10	7	Traction	0.09	7
Temperament	0.09	8	Temperament	0.06	8
Longevity	0.08	9	Longevity	0.05	9
Color	0.07	10	Color	0.02	10

CBHF – Crossbreed Holstein Friesian, CBJ – Crossbreed Jersey

4.7. Productive and Reproductive Performances Traits of Crossbreed Jersey

Although no significant difference was observed in AFS between CBHF (21.68 months) and CBJ (22.76 months) but significantly lower than that of IB (38.22).The mean AFC, however, among CBHF, CBJ and IB were significant (Table 11). Significantly shorter average CI was observed in CBJ (411.79 days) compared to CBHF (445.59 days) and IB (797.44 days). As presented in (Table 11), the DO was significantly different between IB and CBJ, but no significant variation between CBHF and CBJ. Significantly lower average NSC was reported in CBJ (1.55) than CBHF (1.86) and indigenous cow (2.34).

The current study showed that no significant variation in the average longevity of CBJ (16.53 years) and IB (16.09 years), but CBHF (15.03years) was significantly lower than IB. Significantly lower mean DMY was found in IB (1.74 liters) followed by CBJ (5.02 liters) and CBHF (7.36 liters). Significantly longer average LL was recorded in CBJ (241.32 days) than CBHF (227.28 days). A maximum average values of milk production in each of lactation namely early (10.52 liters), mid (7.13 liters) and late (4.44 liters) were observed in CBHF. Regardless of breed, the milk production was decreased with the increase of lactation stages (Table 11).

Age at first service and AFC are economically important traits that determine the ages of dairy cows begin their milk production (Frickle, 2004). The mean AFS for CB cows reported in Ethiopia were with a range of 26.8-36.8 months (Shiferaw *et al.*, 2003; Gebeyehu *et al*., 2005; Berhanu and Chakravarty, 2014; Alemselam *et al*., 2015; Kefale *et al.*, 2019; Belay, 2021), which are longer than the current results. The present values were consistent with finding of Ashit *et al.* (2013) and Birhanu. (2014) who reported 21.6 months and 24.38 months for CBJ, respectively. However, the results observed in CBJ are shorter than 31.32 and 33.3 months of AFS reported for CBJ, respectively by Hunduma (2013) and Sisay (2015). The current study stated that CB heifers reached AFS earlier than indigenous heifers. Besides the genetic merits of CB being faster growth rate, better management attention could also contribute early attainment of sexual maturity of CB heifers (Belay, 2021). Mukasa-Mugerwa *et al*. (1991) noted that the delay growth to attain puberty is a serious economic loss due to unproductive period for the cow lasting several months. Tadele and Nebrit (2014) reported that with good nutrition, heifers would exhibit fast growth and attain higher live weight at relatively younger ages. In addition to the type of breeds involved for crossing, level of gene inheritance, environment and management effects were the probable causes for the variation of AFS results (Kefale *et al*., 2019).

The overall means AFC obtained in the present study (30.56 for CBJ and 32.9 months for CBHF) were shorter and better than the reports of Shiferaw *et al*. (2003) and Belay (2021) who reported 40.6 and 44.4 months for CBHF in Ethiopia, respectively. Prolonged AFC (36 - 47.51 months) also recorded for CBHF in Botswana and Ghana and compared to the current findings (Hagan *et al.,* 2022; Guinguina *et al.*, 2011; Obese *et al*., 2013; Madibela and Mahabile, 2015). The mean AFC in the current finding was nearly matches with 33 months for CBHF (Lemma and Kebede, 2011) and 32 months for CBJ (Birhanu., 2014) in Ethiopia, and 29.92 and 31 months reported for pure breed Jersey in Ethiopia and in Kenya, respectively (Njubi *et al.*, 1992; Direba *et al*., 2015). In contrast, Wilson (2015) reported longer AFC (35.5 months) for purebred Jersey in Malawi.

The current overall-mean of AFC for CBJ seems acceptable and inspiring as best alternative for resource poor farmers although purebred Jersey cattle reared in temperate regions are dropping the first calves at 24 months (Hare *et al.*, 2006),which is nearly three months earlier than the current finding. Heifers with shorter AFC have higher milk production during their lifetime than those having longer AFC (Muller and Botha, 2000). The fluctuation of age at first calving results reported in the previous studies may be attributed to the variation in breeding and fertility management, feeding management, season and the type of breed.

Significantly shorter average CI was observed in CBJ (411.79 days) compared to CBHF (445.59 days) and IB (797.44 days). This might be due to breed differences besides the farmers providing especial management attention for crossbred cows' in terms of feeding, watering, housing and health care. For profitable dairying, the recommended ideal CI is 12 to 13 months (Madebela and Mahabile, 2015), which is nearly align with the current study. The mean CI of CBHF cow in the current study was lower than 636 days in Jimma zone, Ethiopia; however, the present results harmonize with the finding of Alemselam *et al* (2015) who reported 401.5 days. The averages CI observed in this study was also similar to 411.3 days for CBJ reported by Munim *et al*. (2006) and the averages CI of 408.47, 412 and 417 days reported in Ethiopia, Tanzania and Ghana, respectively (Chenyambuga and Mseleko 2009; Birhanu2014; Hagan *et al.*, 2022).

The current study results are better than the overall mean CI (497 days) of pure Jersey cattle found in Holleta, Ethiopia (Diriba *et al.,* 2015). The lower performance traits observed in pure Jersey breeds of previous studies compared with the current performance of CBJ could be associated with farmers' management level limits the pure breed jersey ability to express full genetic performances. Therefore, determining appropriate crossbreeding levels for smallholders depending on the conditions of farmers are crucial. Calving interval (CI) is refers to the period between consecutive calving. Cows in extended periods of non-productivity have increased cost associated feed and lost income resulting from the absence of saleable milk. The lengthy calving interval could also reduce the total number of calves in the herd, which would consequently decline the chances of producing adequate replacement stock (Direba *et al.,* 2015). However, CI has a low heritability and can be improved through nutrition and early breeding (Belay, 2021).

The DO was significantly different between IB and CBJ, but no significant variation between CBHF and CBJ. The shorter mean DO reports in CBHF (130 days) in Jimma zone (Belay, 2021). The result of the present study was inconsistent with the findings of Rokonuzzaman *et al*. (2009), who reported 86.48 days in Bangladesh. Inconsistent with Belay (2021) significant differences of NSC between CB and IB were observed. The mean NSC of CB cows estimated in the current study were lower than previous studies reported in the range of 2 - 2.3 (Mureda and Mekuriaw, 2007; Lemma and Kebede, 2011; Belay, 2021). The overall mean reported NSC in this study for CBJ and CBHF were less than NSC reported for pure Jersey (2.02) and HF (2.01) breeds in central highlands of Ethiopia (Yosef, 2006; Diriba *et al.,* 2015). The average value of NSC for CBJ reported in current study was similar to 1.39 - 1.58 for CBJ and CBHF in Ethiopia (Demeke *et al*., 2004, Birhanu *et al*., 2014). The less NSC in CBJ noted as other reproductive traits could be associated with better adaptation of the breed than CBHF in the study district. According to Mukasa-Mugerwa (1989) generally the mean NSC greater than 2.0 is regarded as poor. The variation in NSC reported in previous studies might be associated with heat detection, semen quality and handling, feed, lactation length, milk yield, parity and reproductive problems (Shiferaw *et al.,* 2003; Gebrekidan *et al.,* 2012).

Longevity refers to the period from birth to disposal of the cow from the herd. The economic output of dairy cattle depends on its lifetime performance rather than single lactation performance. Improvement in the longevity of cows can result in higher lifetime milk production

(Ambhore *et al*., 2017) and help to reduce the cost of replacement (Mirhabibi *et al*., 2018), which tends to efficient economic output. In this regard, CBJ performed well as indigenous breed (IB) but with better productivity. The overall average of longevity in the present study much better than the reports of , 11 years for CBJ and HF (Kefena *et al*., 2013),),7.9 years for HF (Gebeyehu,2014), 7.3 years for pure Jersey breed (Diriba *et al*., 2015) and 9.03 years for CBHF (Sileshi *et al*., 2020) in Ethiopia, respectively. Besides, the current mean value observed in IB was also higher than the overall mean ranges from 11-13 years that reported for Ethiopia indigenous cows' productive and reproductive lifetime (Debir, 2016). Longevity could be fluctuating in farm management such as animal health, feeding and housing (Abdulai and Huffman, 2005). One of the ultimate goals of adoption of crossbreeding program is to increase milk production per animal that leads to maximize the profitability of dairy farming.

The average DMY found in the current study was similar with 5.21 liters reported for CBJ in Ethiopia (Gebregziabher *et al.*, 2014). Rokonuzzaman *et al.* (2009) reported that the average DMY of CBHF was 8.36 liters, the milk production was found higher than the current finding. The low DMY of CB cows reported in the present study could be due to poor feeding regime particularly inadequate energy, protein and mineral supplements, disease prevalence and shortage of water and poor overall management practices that prevent CB cows realizing their real potentials.

The acceptable lactation length recommended for modern dairy farm is 305 days, which is important production traits that determine the total milk yield. However, it is often difficult to meet such standard LL at smallholder dairy cows, which is reflected in the results of the present study. The average estimated LL (241.32 days) found in CBJ in the current study was shorter than the mean LL of 318.42 and 336 days for pure Jersey breed in Ethiopia (Habtamu *et al.*, 2009; Diriba *et al.*, 2015). Lower overall average LL of CBHF cows (206.1 days) was reported in different towns of Ethiopia (Belay *et al.*, 2012; Kumar and Tkui, 2014), but the current results CBJ coincides with reports of Belay (2021) who reported 243 days of LL for CBHF. The lactation period found in the current finding of CBHF is less than the findings of Rokonuzzaman *et al*. (2009) who reported the average lactation period of CBHF was 262 days in Bangladesh. This difference could be associated with genetic makeup, production system, herd management with respect to feed, disease and other environmental differences.

Table 11.Productive and reproductive performance local and crossbreeds' dairy cattle

Parameters	**Breeds (mean and SE)**			**P-value**
	IB	**CBHF**	**CBJ**	
Age at first service (AFS)/months	38.22 (0.43)[a]	21.68(2.15) [b]	22.76(0.26[b]	0.000
Age a first calving(AFC)/months	48.61(0.74)[a]	32.91(0.52)[b]	30.56(0.70)[c]	0.000
Daily milk yield (DMY)/cow/ (liter	1.74	7.36	5.02	0.000
Early	2.43(0.04)[c]	10.52(0.32)[a]	7.06(0.15)[b]	0.000
Mid	1.72(0.03)[c]	7.13(0.23)[a]	4.97(0.13)[b]	0.000
Late	1.06(0.02)[c]	4.44(0.21)[a]	3.04(0.12)[b]	0.000
Lactation length (days)	177.49(2.73)[c]	227.28(4.12)[b]	241.32(4.10)[a]	0.000
Calving interval (days)	504 (11.58)[a]	428 (8.67)[b]	424.(5.58)[c]	0.000
Days open (DO) (days)	221.61(7.05)[a]	144.64(3.20)[b]	141.32(2.14)[b]	0.000
Number of services per conception (no.)	2.34(0.05)[a]	1.86(0.06)[b]	1.55(0.041)[c]	0.000
Longevity (years)	16.09(0.28) [ab]	15.03(0.26)[b]	16.53(0.10)[a]	0.000

CBHF = Crossbred Holstein Frisian, CBJ= crossbred Jersey, IB – indigenous breed. Different superscripts letters in rows indicates significant differences

4.8. Dairy Animal Breeding Practices

Artificial insemination (AI) is cheapest and rapid way of genetic improvement mainly aimed to increase milk yield (Table 12). However, the majority of farmers (78.5%) in the current study district used natural mating of improved bulls .The present study is contradicted with the reports of Demeke and Biruh (2022) who reported 96.1% of farmers practiced AI in Ethiopia. Most of the farmers practiced genetically improved bulls to mate their dairy animals shared from outside of their farms (93%), which is crucial to prevent inbreeding. Farmers targeted HF semen accessed from AI technician or natural mating of improved bulls because they have no any alterative from government sides like Jersey breeds. The average services charged per service was 38.61 ETB, which is more expensive compared to 4 ETB for highly government subsidized artificial insemination services.

Table 12. Breeding practices

Variables	**N**	**Percentage**
Breeding methods		
Improved bull	124	78.5
Artificial insemination	34	21.5
Farmers		
Had own bull	10	6.3
Had no bull	148	93.06
The price of bull birr per service	158	38.61(1.85)

Picture 5. 67.5% HFCB improved bull with calf

4.9 Dairy Animal Feed Resources

Crop residues (0.18), grazing natural pasture (0.17), hay (0.13), wheat bran (0.13) and treated crop residues (0.11) are among the top most ranked feed resources available for crossbred dairy animals in the study district (Table 13). Similarly, in mixed crop livestock farming system farmers practiced grazing of natural pasture and crop residues are the two main feed sources for dairy animal (Mamaru, 2021). The present finding indicate that farmers depend on poor quality feed resources for crossbred animals, this implies that farmers still have high rooms to improve the productivity per cow through adoption of better feeding practices.

Table 13. The major feed resources (rank)

Feed types	Index	Rank
Crop residues	0.18	1
Grazing natural pasture	0.17	2
Hay	0.13	3
Wheat bran	0.13	4
Treated CR	0.11	5
Improved forages	0.10	6
Atela	0.08	7
Brewery byproducts	0.05	8
Factory based concentrate	0.04	9
Mineral	0.02	10

Picture **6 .feed resources**

4.10 Dairy Animal Health

The average distance travelled by farmers to the nearest animal health post was 3.41 km. However, farmers have not accessed drug shops on their respective *Kebeles* as a result famers forced to walk on average 6 km to get animal medicaments (Table 14). This implying huge opportunities for drug vendors if they established the business together with others farm necessities. All farmers taken preventive measures, vaccination, and 55.1% of them reported adequate veterinarian available in their nearby and the farmers were satisfied the service given by veterinarian or animal health workers. Modern treatments and vaccinations were the services that livestock keepers reported using the most frequently-40.9 and 21.4% of respondents, respectively. The least available services are external parasite control, outbreak investigation, herd health advice, training delivery, and disease information, according to 0.2 to 4.0% of the respondents (Solomon *et al*., 2021).

Table14.Types of veterinary services and facility

Variables	**N**	**%, mean**
Health facilities		
Health post (yes)	158	100
Distance health post (km)	158	3.41 (0.04)
Drug shops		
Yes	1	0.6
No	157	99.4
How far the drug shop (km)	157	5.91(0.047)
Adequate veterinarian		
Yes	87	55.1
No	71	44.9
Are you satisfied with veterinary service		
Yes	87	55.1
No	71	44.9
Do you vaccinate your animals (yes)	158	100

Picture 7. Vaccination programme

4.11 Dairy Cattle Housing

The majority (60.8%) of the farmers constructed separate barns for dairy animals from main dwelling home, while the remaining 36.7% of the farmers shared barns to dairy animals usually appended to the main houses (Table 15). Almost all barns of dairy animals had the facilities of both feed and water troughs (67.1%). About 38.6% of famers used locally available materials, grass thatched to construct the roof of the barn, whereas 55.1% of the respondent's roofed with iron sheet. The floors of the barns were stone paved (74.7%) (Table15). Regarding the cow comforts, 45.6% of the farmers reported that barns were not well ventilated and they did not give adequate space for their animals (48.7%). In contrast, 87.3% farmers found the barns are well lighted. Concerning to cleaning frequency of the barn, 57.6% of the farmers practiced two times a day cleaning followed by three times a day (22.8%) and once a day (15.8%) (Table15).

Table 15. Dairy cattle housing

Variables	N	%	Variables	N	%
Types of barns			**Well ventilated**		
Separate barn	96	60.8	Yes	86	54.4
Shared house	58	36.7	No	72	45.6
Fence	4	2.5	**Well lighted**		
Facilities			Yes	138	87.3
Water trough	25	15.8	No	20	12.7
Feed trough	27	17.1	**Well drained**		
Both	106	67.1	Yes	86	54.4
			No	72	45.6
Roofing materials			**Adequate resting space**		
Iron sheet	87	55.1	Yes	81	51.3
Grass	61	38.6	No	77	48.7
Both	10	6.3			
Floor			**Cleaning frequency**		
Paved with Stone	118	74.7	Two times a day	91	57.6
Earthen	30	19.0	Three times a day	36	22.8
Concrete	6	3.8	Once a day	25	15.8
Wood	4	2.5	Once a week	6	3.8

Picture **8.** Feed **and water trough**

4.11. Impacts of Breed Improvements on Livelihoods of Smallholders

Dairy production supported with market-oriented dairy technologies such as cross breed cows, and complementary feed and management can result in increased commercialization of dairy products by smallholders. The increased income from sales of dairy products may also be spent on more and better-quality food leads to improve nutrition and health status of farmers (Ahmed *et al*., 2011). In the current study observed that adoption of crossbred cows increased income of farmers thought sale of milk and milk products. Previous studies also noted that adoption of the improved dairy cows significantly increasing the income of household (Ahmed *et al.,* 2011; Hana, 2019; Assen, 2021).

As presented in Table 16, the majority of farmers confirmed that breed improvement intervention increased the demand for inputs and services such as AI service (100%), veterinary service (100%), concentrate feed (70.9%) and improved forages (72.8%) regardless to access to inputs and services. The demands for extension services reported to be increased with the probability of improved breed adoption (Hana, 2019; Assen, 2021). In addition, adoption of improved breed is also cause for the increased milk consumption for 97.7% sample farmers from 2.21 to 2.88 liters consumption per household (Table 16), market participation (85.4%), improve way of lives thought construction of corrugated iron house (98.7%) and number of farm workers (87.3%). The average milk production of milk per household increased from 4.03 to 10.21 liters. The mean daily milk sold per household also increased from 1.36 to 7.17 liters (Table 16). This means farmers getting extra burden of market linkage as attested by this study, about 85.4% reported that the challenges of milk market are increasing following adoption of improved breed.

The increasing farmers' incomes increasing the number of animals owned by the farmers which tend to raise the quantity of workers to accomplish various routine farm activities. Smallholder dairy production is becoming increasingly important and it contributes marvelously to the improvement of the livelihoods of rural people. This could be achieved by adoption improved breed through improving milk yield, which has direct impact on income generation, poverty alleviation and availability of animal protein (Assen , 2021).

Table 16. Impacts of crossbreeding intervention on the livelihoods of farmers

Variables	**N**	**Increased (%)**	**Decreased %)**
Milk market access	158	85.4	14.60
Income	158	100	0.0
Total milk production	158	100	0.0
Milk consumption	158	97.5	2.50
Farm workers	158	87.3	12.70
Improved iron sheet house construction	158	98.7	1.30
Veterinary service demand	158	100	0.0
AI service demand	158	100	0.0
Use of concentrate feed	158	70.9	29.10
Use of improved forages	158	72.8	27.20
Milk market challenges	158	85.4	14.60
Average production, consumption and marketed milk		**Before intervention: mean (SE)**	**After intervention: mean (SE)**
Daily milk production	158	4.03(0.16)	10.21(0.26)
Daily milk consumption	158	2.21(0.19)	2.88(0.14)
Daily milk sold to market	158	1.36(0.14)	7.17(0.19)

4.13. Challenges of Dairy Productivity

The major constraints of dairy production in the study district are summarized in the (Table 17). Scarcity of feed (0.15) is the top ranked constraint of dairy production in the study district followed by shortage of land (0.14), shortage of water (0.13), and high disease prevalence (0.11) and unavailability of improved heifers (0.10). Labor shortage was reported to be less important constraints of dairy production in the current study district regardless of small family size, which might be due to better availability of cheap hired labor. Feed shortage, water scarcity, and disease prevalence have been documented as the most relevant constraints of dairy production in Ethiopia (Belay *et al*., 2012; Debir, 2016). Besides, feed shortage (0.29), limited access to improved dairy heifers (0.28) and disease (0.15) were the most valued constraints dairy farmers in Dilla Zuriya district (Sara *et al*., 2022). The existence of multifaceted constraints of dairy production in the study areas confirm that the need to address the problems in a holistic way, which entails the development of practical on-farm feed and water resources and conservation practices, and animal health control and prevention strategies.

Table 17. The major challenges of dairy cattle production (N=158) Parameters

Parameters	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**	**Index**	**Rank**
Scarcity of feed	65	83	3	3	0	3	0	0	0	0	1	0.15	1
Shortage of land	59	23	70	2	2	0	0	0	0	2	0	0.14	2
Water shortage	18	52	59	16	0	0	0	1	0	9	3	0.13	3
Disease prevalence	17	9	7	72	24	7	0	2	11	8	1	0.11	4
Unavailability of Improved heifers	1	2	22	29	75	17	5	5	1	1	0	0.10	5
Inadequate vet service	1	11	0	14	20	71	35	5	0	1	0	0.09	6
Lack of AI service	0	0	11	3	13	35	57	33	2	0	4	0.08	7
Inadequate extension	0	12	0	0	4	1	30	72	20	11	8	0.06	8
Lack of credit service	5	9	23	0	1	14	4	1	17	23	61	0.06	9
Milk market problems	0	1	0	0	9	18	11	22	72	23	2	0.05	10
Shortage of labour	0	3	0	12	0	0	11	10	22	66	34	0.04	11

R= rank

4.14 Chemical Composition of Milk from Indigenous and Crossbred Cows

The results of the analysis of variance indicated significant difference ($P<0.05$) in the chemical composition of milk sample collected from different dairy breeds as presented in Table 18. The total solid (TS) content of milk revealed that a significant difference ($P<0.05$) between CBHF and IB, while no significance difference was observed between CBJ and IB. The higher TS content of milk was recorded for IB (13.52%) followed by CBJ (13.14%) and CBHF (12.71%). This finding is consistent with Ayisheshim *et al*. (2015) who reported a total solid content of 13.15%of milk sample. Furthermore, according to the recognized quality standards of the

European Union, the total solids content of cow's milk should not be lower than 12.5% (FAO, 2007). There was no significant difference (P>0.05) between CBJ and CBHF for lactose, however, the analysis of variance showed that, a significant difference in lactose contents of milk between IB and the crossbred cow. This result was higher than the lactose content of milk from Boran Friesian crossbred dairy cow's (4.18%) as reported by Mesfin and Getachew (2007).

Significant difference (P<0.05) were observed in the fat content of the milk samples obtained from indigenous and crossbred dairy cattle. Higher fat content was found from IB (5.31%) followed by CBJ (4.46%). In contrast, to the current finding of Gurmessa (2014), who found higher milk fat content of 6.01%.The current result showed significantly (P<0.05) higher SNF record for CBJ (9.43%) than the indigenous and CBHF breeds. The results of the current study showed a lower SNF percentage than those reported by Helen (2007), who found that the SNF contents of 10.7% cows' milk in Kombolcha woreda but similar with the report of Teklemichael (2012), who stated that the SNF content of milk was 8.75%. The current SNF result meets the minimum standards set by the European Union (EU) and Food and Drug Administration (FDA), which require whole to have SNF contents for whole milk at 8.25% and 8.5%, respectively.

The results of the analysis of variance for protein content indicated that there was a significant difference (P<0.05) between the milk samples that were taken from various dairy breeds. Compared to others dairy cows CBJ (3.36%) had significantly higher protein content. Similar result to the current findings reported by Fikrineh *et al*. (2012), who found the cow milk protein content of 3.46%.According to Food and Drug Administration (2010), the minimum threshold level of whole cow milk protein must be 2.73% (Raff, 2011).

Milk sample taken from CBJ (0.71%) had higher ash level than milk sampled from taken from others dairy cattle. The current study findings is lower than Gurmessa's (2014) report of 0.80% ash content for the Borana breed in the Yabello district. In addition, the result is less than the results of Workneh (1997), who found that the milk from Boran cows had an average ash percentage of (1.0%). Moreover, according to Asaminew (2007), the milk from the local cows at the Bahir Dar milk shed has an ash content of 0.73% were higher than the current result from Local breed and mean.

Table 18.Chemical composition of milk sample collected from the study areas (%)

Breed type	Total solid (TS)	Lactose	Fat	SNF	Protein	Ash
CBJ	13.14[ab]	4.75[a]	4.46[b]	8.82[a]	3.36[a]	0.71[a]
CBHF	12.71[b]	4.67[a]	4.37[b]	8.44[b]	3.13[b]	0.64[c]
IB	13.52[a]	4.51[b]	5.31[a]	8.18 [b]	3[b]	0.67[b]
Mean	13.12	4.65	4.71	8.48	3.16	0.67
CV	5.97	2.52	5.74	12.1	5.49	4.97
LSD	0.58	0.09	0.19	0.76	0.13	0.05
Sig	0.0251	<.0001	<.0001	0.0007	<.0001	<.0001

5 CONCLUSION AND RECOMMEDATIONS

5.1 Conclusion

The performance of Jersey crossbreeds in terms of productivity and reproduction shows promising results as compared to Holstein-Friesian crossbreds. This is likely due to the Jersey breed's superior fertility, growth, and adaptability. Farmers' preferences for specific traits align with revenue generation, emphasizing the importance of focusing on parameters such as milk solid content, fertility, growth, and adaptive traits. The Jersey breed appears particularly suitable for rural areas, where there's a demand for higher milk solid content essential for butter and cheese production. Thus, initiatives like Project Mercy, which promotes dairy farming supported by Jersey breeds along with comprehensive training and support packages, are crucial for sustainable livelihood improvements among smallholders in the district.

Commercially, milk is valued primarily for its milk fat and solids-not-fat (SNF) content, with SNF consisting largely of proteins and lactose. Milk composition serves as a quality indicator for processing into various dairy products like butter, yogurt, and cheese. Genetic and environmental factors, along with management practices, influence milk composition and component yields.

In the current study area, reproductive and productive performances of crossbred and indigenous dairy cattle are influenced by management practices, genetics, and production systems.

5.2 Recommendation

Based on the findings of the study the following recommendations were suggested,

- Training should be provided related feed conservation, improved forage development, feeding and other management practices
- Implementing regular vaccination programs is critically important as it is one of the challenge in the study area
- The infrastructures should be improved in rural areas so that technological inputs (AI, feeds, drugs) can be accessed easily by the farmers and the market challenges for fluid milk will be addressed

- providing farmers with access to feed, training in, promoting cut-and-carry feeding practices, implementing vaccination programs, establishing improved forage development, setting up bull stations, ensuring road infrastructure access, deploying liquid nitrogen processing machines, and continually modernizing community-based AI technician services.
- To foster market-oriented dairy production, attention must be given to addressing constraints such as feed availability and cost, land and water scarcity, disease prevalence, and the lack of improved heifers.
- Therefore, intensive extension supports would be crucial for farmers to hold very few productive animals.

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7. APPENDIX

Research as a requirement for the award of a master's degree of science in animal science (specialization: animal production) in Debre Berhan University College of Agriculture. Research topic "***Comparative performance evaluation of dairy cow breeds and farmers' trait preference in Angolelana Tera district, north shewa zone, Ethiopia*** "

1. General information

Numerator's name ---------------------------- Code----------------------------

Name of interviewee ----------------------sex ----------------------age ----------------------woreda -----------kebele ------------------------village----------------------

Household characteristics

2.1. Family size

No	Age category	M	F	T	remark
1	Age under 7 years				
2	Age 8-15 years				
3	Age 16-30 years				
4	Age 31-60 years				
5	Age above 61 years				
	Total				

2.2. Educational status of family size

No	Sex category	Educational status of family size						Total	remark
		Under grade 3	Grade 4-6	Grade 7-8	Grade 9-10	Grade 11-12	Over 12 grade		
1	Male								
2	Female								
	Total								

3. Land size (hectare) and utilization

	Five years trends of land size hectare				
	2010	2011	2012	2013	2014
Total land size					
Crop land					
Rain fed					
Irrigable					
Fallow land					
Grazing land					
Private					
Communal					
Improved forages					
Land covered by tree/forest (Example eucalyptus)					
Backyard					

1.1. Length of grazing times (in hours) per day? Local breed -----crossbreed/HF/-------- crossbreed/JE/ ……

3.2. Length of rumination times (in hours) per day? Local breed -----crossbreed/HF/----- crossbreed/JE/ ……

3.3. What are the reasons for decreasing grazing?

Reasons	Rank (1,2,3…)
Expansion of crop land	
Expansion of eucalyptus tree plantation	
Road construction	
House construction	

Land slide	
Expansion of government and private investment	

4. Herd size and structure

4.1. Cattle

	Stock at establishment	Current number (2014 E.C)				Current value (birr)
		Local	Crossbred(HF)	Crossbred (Jersy)	Total	
Female calves						
Male calves						
Heifers						
Lactating cows						
Non-lactating cows						
Pregnant cow						
Bull						
Oxen						

4.2. Source of dairy cattle breed

	Mercy project	NGOs	Government	Inherited from parent	Bought from market
Local					
Crossbreed (HF)					
Crossbreed (Jersey)					

4.3. Other livestock species

	Local	Crossbred	Purebred
Sheep			
Goat			
Donkey			
Horse			
Mule			
Poultry			
Bee colony	Traditional--------	Transitional--------	Modern--------

4.4. Purposes of keeping cattle

Purposes	Rank (1,2,3….)			
	Local	Crossbred (HF)	Crossbred (Jersey)	Remark
Meat				
Milk				
Draft				
Income				
Maure				
Saving				
Hides				
Other specify				

4.5. Trait's preferences of farmers for dairy cattle (rank 1, 2, and 3… per breed)

Traits	Local	Crossbred (HF)	Crossbred (Jersey)
Milk yield			
Milk fat			
Growth			
Fertility			
Traction			
Disease resistant			
Adaptation (drought resistance)			

Good temperament			
Longevity			
Coat color (specify)			

5. Labour division different dairy routine dairy activity

Family	Herding	Milking	Milk processing	Feed collection	Feeding and watering	Milk marketing (transport to cooperatives)	Barn cleaning	Input purchasing	Milk utensils cleaning	Heat detection and breeding	Health care	Selling and buying animals
Son												
Daughters												
House wife												
Husband												
Hired labour												

6. Productive and reproductive performance dairy cattle

	Local	Crossbred (HF)	Crossbred (Jersey)
Average age at first service			
Average age a first calving			
Average daily milk yield/cow			
The first 3 months			
3-6 months			
6 - end of lactation			
Average lactation length (months)			
Average calving interval (months)			
Days open (days)			

Average number of services per conception (no.)			
Average longevity (years)			
Average dry period (days)			

7. Breeding practices

7.1. Methods of breeding a) local bull b) crossbreed bull c) purebred bull d) AI

7.2. Do you have your own bull a) yes b) no?

7.3. If yes, how frequent do you replace bull a) every two-year b) every three-year c) every four-year d) did not replace at all until the death/sold of bull

7.4. If you don't have, where is the source of bull a) neighbor b) research center c) community bull

7.5. The price of bull -----------birr per service and the price of AI ------------per service

8. Animal health and veterinary services

8.1. Types of veterinary services and facility

Health facilities available	a) yes b)no		km and minute
Health post		How far the health post	----- km and ---min------
Drug shops		How far the drug shop	-----km and ---min--------
Adequate veterinarian			
Are you satisfied with veterinary service			

8.2. Number of animals vaccinated the last one year

	Local	Crossbreed(HF)	Crossbred(Jersey)	Mention five vaccinated diseases	
Female calves					
Male calves					
Heifers					
Lactating cows					
Non-lactating cows					
Pregnant cow					
Bull					
Oxen					

8.3. Season and causes of animal death the last one year

Livestock category	Season of disease occurrences				Sick and death		Cause of death
	July - Sep	Oct - Dec	Jan - Mar	Apr - Jun	No of sick	No of death	
Local calves							
Crossbred calves (Jersey)							
Crossbred calves (HF)							
Purebred calves (Jersy)							
Purebred calves (HF)							
Local heifers							
Crossbred heifers (Jersey)							
Crossbred heifers (HF)							
Purebred heifers (Jersy)							
Purebred heifers (HF)							
Local cow							
Crossbred cow (Jersey)							
Crossbred cow (HF)							
Purebred cow (Jersey)							
Purebred cow (HF)							
Local bull							
Crossbred bull (Jersey)							
Crossbred bull (HF)							
Purebred bull (Jersey)							

Purebred bull (HF)							
Local ox							
Crossbred ox (Jersey)							
Crossbred ox (HF)							
Purebred ox (Jersey)							
Purebred ox (HF)							
code: Cause for death 1) disease 2) feed shortage c) other specify if it is disease, mention the types of diseases per each category?							

9. Feed and feeding management

9.1. Feed resources

	Local breed: rank (1, 2, 3…)	Pure and crossbreed: rank (1,2,3…)	Crop residues	Rank (1, 2, 3.)
Grazing			Barly	
Crop residues			Teff	
Concentrate			Wheat	
Brewery byproduct			Oat	
Attela			Pea	
Improved forages			Bean	
Treated crop residues (urea and molasses)			Chickpea	
Wheat bran			Lentil	
Mineral supplement			Grass pea	
Hay			Other specify	
Other specify				

9.2. Amount and types of feed provision during the entire lactation (kg/day)

Phases of lactation	Concentrate	Oilseed cake	Wheat bran	Wheat bran and oilseed cake	Improved forages	Brewery byproducts	Homemade attela
Early lactation (the first 3 months)							
Mid lactation (3-6 months)							
Late lactation (6-end of lactation)							
Dry period (end of lactation – next lactation begins)							

9.3. Feed utilization

Feed resources	Proportion used for (%)						Purchased feed the last one year (birr)
	Feed	Fuel	Housing	Mulch	Sell	Total value (birr) if sold	
Grazing							
Private							
Communal							
Fallow land							
Crop residues							
Barly							
Teff							
Wheat							
Oat							
Pea							
Bean							

Chickpea							
Lentil							
Grass pea							
Forage crops grown							

9.4. Crop cultivated

	Rainfed			Irrigation			Short rain season		
	Area	Crop yield (qtl)	Crop residues yield	Area	Crop yield	Crop residues yield	Area	Crop yield	Crop residues yield
Barly									
Teff									
Wheat									
Oat									
Pea									
Bean									
Chickpea									
Lentil									
Grass pea									

10. Water source and access

Water sources	June	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	M	Ap	M
River												
Distance (km)												
Travel hours												
Water quality												
Stream												
Distance (km)												

Travel hours												
Water quality												
Well												
Distance (km)												
Travel hours												
Water quality												
Pond												
Distance (km)												
Travel hours												
Water quality												
Tap water												
Distance (km)												
Travel hours												
Frequency of access*												
Oxen												
Dry cows												
Lactating cows												
Calves												
Heifers												
Bulls												
*Frequency: 0= free access 1= once in a day, 2= twice in a day, 3=3 times in a day, 4=every other day (once in two days), 5=Other (specify), distance and travel hours from home. Water quality: 1=clean, 2=muddy, 3=others												

10.1. Water pollutants

Water source	Dung /fecal waste	Agro chemical residues	Waste from commercial farm	Sewage from municipal	Mud pollution	Factory effluents
River						
Steam						

Well						
Pond						
Tap						

11. Dairy Animal Housing

11.1. What type of barn do you have for your dairy cattle? a) Separate barn b) shared family house c) fence

11.2. What are the facilities in the barn? a) Water trough b) feed trough c) both d) no facilities

11.3. What type of roofing materials used to construct roof? a) Iron sheets b) grass

11.4. What type of materials used to construct floor? a) Concrete b) earthen c) wood d) stone

11.5. Is the barn well ventilated? A) Yes b) no

11.6. Is the barn well lighted? a) A) yes b) no

11.7. Is the barn well drained? A) Yes b) no

11.8. Are the animals get adequate resting space? A) yes b)no

11.9. How often do you clean the dairy barn? a) Three times a day b) two times a day c) once a day d) once a week

11.10. Do you use bedding materials for dairy animals? a) Yes b) no

11.11. If yes, what types of bedding materials do you use? a) straw/grass b) sawdust c) sand

11.12. If yes, how often do you replace the bedding materials? A) two times a day b) once a day d) once a week

12. Manure utilization and management practices

Manure source	How often do you collect manure	Storage method (a) pit b) heap c) deep litter d)other specify	How long do you store before applied to field	Proportion (%) of manure used for				Do you sell manure (a) yes b) no	Form of sell (a) fresh b) dung cake c) composted
				Fuel (home)	House plastering	As organic fertilizer			
						Compost	Direct spreading		
Cattle									
Sheep and goat									
Equine									
Poultry									
Mixed									

13. Dairy marketing

13.1. Are you members of dairy cooperatives a) yes b) no?

13.2. If yes, what types of service or benefit obtain from cooperatives? a) Concentrate feed b) milk market c) drugs d)credit e)advisory service f) other specify

13.3. Do you sell milk? a) yes b) no

13.4. Amount of milk sale per day -------------liters and price ------per liter of milk

13.5. If yes, where do you sell milk? a) Local market b) milk cooperatives c) neighbor individual consumers) hotels d) milk processors

13.6. Do you face any challenges in milk marketing? a) Yes b) no

13.7. If yes what type of challenge? a) Price fluctuation b) less demand during fasting c) low price d) other specify

14. Livelihoods

14.1. Impacts of crossbreeding intervention (provision of improved breed)

Variables	Increased	Decreased	Remark
Income			
Farm workers			
Veterinary service demand			
AI service demand			
Use of concentrate feed			
Use of improved forages			
Total milk production			
Milk market access			
Milk market challenges			
Herd size			
Grazing			
Milk consumption			
Improved house construction (corrugated iron)			

15. What was the impact of before and after your owned crossbred cattle in household income?

Livelihood Increment indicator	How big before & after owning crossbreed	
	Before	After
Number of crossbred animals		
HF crossbred		
• Cow/heifer		
• Calves		
• Ox		
• Breeding bull		

Jersey cross		
• Cow/heifer		
• Calves		
• Ox		
• Breeding bull		
Milk production & consumption		
• Daily milk production li/da		
• Daily milk sold		
• Daily milk home consumption li/da		

16. Based on the above question which breeding animal do you prefer in cattle you use for reproduction and production? / a) Local zebu b) HF crossbred c) Jersey crossbred

16.1. Why do you prefer these levels of exotic blood level for heifers/cows and bulls? a) Adaptation and resistance ability b).Reproduction and production capacity c) Management and handling availability

16.2. Challenge adoption of improved breed

	Rank (1, 2, 3…)	Remark
Health /adaptation		
Workload		
Feed shortage		
AI shortage		
Marketing/financial problems		
Water shortage		
Unsatisfactory support service		
Productivity		

17. Major dairy and improved forage production constraints

15.1. Dairy production constraints	Rank (1, 2,3…)	15.2. Major improved forage production constraints	Rank (1, 2,3…)
Feed shortage		Land shortage	
Land shortage		Lack of awareness	
Water shortage		Lack of locally adapted productive seed and seedlings	
Disease		Lack of extension support	
Lack of improved or crossbreed cattle		Lack of credit	
Shortage of vet services		Diseases and pest	
Lack of AI		Other specify	
Inadequate extension service			
Marketing problems			
Lack of labour			
Lack of credit			
Other specify			

18. Do you have any taring about dairy production (a) yes----------- (b) no---------?

18.1. If yes which family member is more participant **(a)** husband **(b)** wife**(c)** sun/daughter **(d)** all?

18.2. Which training title is given in better technique?

Training title	Rank (1, 2, 3…)	Length of training given in days or hours
About Dairy cattle Classification		
About forage production		

About feed formulation /treatment		
About Milking practice & milk handling		
About Health care & vaccination		
About Manure management		
About Other types of training about dairy		