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Thesis

Evaluation of reproduction performance and calf sex ratio of dairy cattle in selected locations of South-East Oromia

Debele Guta*

Department of Animal Science, College of Agriculture and Environmental science, Arsi University, P.O Box.193, Asella, Ethiopia

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***Corresponding author:** Debele Guta, Department of Animal Science, College of Agriculture and Environmental science, Arsi University, P.O Box,193, Asella, Ethiopia, Tel: +251910957063, +251988652601; Fax: 022-331-34-30;
E-mail: gtdebe@gmail.com; Debele@arsiun.edu.et

ORCID: https://orcid.org/0000-0002-3165-4758

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Abstract

Dairy farmers in many parts of the world complain about the deviation from the normal calf sex ratio following Artificial Insemination (AI). The prospective and retrospective studies were conducted to compare the sex ratio of the calves born following Artificial Insemination (AI) and Natural Mating (NM) under institutional and smallholder-managed dairy farms. This study also compared the reproductive performance of dairy cattle under institutional management and smallholder systems. The data encompassed farm records maintained between 1996-2014 G.C by dairy farms at Arsi University-Asela, crossbreeding center at Gobe ranch, and Agarfa ATVET College. These farms reared both F1 and crossbreds with higher (>75%) exotic inheritances (grade crosses). The study also considered household and progeny history surveys on smallholder dairy farms (n=90) adjoining to the institutional farms which were randomly selected from Tiyo, Kofele, and Sinana districts. The result indicates that most of the respondents at Tiyo (96.8%) and Kofale (100%) were concerned about the differences in the sex ratio of calves born from AI service and natural mating, while most of the respondents at Sinana (29%) did not report such differences. The respondents in Tiyo and Kofale districts reported higher numbers of male calves (58%) and higher numbers of female calves (58.1%) born from cows inseminated artificially respectively. The Average Age at First Calving (AFC) had no significant difference between genotypes (F1 and grade crosses) reared at the institutional farms. There were significant differences (p<0.05) in AFC across the ranches. The AFC was lower in the institutional farms when compared to those managed at smallholder management conditions. The number of services per conception (NSC) varied p<0.05) across the dairy farms. No significant differences were observed among the sex ratio of the calves born through natural and AI mating systems either at the institutional or smallholder farms. However, differences due to season and year were observed, indicating the effect of non-genetic factors influencing the sex ratio of the calves. In some seasons the numbers of male calves were higher while the reverse was true for some other seasons. Therefore, the reproduction traits of the cattle differed (P<0.05) across the institution and smallholder production systems having lower values observed among the cattle raised at the dairy farms and higher for the F_1 crossbred than grade crosses, while production trait of the cattle differed (P<0.05) across the three dairy farms and there were no significant differences in calf sex ratio among the calves born from AI and NM.

Abbreviations

AFC: Age at First Calving; AI: Artificial Insemination; ATVETC : Agricultural Technical and Vocational Education and Training College; CI: Calving Interval: CSA: Central Statistic Authority; E.C: Ethiopian Calendar; FAO: Food and Agricultural Organization of the United Nations; FSA: Food Standards Agency; GLM: General Linear Model; G.C: Gregorian Calendar; HH: Household; IDF: International Dairy Federation; ILCA: International Livestock Center for Africa; ILRI: International Livestock Research Institute; LL: Lactation Length; LML: Lactation Milk yield; Masl: Meter above sea level; MOA: Ministry of Agriculture; NAIC: National Artificial Insemination Center; NM: Natural Mating; NMSA: National Meteorological Service Agency; NS: Not Significant; OBPED: Oromia Bureau of Planning and Economic Development; P: Probability level; SPSS: Statistical Package for Social Sciences; SSR: Secondary Sex Ratio; TLU: Tropical Livestock Unit

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Introduction

Ethiopia is reported to possess the largest livestock population in Africa. The total cattle population for the country is estimated to be about 55.0 million heads [1]. The indigenous breeds accounted for 98.7% of the total cattle of the country with a minuscule number of crossbreds, [1].

Despite the large cattle population, the average productivity of the cattle in the country is dismally low. This may be attributed to several factors, which are both non-genetic and genetic, The non-genetic factor includes a shortage of fodder supply, disease, low level of management, and lack of proper breeding management practices. These constraints result in poor production and reproductive performance of dairy cattle [2,3]. This often leads to longer days open (postpartum anoestrous), late age at first calving, extended calving interval, besides shorter lactation length, and low milk production [4]. The overall efficiency of dairy cattle is influenced by factors such as delayed age at first service, undetected oestrus, a higher number of services per conception, prolonging the calving interval. These results in higher replacement costs because of the fewer number of calves born in the lifetime of the cows [5].

In Ethiopia the mating is panmictic and the overall efficiency of Artificial Insemination (AI) is dismally low [6]. Studies by [7] have indicated that at the national level the overall efficiency of AI service is as low as 60 %, which is lower than most of the developing countries.

In addition to reproduction traits, dairy farmers are also concerned about calf sex ratios. Theoretically, the average calf ratio (Secondary Sex Ratio, SSR) under normal circumstances is 50% for both sexes [8]. However, there have been complaints from the cattle rearers that there is a deviation from the normal calf sex ratio. Although Artificial Insemination (AI) is an important technique for genetic improvement of low producing dairy cattle, farmers in many parts of the world complain about its effect on calf sex ratios. Still, the development and use of AI has revolutionized cattle production and genetic improvement, particularly and its impact has been revolutionary in the dairy sector. As indicated in a study by [9] it was reported that the Irish farmers prefer natural mating over AI as they believe that in doing so the probability of female calf increases in dairy herds. According to [10] indicated that the sex ratio was 48:52, (female: male) for calves born from AI, while it was 55:45 (female: male) for calves born from natural mating. Generally, the sex shift towards female calves was with a numerical difference by 10% when natural service was used, but it did not show a statistical variation.

In Ethiopia too, a study by [7] from the Mekelle area indicated that the sex ratio was favoring the birth of bull calves when the cow was inseminated.

According to [11] indicated that, unlike natural mating, AI does not affect calf sex ratio as widely perceived by smallholder dairy producers in Ethiopia. Therefore, dairy farmers who started using AI to improve their dairy genetics and those who tend to use it in the future should not bother about the effect of AI on calf sex ratio. Based on this hard evidence, AI should be considered as one of the means that bring rapid genetic changes to the dairy subsector in Ethiopia.

Some studies also associated the outcome of calf sex ratios with various factors. For example [12,13] suggested that early insemination usually results in the birth of more numbers of female calves whereas late inseminations (i.e. close to ovulation) often would result in more numbers of male calves being born. This may be attributed to different timing of capacitation and differences in the survival time of the X- and Y-chromosome-bearing spermatozoa in the reproductive tract of the heifer/cow. This difference in the sex ratio of calves regarding the time of insemination is explained considering that there are many physiological differences between Y and X spermatozoa [14] found that Y chromosomebearing sperm progress more quickly through cervical mucus than those carrying mating an X chromosome-bearing sperm. There is a process of sperm selection in the oviduct, in which spermatozoa interact with the oviductal epithelium, forming a reservoir at the uterotubalisthmus junction and undergo capacitation Those sperm that reach an adequate capacitation state are released and can move to the fertilization place and also [15] reported that the high percentage of female calves when cows are inseminated within the first 18 h from the onset of estrus can be explained by the fact that Y chromosome bearing sperm in the isthmus would achieve capacitation earlier than X chromosome bearing sperm, release from the oviductal epithelium and reach the fertilization place long before the ovulation. Having undergone capacitation, most of these cells would die. However, X chromosome-bearing sperm, which would have undergone capacitation later and have a longer lifespan, would reach the fertilization place at an adequate moment. Thus, in these conditions, it is more likely that X chromosome-bearing sperm would, fertilize the ovum.

Similarly [16], in their study on non-human mammals observed that the secondary sex ratio of newborn offspring was influenced by several factors such as litter size, maternal age, maternal parity, mother's milk yield, maternal stress, birth type, birth season, time of insemination, inbreeding levels, managerial conditions, and population demography.

[8] their study also indicated that Body Condition Scores (BCS) affected calf sex ratios where animals with higher BCS usually gave birth to male offspring. Other studies also linked calf sex ratios with cattle management, for example, the deviation in the sex ratio from the normal 1:1 (male: female) could be attributed to differences in levels and concentrations of the sex hormones in both the males and female offspring [17-19].

In another study [20] observed that there was a positive ($P<0.05$) relationship between herd size and the sex ratio of the calves born. The linear trend revealed that the chances of male births increase in parallel with herd size. Herd size by itself cannot influence directly but some other factors closely associated with herd size may be responsible. Concerning factors such as the condition of the dam and nutritional status, it can be recognized that animals would be kept in better circumstances in large dairies than in smaller ones [21].

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Overall, there have been no satisfactory explanations as to why there is skewness observed among the sex ratio of mammals. Some of the reasons are hormone levels, fetal mortality exhibited by individual dams causing the deviation from the expected 1:1 ratio. Perhaps the skewed sex ratios exhibited by some bulls were due to coital frequency [20,22]. That is, bulls with increased sexual frequency could have produced a sex ratio that differed from bulls with a decreased sexual frequency (i.e number of male offspring produced decreased with increased mating). It is reported that dairy cows, but not heifers, on a high plane of nutrition give birth to proportionately more male than female calves than cows on a poorer diet [23].

The ability to alter the secondary sex ratio in cattle is economically attractive. There has been a growing concern about the determination of the sex ratio of calves born in dairy cattle. Dairy farmers prefer cow calves to perpetuate their herd while crossbred bull calves are desired in beef production. The desired male to female sex ratio (i.e., lower sex ratio) in dairy cattle is fulfilled when the female replacement rates are high. The financial attraction to manipulate sex ratio viz. Semen sexing and embryo sexing are quite attractive [20]. It was suggested by [24] that alteration of sex ratio through biotechnological applications such as superovulation, in vitro fertilization, in vitro embryo production, embryo division, and embryo transfer can be beneficial for the dairy industry. In the long-term, the profitability of a dairy enterprise may be enhanced with more numbers female calves being born.

There has been growing concern from the agrarian community about the sex ratio favoring male calves in herds where AI is prevalent, however, to date no satisfactory explanation has been put forward on the relationship between the reproductive performance of dairy cows and differences in calves' sex ratios for calving following natural vis-à-vis AI insemination. Thus, this study was conducted to assess the reproductive performance of cattle reared in the study areas and the effects of natural vs artificial insemination on the calf sex ratio.

Objectives

General objective

- To evaluate reproductive performance and calf sex ratio in selected institutional and smallholder dairy farms in southeast Oromia.

Specific objectives

- To assess farmers' perception of calf sex ratios in the study area
- To assess the reproductive performances of crossbred and indigenous dairy cows managed at selected institutional and smallholder dairy farms.
- To assess the effect of the mating-type (natural and artificial insemination) on calf sex ratios in established dairy farms and study the factors.

Literature review

Dairy production systems: In Ethiopia, cattle are reared under different farming systems viz. pastoral, agro-pastoral, and crop-livestock farming systems. However, the milk production system can be broadly classified into urban, peri-urban, and rural milk production systems [25]. The urban and peri-urban milk production system, include small and large private farms situated in the urban and peri-urban areas are mostly commercial in nature and rear crossbred animals having the potential to produce around 1120-2500 liters of milk /lactation. This production system is now expanding in the highlands of the country and among the mixed croplivestock farmers [25].

The traditional smallholder system, roughly corresponding to the rural milk production system and accounts for 97 percent of the total national milk production and 75 percent of the commercial milk production [26].

The traditional smallholder farming system is grossly dependent on indigenous breeds, which by and large have low productivity and comprise native zebu cattle. These native cattle have a lactation yield of around 400-680 kg of milk /cow [27]. The erstwhile state dairy farms, (now being privatized or in the process of privatization), use grade animals (those with more than 87.5 percent exotic blood) and are mostly concentrated with in100 km distance around Addis Ababa.

The Ethiopian highlands possess a high potential for dairy development. These areas occupying the central part of Ethiopia, over about 40% of the country (approx. 490.000 km^2), and are the largest of their kind in sub-Saharan Africa [28]. In the highland areas, the agricultural production system is predominantly substance smallholder mixed farming, with crop and livestock husbandry typically practiced within the same management unit. In this farming system, all the feed requirement is derived from native pasture and a balance comes from crop residues and stub grazing.

The majority of milking cows are indigenous animals that have low production performance with the average age at first calving is 53 months and the average calving intervals is 25 months. Cows had three to four calves before leaving the herd at 11-13 years of age, the average caw lactation5 yield is 524 liters for 239 days of which 238 liters is offtake for human use while 286 liters is suckled by the calf. But also a very small number of crossbred animals are milked to provide the family with fresh milk butter and cheese. Women, who use the regular cash income to buy household necessities or to save for festival occasions, sell surpluses, usually. Both the pastoralist and smallholder farmers produce 98% of the country's milk production [2].

Traditional crop/livestock farms in rural areas: These farms are located between 25 and 130 km of Addis Ababa. They are small farms with an average of four dairy cows and provide very little or no specialized inputs to their dairy enterprise. They sell fresh milk daily to the government-owned Dairy Development Enterprise (DDE). Excess milk is processed into butter and local cottage cheese, ayib, and sold in local markets.

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Intensified dairy/crop-livestock farms

These are smallholder farms located around Addis Ababa and exercise some form of an intensive dairy production system. These farms have had experiences with dairy development projects under the Ministry of Agriculture. Projects such as the Selale dairy development project and the smallholder dairy development project have been operational in these areas and have influenced the production system. Improved genotypes, artificial insemination, improved forages, concentrate feeding, housing, calf bucket feeding, and early weaning are common practices by farmers.

Compared to those traditional crop/livestock farmers, landholding is about half the size and milk production is about 15% higher, but the number of cows per household is similar.

Crop/livestock farms with intensive cropping: These farms are located relatively closer to Addis Ababa city, between 25 and 60 km. The farms and herds are 25% larger than the traditional crop/livestock farmers. The cropping system is more intensive and often uses fertilizers. They provide supplementary feeds to their animals. Fresh milk is sold to the DDE and they seldom practice making dairy products.

Specialized dairy farms: These are large farms located within 15 and 60 km from Addis Ababa. Their average holding is 8.9 ha and 17 cows and uses specialized inputs such as improved genotypes, AI, forage production, improved housing, concentrate feeding, veterinary care, etc. They sell fresh milk in relatively large quantities of over 30 liters per day primarily to local informal markets or to the DDE.

Most farm owners have additional off-farm activities often generating more income than livestock. Peri-urban farms in secondary towns: These farms are located in and around secondary towns within 25 to 50 km from Addis Ababa. Cattle are grazed on owned or rented land. Special inputs are linked to the type of genotype and involve artificial insemination and supplementary feed to grazing and stallfed roughages. These farmers, on average, own five dairy cows. The primary outlet for milk is either the DDE or local informal markets.

Intra-urban dairy farms in Addis Ababa: These dairy farms are specialized and intensive production units based on zero-grazing of crossbred and high-grade cows. There is no or little grazing within the city and stall-feeding is based on purchased hay and concentrates. The level of exotic blood in the herd is highest, annual milk production per cow is high, and milk is directly sold to the local market.

Urban dairy in secondary towns: These are specialized dairy farms found in most secondary towns within the milk shed. In these small towns, farmers have more access to grazing; stallfeeding is, therefore, less intensive. The level of exotic blood in the herd is high, but herd size is the smallest and averages about two cows per farm. Milk is sold fresh to local markets or the DDE, processed into butter and ayib, and sold. Most farm owners have off-farm activities representing about two-third [6].

Artificial insemination service in Ethiopia

In Ethiopia, AI was introduced in 1938 in Asmara (the current capital city of Eritrea), which was interrupted due to the 2nd World War and restarted again in 1952 [29]. However, it was again discontinued due to unaffordable expenses of importing semen, liquid nitrogen, and other related inputs requirement. In 1967, an independent service was started in the Arsi

Region, Chilalo Awraja under the Swedish International Development Agency (Sida). Artificial insemination services were introduced at the farm level over 35 years ago [30].

The present National Artificial Insemination Center (NAIC) was established at Kaliti, Addis Ababa in 1984 to coordinate the overall AI operation at the national level [31].

The efficiency of the service in the country, however, has remained at a very low level due to several constraints viz. infrastructure, managerial, and financial, besides poor heat detection of the cattle by the beneficiaries, improper timing of insemination, lack of inseminators and also embryonic death [2].

Feed resources for dairy cattle

The urban and peri-urban dairy operations depend specifically on the herbal pasture hay as a source of roughage feed within the critical highlands of Ethiopia [32]. The predominant roughage feed assets for dairy animals throughout all the special manufacturing structures consist of herbal pasture/grasslands, grass hays, crop residues, and non-conventional feed sources [33-35]. The crude protein content material of pastures most often is lower than 7%, which couldn't guide the protection necessities of ruminants [26]. Good grass and legume hays are adequate for preserving maximum training of livestock, in particular those in a non-effective kingdom [36].

Therefore, dairy cows which depend upon poor fine basal feeds will now not express their full genetic capacity. According to [35], agro-industrial by-products which include bran, middling, oilseed cakes, and molasses are fed as a supplement to crossbred dairy cows in urban and peri-urban areas.

Reproductive performance of dairy cows

Reproductive traits identify characters, which influence the overall reproduction efficiency of the cattle especially those related to the female reproductive system. These traits include age at first calving, calving interval, days open, and several services per conception. [37,38] reported that herd profitability is determined by the reproductive performance of the dairy cows, as it correlates with the numbers of lactation and also the numbers of replacement herd. Furthermore, studies by [39] indicated that the major factors influencing reproductive performance include management both at the herd and individual cows [3] reported that in tropical countries the performance of cattle at the smallholder level is influenced by several factors viz. genotype, location (geographical location), the season of calving, suckling status (of the calves), parity, and body condition score).

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According to [32] under tropical conditions and for zebu breeds, the calving intervals usually vary from 12.2 to 26.6 months, the number of services per conception from 1.4 to 2.8, and days' open average around 123 days. Similarly, for the temperate breeds of cattle [40,41] reported the desired calving interval varying from 12 to 13.5 months while the numbers of services per conception vary from 1.3 to 1.5 and the days' open average around 85 days Table 1.

Non-genetic factor affecting reproductive traits

Season of calving: Season of calving has an important impact on reproductive traits, as the high temperature increases respiratory rate and severely depresses feed intake. A significant effect was detected for the season of calving on reproductive traits [46,47].

Nutrition

Nutrition is considered a reproductive problem in dairy herds; two factors should be kept in mind about the relationship between nutrition and reproduction. Malnutrition on one hand is only one possible cause of reproductive problems. Factors like poor estrus detection and poor hygiene at calving should be ruled out before looking for nutritional causes of breeding problems. Secondly, relatively little is known with certainty about the complex interaction between nutrition and reproduction [48].

Factors associated with a negative energy balance have been considered as causes of reproductive failure. Lower conception rates, longer calving intervals, and an increased incidence of silent heat have been considered the results of energy deficiency [49].

Excessive energy intake during late lactation and dry periods can lead to "fat cow" problems. Over-conditioned cows have a higher incidence of retained placenta, more uterine infections, and more cystic ovaries. They also have more metabolic disorders, which again can result in poor reproductive performance [50,51] indicated that body condition scoring is, recommended to assess the nutritional status of dairy cows during the reproduction cycle.

Table 1: Estimates of some reproductive trait for different breeds.

Trait	Breed	Estimates	Reference
Age at First Calving (AFC)	Crossbred x HF	37.95 ± 9.4 months	[42]
	Indigenous	47.16 ± 8.7months	[42]
	Friesian	43.16 ± 3.5 months	[43]
	Jersey	39.72 ± 1.08 months	[24]
	Jersey crosses	48.24 ± 0.84months	[24]
Calving Interval (CI)	Indigenous	24.94 ± 4.1 months	[42]
	Crossbred x HF	22 ± 4.4months	[43]
	Holstein	456± 5.4 days	[43]
	Indigenous	12.2 months	[40]
Days Open (DO)	Holstein Friesian	123 days	[44]
	crosses Friesian	187± 5.4 days	[42]
	Holstein Friesian	177± 5.4 days	[43]
Number of Service Per Conception (NSC)	Zebu	1.74-1.8	[6]
	crossbred cattle	1.95	[6]
	Indigenous	1.5	[45]

Phosphorus deficiency has been most commonly associated with decreased reproductive performance in dairy cows. Anoestrus delayed sexual maturity, and low conception rates have been accounted for when phosphorus intake was low. A major concern in mineral feeding of dry cows relates to providing optimum levels of calcium and phosphorus to decrease the occurrence of milk fever. In a study of 33 herds, cows with milk fever were 4.2 times more likely to require assistance at calving, 2 times more likely to have retained placenta, and 1.6 times more likely to be treated for metritis [48].

Dairy housing

A suitable dairy housing and husbandry system should meet the fundamental needs of cattle, based on the principles of sound animal care. According to [51] there are three predominant goals of environmental management in dairy herds:- Reduce the absolute number of pathogens in the environment, reduce the potential for contact between the pathogens and the cows, minimize the detrimental effects of the environment on the animal, which may modify the host defense mechanism.

Dairy herds' problem during housing is the lack of enough space for each group of animals according to age and production. The need to group cows, based on the reproductive and/or production group system, becomes rapidly apparent in large herds. Some of the most important reproductive problems associated with the design of facilities and management of the environment can be summarized as follows [51].

Inadequate space for each group of animals in the herd may result in overcrowding and thus increases the risk of spread of infectious diseases and problems with nutritional management.

Inadequate housing facilities can limit the detection, identification, and handling of cows in heat, resulting in sub-optimal reproductive performance. Cows calving in well-bedded calving pen are less prone to traumatic injuries associated with slipping, falling, and decumbency secondary to parturient paresis. Inadequate and insufficient manure disposal can lead to environmental contamination and increase the risk of spreading infectious diseases.

Sex ratios of calves

According to [52] sex ratio theory is defined as the ratio of male-to-female offspring at birth, the sex ratio is an evolutionarily developed feature of the norm of 50:50 and does not have objective refutations. In livestock production, the possibility to modify the sex ratio of the calf can result in a substantial increase in the production of livestock farms [53] that the manipulation of sex ratio can sensibly enhance the effectiveness of selection and genetic improvement programs, through the differential increase in the numbers

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of males or females calves being born. as well, the sex of the calf is considered the most important genetic trait for animal production as it exerts a profound influence on several factors such as growth rates, milk production, and susceptibility to diseases. As it is a genetic trait, the sex of the unborn cannot be manipulated by genetic selection, but only through sex predetermination methods.

As indicated in a study by [54], selection for particular sex is currently possible only by pre-implantation diagnosis and transfer of embryos of a given sex, by prenatal diagnosis and abortion of undesired sex, or through sperm separation using flow cytometry combined with *in-vitro* fertilization (IVF). However, the cost and clinical nature of preimplantation diagnosis and IVF limit their use, especially in developing countries.

Factors affecting calves sex ratios

Calves sex ratio can be affected by diverse genetic factors maternal influence geographical location of the concerned farm, dominant weather patterns, timing and frequency of coitus (relative to ovulation), diet of the dam; paternal age, parental age gap, maternal blood type, Body Condition Score (BCS), vaginal pH have all been statistically associated with an altered secondary sex ratio (SSR) in mammals [8].

Timing of service may also contribute to the difference in secondary sex ratio between mating types. Although a consensus has not been reached in the scientific literature on the effect of timing of service on sex ratio some studies have reported a higher proportion of female offspring following early insemination, which would predominantly occur with natural mating.

Effect of genetic

According to [23], genetic variation in sex ratio (male offspring as a proportion of total births) can be sought at various levels. The genetic differences could exist among species (which would not be of particular concern to livestock producers) or among breeds, strains, lines, families, or individuals. Also, crossbreds or strain or line crosses could differ among themselves or from their straight bred parents in the sex ratio of the offspring

Effect of maternal influence

Some maternal features such as body condition, diet, blood glucose level, dominant status in the herd, estrogen, testosterone levels, stress and age of the dam, parity, litter size, and some female-linked parameters such as time of insemination, the side of the active ovary, exposure to contaminants and environmental temperature have been suggested to alter sex ratio [8].

Correspondingly [55] accounted that the sex ratio of embryos at the expanded blastocyst stage was more than 75% male when glucose was included in the medium, whereas the sex ratio did not deviate significantly from 1:1 in the glucose-free medium. Concerning vaginal pH, there was a strong negative correlation between vaginal pH and sex ratio during the early and late stages of the fertile cycle in hamsters. near the beginning of the fertile cycle, when the pH was the least acidic, the number of male offspring produced was the least. On the contrary, late in the fertile cycle, when the vaginal pH was most acidic, the number of male offspring was the greatest [56].

According to [57] there seems to be no indication that the age of the parents had any particular effect on the sex ratio of the offspring.

In Ethiopia, the rainy months and the first month of spring are characterized by critical feed scarcity in terms of both quantity and quality. Calving of more female calves to cows that showed estrus during this season of the year is in agreement with the theory of [58]who suggested that organisms that experienced negative energy balance or face environmental shocks tend to give more births to female offspring.

The effect of dam parity on calf sex is at odds with previous findings where no association between calf sex and dam age or parity was evident in dairy cows [8] or humans [59] Nonetheless, maternal age was reported to positively influence secondary sex ratio in other studies across species, which is in line with trends observed in the present study [60] reported different secondary sex ratios in purebred Angus calves from heifer dams (male: female ratio = 50:50) or cow dams (ratio male: female = 51:49). The positive effect of parity on sex ratio in the present study may reflect the [58] hypothesis, which stated that mothers in poorer physiological conditions or with limited resources would be advantaged by investing more heavily in the more reproductively stable sex (i.e., the female).

[61] suggested that parental care can influence the breeding success of one sex. Studies by [62] indicate that in Red deer the sons of the dominant mothers are more successful than their daughters are, whereas, the daughters of subordinate mothers are more successful than their sons. Similarly [63] reported that these effects occur partly because of the breeding efficiency of males.

studies have indicated that sexual dimorphism favors the females in times of food shortages, the juvenile females have better survivability than the males during such periods, it may be because the nutrient requirements of the males (for growth) is higher than the females [64].

Effect of sibling competition

Studies by [65] suggested that, if sons and daughters are equally costly to the rear but siblings of one sex are more likely to compete for mates than are those of the other sex, the sex ratio of progeny should be biased toward the sex that will compete less intensely. Besides [66] also stated that under these conditions the production of a large proportion of females not only reduces mating competition between siblings but is likely to increase the mating success of the male siblings. According to [55] changes in the intensity of sibling competition or the degree of inbreeding would favor changes in the sex ratio.

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Effect of breeding method

There have been several reports highlighting the differences in sex ratio attributable to that of the method of breeding. Results of a study by [67] from Pakistan indicated that the numbers of male calves born were higher ($P<0.05$) amongst the dams inseminated artificially.

Similarly, a study by [68] indicated that there is a high incidence of male calves being born among the cows inseminated artificially. One contributing factor may be the effect of timing of mating on the resultant sex ratio. Nevertheless, other studies in cattle have failed to identify a relationship between time of service and sex ratio. However, the results of a study by [11] from Ethiopia did not show any significant deviation in calf sex ratio among the cows inseminated artificially, however they did mention that the sex ratio favored the female-born calves under natural mating conditions.

Effect of nutrition

According to [69] there can be an alteration in the sex ratio in mammals under natural selection. They hypothesized that under favorable conditions the chances of male offspring being born are higher than those of female offspring [60] their study indicated that the dams maintained on a high plane of nutrition would be able to invest more heavily in their offspring than those on poor nutritional planes thus altering the sex ratio. Selective abortion takes place favoring the female offspring at different stages of gestation among dams raised on the poor plane of nutrition [9,11].

Effect of the season beyond the immediate feed supply can indicate an innate evolutionary adaptation whereby climatic variables, which are related to feeding supply can also, influence peri conception selection of embryos based on their sex.

According to [70] indicates that the calving season has a slight effect on the sex ratio of the calves. Similarly, studies by [8] indicated that the probability of a bull being born increased with increasing air temperature and humidity around the time of conception. Studies by [68] indicate that there were more numbers male calves born in the monsoon and winter months when compared to the summer months. This may be because winters and monsoons are more comfortable when compared to summer and there may be the selective abortion of a male fetus in summers due to environmental stress. It has also been reported that during the summers the feed quality and feed consumption of the dams decreased, the male fetus has higher growth and weight rate when compared to the female fetus. Thereby the nutrient requirements are higher and hence selective abortion of the male fetus occurs during the stressful months.

Similarly, some psychological disorders of mammals are known to have a pronounced annual rhythm [70], indicating climatic effects. Weather factors are said to be positively associated with the SSR. The effect of climate is known to influence forage production and the levels of estrogens in some leguminous plants [71,72].

Similarly, a study by [73,74] demonstrated that a significant effect of pre-conceptual maternal diet on the sex ratio, female mice fed a very high saturated fat diet had significantly more male offspring than either control or restricted fat diet females.

Effect of population dynamics

According to Sharpe and Wyatt (1974) and Burley (1980), the sex ratios of offspring vary with population demography, including the juvenile sex ratio the adult sex ratio [13] population density (Emmerson, 1948), the phase of the population cycle [52] the size of the maternal lineage of the mother [75] and the extent of mortality among male and female juveniles in the previous season. If the cows are subjected to harassment by the bulls, then there are chances that it can influence the calf sex ratio favoring the birth of more male calves due to selective abortion of the female calves. However, these random fluctuations are more commonly observed in small populations [62].

Materials and methods

Description of the study area

The study was conducted in three woredas and three selected institution dairy farms and one kebeles of smallholder dairy farms from each woreda situated in the vicinity of the selected farms, these kebeles were selected in a way that the climatic variation between the farms and the kebeles were minimum. The institution dairy farms were Agarfa ATVETC dairy farm, Arsi University dairy farm, and Gobe dairy cattle ranches. In addition to farm records used from the three institutions' dairy farms, a questioner-based survey was also carried out to assess the response of some selected smallholder dairy farmers towards the studied topic Figure 1.

Arsi University dairy farm

The dairy farm of Arsi University was established in 1979.G.C. for a distribution-crossbred heifer, provision of artificial insemination (AI) service, and forage production and marketing. The current herd size of the farm is 239 cattle with different age groups and having 57-99% blood levels. The farm is situated at 07º 33`09" N latitude and 39º15`37" E longitude, at an altitude of 2804 m.a.s.l. The average annual rainfall in Assela town is reported to be 1120 mm, while the average mean minimum and maximum temperatures were recorded to be 7.8 ºC and 18.9 ºC, respectively [76].

Gobe dairy cattle ranch

The Gobe ranch was established in 1938.G.C. under government organization for extension services such as the distribution of Arsi-Bale cross heifers to the farmers and producers of different cereal crops and sale to the community at a low price. However, the farm was relocated to the private sector in 2009.G.C. mainly for milk production purpose the current herd size of the farm is about 103 dairy cattle with different blood levels ranging from 5095% and is located at 7°4'0" N latitude and 38°46'60" E longitude; at an elevation of 2,515 meters above sea level [76].

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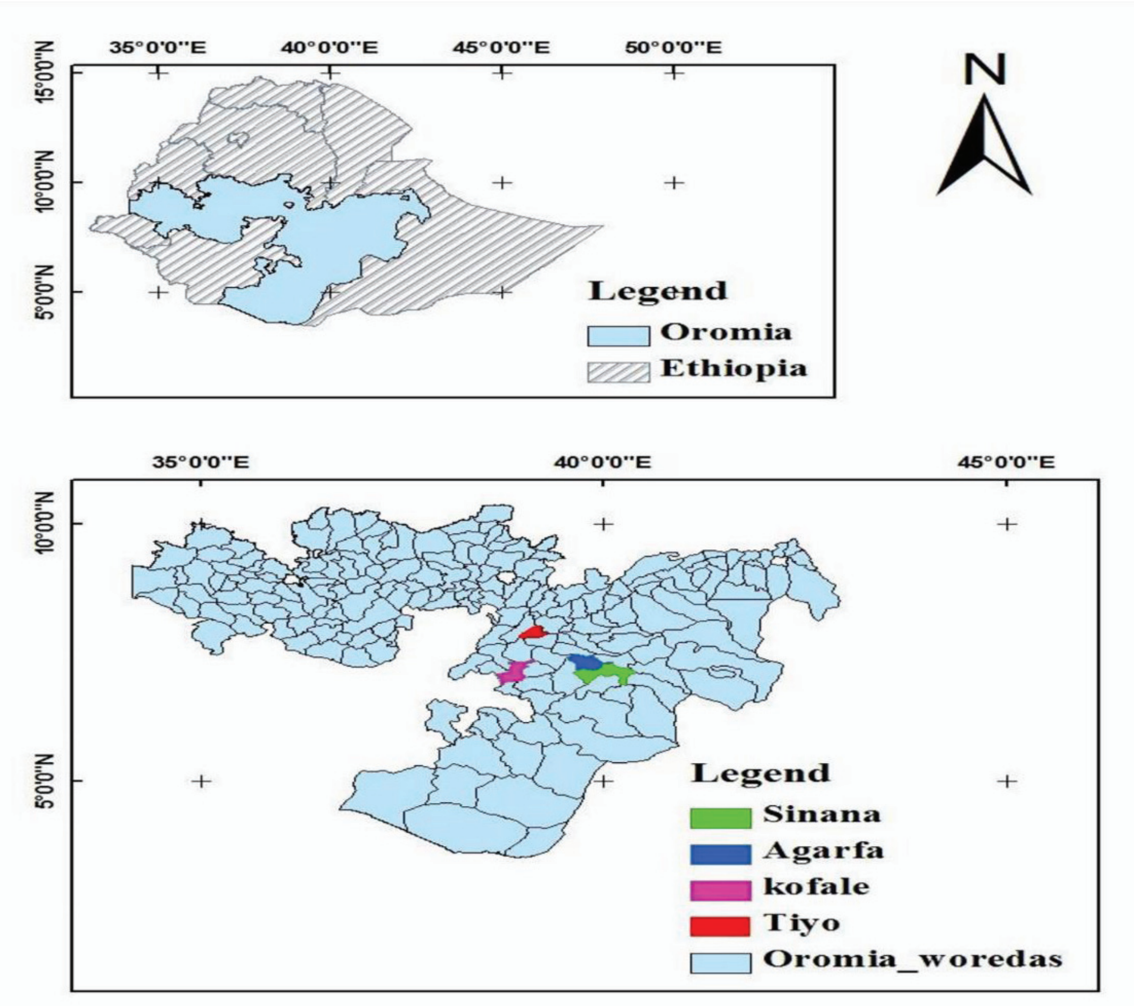

Figure 2: Maps of the study area.

Agarfa ATVETC dairy farm

Agarfa Agricultural Technical and Vocational Education Training College (ATVET), a dairy farm was established in 1983 G.C. for the provision of practical training for model farmers and DA's and to produce milk for children in the college. The farm had a herd size of about 132 dairy cattle having blood levels ranging from50-95% is situated 40° 03' E and 6°11' N at an altitude is 2350 m.a.s.l. The mean annual rainfall and maximum and minimum temperature are about 836.1 mm, 22, and 8.6°C respectively (NMSA, 2010).

Sampling techniques

Farm record: Data on the sex ratio of the calves born at the farms, and its relationship with the type of mating (natural or artificial), production, and reproduction records of the cows over the parities were used from the three institution dairy farms. Only the data of the cows with complete information were included in the study.

Survey: For the survey, one kebele, Tiyo represents Arsi university dairy farm, Kofale represents. Gobe dairy cattle ranch, Sinana represents Agarfa Agricultural Technical and Vocational Education Training College in the vicinity of the farm, and based on it seems similarity in environmental condition and infrastructure was purposively selected. The respondents were also purposively identified based on the number of cows owned by them and their experience in dairy farming. The sample size (N) will be determined using the formula recommended by Arsham (2005) for survey study as N = 0.25/SE2, where N is a sample size, and SE is the standard error. Thereafter 20% of the identified households were selected randomly for the study. Before the actual study preliminary study was conducted to identify the key informants (farmers, development agents, and elders) who provided the basic information on the method of breeding prevalent in the area.

Methods of data collection

I got data from two categories of dairy farms vis a vis three institution dairy farms and 90 smallholder farms 30 households from each PA.

Farm record data

The reproduction and production-related data maintained from 1996-2014 G.C. at the respective institution dairy farms were used from the pedigree records maintained of the cattle reared at the farms. The reproductive traits of the cattle from

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the different genotypes used in the study were, the age at first calving, calving interval, days open, and number of services per conception, Production traits included in the study were lactation length, lactation milk yield, birth weight of a calf, the sex of the calf born and types of service (natural or artificial)

Age at first calving (AFC) is the age at which the first calving of heifer occurs. Thus, the difference between the date of the 1stcalving and the cow's birth date gives the value of age at first calving, calving interval refers to the period between consecutive calving. Days open is defined as the interval from calving to the day of conception (the period from calving to the next conception).

The number of services per conception (NSC) is the number of services required for a successful conception by artificial insemination, Lactation length (LL) is the length of lactation in days until the advanced stage of gestation exerts pressure on milk secretion [41]. The standardization procedure of incomplete lactations (i.e. lactations still in progress or lactations terminated due to the cow's death or sale while still milking) developed by Rege (1991) and adaptable for Tropical Africa was applied for correcting incomplete lactation records of cows that died or left the herd before 305 days in milking.

Survey: A structured questionnaire was prepared and pre-tested before administration and some rearrangement, reframing, and correcting by respondents perception was made. The questionnaire was administered to the randomly selected household heads by enumerators recruited and selected for this purpose with close supervision by the researcher. A recall method as suggested by [77] was used to obtain the reproduction and production-related data from the farmer's end. Based on the questionnaire, the following major information was gathered.

1. Mating type, calves ratios (male or female)
2. Complaints about calf sex ratios, if then if it is associated with AI practices
3. Perceived factor affecting calves sex ratios
4. Reproduction parameters, which is based on the Progeny History Survey (PHS)

Data analysis

The data collected was analyzed statistically using a statistical package for social science (SPSS) v 16 for Windows. The qualitative data were tested using Chi-square analysis. Descriptive statistics were used for the quantitative traits, the means were compared using. One way ANOVA and Duncan's multiple range test and the effect of ages, location, mating type, breed, year, season, and parity on the sex ratio of the calves.

The following general linear statistical models were used:

- The first model for the reproductive trait(AFC, DO, CI, NSC)

Institution farms model

Y_{ijk}=μ+ f_i +bj+ pk+ s (i.j.k) + e_{ij} Where, μ=over all mean. $f_{i\,=}$ effect of farm, bj = effect of breed , p_k =effect of parity , e_{ijk} =is the error term.

Smallholder farm model

Y_{ij} =μ+ di+ e_{ij} Where μ=over all mean. $d_{i\,=}$ effect of district, e_{ij} =is the error term.

- Model for production performance (Birth weight ,LL, LMY)

Yijk=μ+ fi + pj+ eijk

Where, μ=over all mean. $f_{i\,=}$ effect of farm, bj = effect of parity, e_{ijk} =is the error term

- Model for calves sex ratios (Male:Female)

Institutional farms model

Y_{ijk}=μ+ m_i + pj+ c($_{i)j}$+ dk+ e_{ijk}

Where μ = is overall means, mi = is type of breeding (AI/NM), pj= effect of parity,

dk= environmental factor (season, nutrition), $e_{ij=}$ is the error term.

Smallholder farm model

Y_{ijk}=μ+ m_i + pj+ dk+ e_{ijk}

Where μ = is overall means, mi = is a type of breeding (AI/NM), pj= effect of parity, d_k= effect of the district, $e_{ij=}$ is the error term.

Results

Household characteristics

The results about the household types, age categories, and educational level of smallholder dairy farmers of the study area are presented in Table 2. The results indicate that most of the respondents are male-headed in all the studied locations. The average age of most of the respondents in the Tiyo and Kofale districts are between 35-<45 years. At Sinana the average age of most respondents was greater than 55 years. The results further indicate that most of the respondents had some sought of primary education. However, the proportions of illiterate respondents were higher in the district adjoining Sinana and Kofele Table 2: Household demography of the respondents in the three study districts

Household size

As indicated in Table 3, the mean household size below 15 years was significantly different at (P<0.05) among the three study districts. While those in productive age (16-60 years) and above 60 were not significantly different among study districts. The minimum and maximum household size were highest at the categories of 16-60 with a minimum value of

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family size and a maximum value of 11 at Sinana followed by 9 at Tiyo and 8 at Kofale.

Livestock demography and land holdings in the study area

The results about the livestock demography, average landholding, and herd size of the studied locations are presented in Table 4. The findings in the Total Livestock Unit (TLU) indicate that the numbers of oxen were highest at Tiyo followed by the numbers of cows in the herd. The population of the cows was however higher at Kofale, while the population of the oxen and the cows were similar at Sinana. The study further indicates that there were no significant differences in landholding among the respondents in the three locations, while the average herd size varied ($P<0.05$) across the locations with the highest herd size reported from Kofele and lowest at Sinana.

Perception of the respondents regarding factors influencing calf sex ratio and the type of mating. The results as presented in Table 5 indicate that most of the respondents at Tiyo and Kofale were concerned about the differences in sex ratio (male: female) of calves born from natural mating vs artificial insemination while most of the respondents at Sinana district did not observe any significant differences in the sex ratio. The results further indicate that majority of the respondents ($P<0.05$) at Tiyo thought that the calf sex ratio varied, favoring the birth of the male calves while most of the respondents (who followed the differences in the sex ratio). The respondents from Kofale responded otherwise and while they too observed the differences in the sex ratio, but those favoring the birth of the female calves.

The results as presented in Table 6 indicate that most of the respondents irrespective of all the locations thought that there

Table 2: Household demography of the respondents in the three study districts.

Description	District				
	Tiyo N=31(%)	Kofale N=31(%)	Kofale N=31(%)	Total N=93(%)	X^2
Type of household					0.216
Male headed	83.9	64.5	71.0	73.1	
Female headed	16.1	35.5	29.0	26.9	
Age categories of the respondents					0.000
20-<25 years	3.2	0.0	6.5	3.2	
25-<30 years	0.0	3.2	3.2	2.2	
30-<35 years	9.7	6.5	19.4	11.8	
35-<45 years	51.6	58.1	9.7	39.8	
45-<55 years	25.8	32.3	19.4	25.8	
>55 years	9.7	0.0	41.9	17.2	
Education status of the respondents					0.05
Illiterate	6.5	16.1	25.8	16.1	
Barely able to read and write	0.0	0.0	6.5	2.2	
Grade 1-4	22.6	9.7	22.6	33.3	
Grade 5-8	41.9	25.8	32.3	12.9	
Grade 9-10	6.5	22.6	9.7	16.1	
Grade 11-12	22.6	22.6	3.2	1.1	
Graduate	3.2	3.2	0.0	18.3	

Table 3: The household size of smallholder dairy farms in the three study districts.

Age categories	N	Mean ± SE	95% confidence interval for mean				
	-	-	Lower Bound	Upper Bound	Min	Max	X^2
below 15							
Tiyo	31	4 ± 0.3^b	3.35	4.72	2	9	**
Kofale	31	3 ± 0.2^a	2.65	3.35	2	6	
Sinana	31	3 ± 0.31^a	2.05	3.31	0	9	
Total	93	2.24 ± 0.2	2.90	3.58	0		
HH b/n 16-60							
Tiyo	31	4± 0.4	3.05	4.57	2	9	NS
Kofale	31	4± 0.3	3.30	4.63	2	8	
Sinana	31	4± 0.5	3.88	5.73	2	11	
Total	93	4.2 ±0.2	3.74	4.64	2	11	
HH above 60							
Tiyo	8	0.35 ± 0.12	0.11	0.60	0	2	NS
Kofale	3	0.10 ± 0.05	0.01	0.21	0	1	
Sinana	17	0.74 ± 0.14	0.46	1.03	0	2	
Total	28	0.40 ± 0.19	0.26	0.53	0	2	

N= Number of respondents, HHn= Household number, SE= Standard Error NS= Not Significant, **= Significant. Means with a different superscript in the column show a significant difference ($P<0.05$)

Table 4: Livestock demography and landholding in the studied locations.

Livestock classes		Mean (TLU) ± SE	
		Name of District	
	Tiyo, N=31	Kofale N=31	Sinana N=31
Oxen	4 ± 0.3^c	2.13 ± 0.3^a	2.7 ± 0.3^b
Cow	3.35 ± 0.1^b	3.65 ± 0.2^b	2.7 ± 0.2^a
Heifers	0.9±0.1	1.2±0.2	1.2±0.1 cc
Bull	1.5±0.2	1.5±0.2	1.3±0.2
Calves	0.8±0.1	0.64±0.1	0.43±0.6
Sheep	1.3±0.2	0.9±0.2	0.7±0.2
Donkey	1.1 ± 0.1^a	0.9 ± 0.1^a	1.6 ± 0.2^b
Land size (ha)	2.8±0.1	2.5±0.12	2±0.1
Herd size	3.9 ± 0.13^a	4.3 ± 0.3^b	3.8 ± 0.3^a

Storch, et al. (1991)

TLU= Tropical Livestock Unit, 1weaned calf= 0.34 TLU, 1Heifer = 0.75 TLU, 1Young Bull= 0.80, 1cowand ox = 1.00 TLU, 1Adult sheep and goat =0.13, 1Adult Donkey = 0.70, SE= Standard Error, N= Number of respondents,^{a,b,c} $P<0.05$, values across the rows are different

Table 5: Perception of the respondents on calf sex ratio in the studied districts.

Description	District			
	Tiyo N=31 (%)	Kofale N=31(%)	Sinana N=31 (%)	X^2
The difference in sex ratio				0.000
Yes	96.8^b	100.0 b	29.0^a	
No	3.2^a	0.0	71.0^b	
The sex ratio is influenced by Artificial insemination				0.000
Yes	93.6	93.5	19.4	
No	3.2	6.5	6.4	
Unknown	3.2	0.0	74.2	
Sex ratio of the calves using artificial insemination				0.000
More number of males	58.0^b	25.8^a	16.1^a 9.7^a	
More number of females	29.0^b	58.1^c	0.0	
Similar proportion	6.5	16.1	74.2	
Not observed	6.5	0.0		

N=Number of respondents, AI=Artificial Insemination

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are several genetic and non-genetic factors influencing the calf sex ratio. The respondents at Tiyo believe that the differences were attributable to the genetic makeup of the animals. There were also people in Tiyo and Kofale who indicated that the season of mating influenced the calf sex ratio. The respondents from Sinana were, however, of the opinion that the nutrition received by the cow at the time of mating and thereafter influenced the sex ratio of the calf. However, they also observed that some unexplainable reasons were influencing the calf sex ratio.

The study further indicated that the method of breeding (artificial vis-à-vis natural) too influenced the calf sex ratio while the respondents of Tiyo and Kofale indicated that the differences were more when the cows have mated artificially (Table 7). The respondents from all the studied locations were however in favor of artificial insemination.

Farmers also indicated that they detect estrus signs very well. Concerning dairy cattle housing systems, differences were observed among study districts. While free-stall housing was common in Sinana at Tiyo and Kofale the respondents housed their livestock in houses but without the provision of any individual pens.

Reproductive performance of dairy cattle managed under three institution dairy farms and smallholder dairy farms. The results as presented in Table 8 pertains to some of the reproductive traits of crossbred (F_1 and higher crosses (>75 % exotic inheritance) cattle reared with the respondents in the three districts. The result indicates that there are differences at (P<0.05) in most of the traits. The age at first calving (AFC) and calving intervals were longer for the F_1 crossbreds while the numbers of days open (DO) were higher among the grade crosses.

The findings as presented in Table 9, further indicated that there were differences (P<0.05) across the districts, which might be attributed to both the genetic makeup of the cattle and the management. The AFC was lowest among the cattle raised in Kofele and the highest value was observed in Sinana. The findings further indicate that the DO was lowest among the cattle raised at Tiyo while the values were highest among those reared at Sinana. The numbers of services per conception (NSC) too varied across the districts, with the lowest values observed among the cattle raised at Sinana while no differences in the trait were observed between the other two locations.

Table 6: Perceptions of the respondents on the factor that affect calf sex ratios in the study districts.

Description	District		
	Tiyo N=31 (%)	Kofale N=31(%)	Sinana N=31 (%)
Are there external factors influencing the sex ratio			
Yes	90.3^{b}	96.8^{b}	64.5^{b}
No	6.5^{a}	3.2^{a}	12.9^{a}
Unknown	3.2^{a}	0.0	22.6ab
Factors influencing the sex ratio of the calves			
Genetics	41.9	9.7	32.3
Season of mating	32.2	54.9	3.2
Nutrition	9.7	9.7	22.6
Maternal Influence	0.0	3.2	6.5
Genetic +season	3.2	16.1	0.0
Nutrition + Maternal Influence	3.2	3.2	0.0
Other	9.7	3.2	35.5

^{a,b} P<0.05 values across the columns are different

Table 7: Methods of breeding, estrus detection, and type of houses used by dairy farmers in the study areas.

Description	District		
	Tiyo N=31(%)	Kofale N=31(%)	Sinana N=31(%)
Methods of breeding AI	45.2^{b}	45.2^{b}	6.5^{a}
NM	3.2^{a}	16.1^{a}	77.4^{b}
Both	51.6^{b}	38.7^{ab}	16.1^{a}
Preferred method			
AI	96.8	96.8	61.3
NM	3.2	3.2	38.7
Estrus detection			
Yes	90.3	93.5	87.1
No	9.7	6.5	12.9
Type of housing			
Free stall	29.0^{a}	25.8^{a}	71.0^{b}
With individual pen	16.1^{a}	12.9^{a}	22.6^{b}
Without individual pen	54.9^{b}	61.3^{b}	3.2^{a}
Open Fence	0.0	0.0	3.2^{b}
Total	100.0	100.0	100.0

P<0.05 values across the columns are different.

Table 8: Reproductive performances of cattle of different blood levels managed under three institution farms.

Reproductive Traits	Breed	N	Mean ± SE (days)
AFC (Days)	Arsi Bale×HF(50%HF) Higher cross(>75%HF)	122 130	1478.69 ± 17.5^{b} 1162.4 ± 13.1^{a}
DO (Days)	Arsi Bale×HF(50%HF) Higher cross(>75%HF)	121 129	182.66 ± 5.5^{a} 187.8 ± 5.5^{b}
NSC (No)	Arsi Bale×HF(50%HF) Higher cross(>75%HF)	122 129	1.3 ± 0.1 1.35 ± 0.1
CI parity1 (Days)	Arsi Bale×HF(50%HF)	122	612.4 ± 24.04^{a}
	Higher cross(>75%HF)	130	667.8 ± 29^{b}
CI parity2 (Days)	Arsi Bale×HF(50%HF)	98	610.3±32.2
	Higher cross(>75%HF)	112	613.02±23.8
CI parity3 (Days)	Arsi Bale×HF(50%HF)	37	575.3 ± 49.9^{a}
	Higher cross(>75%HF)	31	622.2 ± 50.5^{b}
Overall average of CI	Arsi Bale×HF(50%HF)	263	538.8±33.8
Overall average of CI	Higher cross(>75%HF)	278	656.8±63.7

N= Number of the sample, Arsi Bale×HF^{1} = 50% blood level, Higher cross (>75% Holstein Friesian inheritance AFC= Age at First Calving, DO=Days-Open, NSC=Number of Service Per Conception, CI1= Calving Interval between 1st parity and 2nd, CI2= Calving Interval between 2nd parity and 3rd parity CI3= Calving Interval between 3rd parity and 4th parity, CI4= Calving Iterval between 4th and 5th parity. Means with a different superscript in columns with categories for breed show significant different (P<0.05)

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The results further indicated that there was no significant difference between calving intervals across all the parties.

The results as presented in Table 10 indicate that there are differences in reproductive traits of cattle raised at the different farms. The results about AFC indicate that there were no differences ($P<0.05$) for the trait across Gobe and Asela farms, while Agarfa varied across two farms. The value being lowest among the cattle reared at Asela while the values were higher among the cattle reared at Agarfa dairy farm. The results further indicate that the numbers of services per conception (NSC, 1st, 2nd, and 3rd) significant ($P<0.05$) across the dairy farms with the values being lower at Agarfa and Asela when compared to those of Gobe dairy farm. The CI for 1st (in days) significant among the cattle reared across the three dairy farms, with values being similar among the cattle raised at Gobe and Agarfa dairy farm and the value is lower among the cattle raised at Asela dairy farm. The results about the CI for the 2nd parity indicate that the trait significant ($P<0.05$) across the three dairy farms, with the values being lower at Agarfa and highest at Asela dairy farm, while those of Gobe dairy farm were intermediate between the two. The CI for the 3rd parity indicates that there are differences ($P<0.05$) across the dairy farms, with the Gobe, Agarfa, and Asela. The NSC for 5th parity significant ($P<0.05$) across the dairy farms, with lower values reported from Agarfa and Asela. The CI for the 4th parity too indicates differences ($P<0.05$) with lower values from Agarfa, while there were no differences across the other two farms.

The findings as presented in Table 11 indicate that there were differences in reproductive traits among the cattle reared at the farms and the respondent's end. The AFC, CI parity1, and CI parity2 significant ($P<0.05$) across the two production systems, with lower values observed among the cattle raised at the dairy farms. However, the NSC varied under the two production systems with the values being lower at the farmer's end when compared to those reared at the large dairy farm.

The results about the effect of season on age at first mating (AFM) in Table 12 indicate that there were differences across the seasons; however, the values did not vary significantly. The AFC too varied across the seasons with the lower values ($P<0.05$) being observed between June- August, and September to November. While the CI values also differed ($P<0.05$) across the seasons with a high CI observed between June and August. The values for days open (DO) too indicate that it too varied across the seasons with lower values observed across March to May.

Table 9: Reproductive performances of dairy cattle managed under smallholder management conditions of three study districts.

Reproductive Traits	N	District	Mean ± SE
AFC (Days)	92	Tiyo	1305.3 ± 26^{ab}
	85	Kofale	1258.2 ± 24.8^{a}
	74	Sinana	1397.1 ± 22.7^{b}
DO (Days)	92	Tiyo	149.7 ± 4.0^{a}
	85	Kofale	220.7 ± 6.4^{c}
	72	Sinana	188.7 ± 7.6^{b}
NSC (No)	92	Tiyo	1.5 ± 0.1^{b}
	85	Kofale	1.4 ± 0.1^{b}
	74	Sinana	1.0 ± 0.0^{a}
CI parity1(days)	92	Tiyo	681.5 ± 30.7
	85	Kofale	643.5 ± 38.9
	74	Sinana	589.6 ± 26
CI parity2	72	Tiyo	598.2 ± 30.3
	83	Kofale	608.2 ± 26.3
	54	Sinana	640.2 ± 50.7
CI parity3	30	Tiyo	590.6 ± 58.4
	23	Kofale	684.5 ± 61.2
	14	Sinana	481.7 ± 49.3
Overall average of CI	51	Tiyo	600.6 ± 54.1
Overall average of CI	64	Kofale	645.4 ± 42.1
Overall average of CI	47	Sinana	570.5 ± 42

N= Number of a sample, AFC= Age at first calving, DO=Days-open, NSC=Number of service per conception, CI1=Calving interval between last parity and 2nd, CI2= Calving interval between 2nd parity and 3rd parity, CI3= Calving interval between 3rd parity and 4th parity, CI4= Calving interval between 4th parity and 5th parity. Means in columns at three districts that bear different superscript letters are significantly different (p< 0.05)

Table 10: Some reproductive traits of crossbred cattle reared in three institutional dairy farms.

Reproductive traits	Farm	N	Mean ± SE
AFC (Days)	Asela	57	1140.1 ± 54.5^{a}
	Gobe	33	1166.2±84.6^{a}
	Agarfa	122	1200.2±21.0^{b}
NSC for last parity	Asela	75	1.4 ±0.1$^{a\ ccc}$
	Gobe	83	2.7± 0.2^{b}
	Agarfa	156	1.4±0.1 ^{a}
NSC for 2nd parity	Asela	75	1.4±0.1 ^{a}
	Gobe	83	2.43±0.1 ^{b}
	Agarfa	128	1.4±0.1 ^{a}
NSC for 3rd parity	Asela	51	1.5±0.1^{a}
	Gobe	52	2.9±0.2^{b}
	Agarfa	97	1.3±0.1^{a}
NSC for 4th parity	Asela	36	1.69±0.2
	Gobe	16	1.69±0.1
	Agarfa	77	1.51±0.1
NSC for 5th parity	Asela	26	2±0.2^{a}
	Gobe	13	2.3±0.1^{b}
	Agarfa	59	1.6±0.1^{a}
Overall average of NSC	Asela	59	1.5 ±0.1
Overall average of NSC	Gobe	58	2.43±0.2
Overall average of NSC	Agarfa	114	1.4±0.1
CI parity1 (Days)	Asela	75	597.7±28.1^{b}
	Gobe	83	594.5±30^{a}
	Agarfa	127	476.5±13^{a}
CI parity2 (Days)	Asela	51	497.7±25.5^{c}
	Gobe	54	483.9±25.5^{b}
	Agarfa	100	434.3±11^{a}
CI parity3 (Days)	Asela	36	499.5±34^{c}
	Gobe	16	442.1±47^{a}
	Agarfa	79	444.3±17.4^{b}
CIparity4 (Days)	Asela	26	564.7±87.3^{b}
	Gobe	14	554.9±39.5^{b}
	Agarfa	62	449.3±22^{a}
Overall average of CI	Asela	47	539.9±43.7
Overall average of CI	Gobe	42	518.8±35.5
Overall average of CI	Agarfa	92	451.1±15.8

N= Number of a sample, SE = Standard Error, AFC= Age at first calving, NSC1= Number of service per conception for last parity, NSC2=Number of service per conception for 2nd parity, NSC5= Number of service per conception for 5th parity, CI1= the difference between last parity and 2nd parity, CI2= the difference between 2nd parity and 3rd parity, CI3 = the difference between 3rd parity and 4th parity, CI4= the difference between 4th parity and 5th parity. Mean values under the same category that bear different superscript letters are significantly different (p< 0.05)

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Production trait of dairy cattle managed under three institution dairy farms. The results as presented in Table 13 pertain to the average birth weight and some production parameters of cattle raised at the three dairy farms. It transpires from the result that the birth weight of the cattle differed ($P<0.05$) across the three dairy farms irrespective of the parities. The results indicate that the birth weight of the calves was higher at Asela when compared to the other two locations, with the lowest birth weight observed among those born at the Gobe dairy farm.

The results about the lactation length (LL) of the cattle across the parities and reared at the two dairy farms indicate differences with lower LL among the cattle reared at Agarfa dairy farm.

The lactation milk yield only varied ($P<0.05$) across the current parity with no differences observed in the other two parities. The values being significant among the cattle reared at Agarfa dairy farm.

Table 11: Comparison between the reproductive traits of cattle raised at the institution dairy farms and smallholder farmers management conditions.

Reproductive traits	Type of data	N	Mean ±SE
AFC (Days)	On station data	212	1178.8±23.0^{a}
	Farmers data	251	1316.4±14.7 ^{b}
CI1 (Days)	On station data	285	542.78±13.2^{a}
	Farmers' data	250	640.85±19.1^{b}
NSC (Nos)	On station data	314	1.73±0.1^{b}
	Farmers 'data	251	1.32±0.1^{a}
CI2 (Days)	On station data	205	463.15±10.8^{a}
	Farmers' data	209	613.05±19.7^{b}

N= Number of a sample, SE= Standard Error, AFC= Age at first calving, NSC= Number of services per conception, CI1= the difference between last parity and 2nd parity, CI2= the difference between 2nd parity and 3rd parity. Mean values under the same category that bear different superscript letters are significantly different (p< 0.05)

Table 12: Average values of some reproductive traits of crossbred (Arsi Bale X HF) cows across different seasons at smallholder.

Reproductive traits	Season	N	Mean ±SE
AFM (Days)	Sep-Nov.	48	916.2±31.4
	Dec- Feb.	52	1024.8±33.3
	March-May	100	934.4±24
	June-August	45	924.67±34.01
AFC(Days)	Sep-Nov.	48	1286.98±31.0^{a}
	Dec. - Feb.	52	1389.8±33.3^{b}
	March-May	100	1303.0±23.9^{b}
	June-August	45	1297.8±33.9^{a}
CI (Days)	Sep-Nov.	48	577.6±37.9^{a}
	Dec. - Feb.	52	606±35.4^{b}
	March-May	99	676.6±29.2^{bc}
	June-August	45	682.5±60.3^{c}
DO (Days)	Sep-Nov.	48	189.4±7.9^{a}
	Dec. - Feb.	52	211.0±9.4^{b}
	March-May	98	172.2±5.6^{a}
	June-August	45	179.7±10.2^{a}

N= sample size, AFM=Age at first mating, AFC=Age at first calving, CI=Calving interval, DO=Days open, SE =Standard error. Means under the same reproductive traits with a different superscript in columns show significant differences (p<0.05)

Table 13: Birth weight and some production traits of cattle reared at the three institution dairy farms.

Production traits	Farm type	N	Mean± SE
Birth_weight parity1(kg)	Asela	41	32.2±0.8^{c}
	Gobe	83	21.6±0.2^{a}
	Agarfa	74	28.8±0.7^{b}
Birth_weight parity2 (kg)	Asela	72	32.4±0.5^{b}
	Gobe	81	21.5±0.3^{a}
	Agarfa	50	29.6±0.9^{b}
Birth_weight parity3 (kg)	Asela	50	32.2±0.6^{c}
	Gobe	52	21.3±0.2^{a}
	Agarfa	36	28.9±0.9^{b}
Overall average of birth weight	Asela	54	32.3±0.6
	Gobe	72	21.5±0.2
	Agarfa	53	29.1±0.8
LL parity1 (Days)	Asela	13	304.3±3^{a}
	Agarfa	66	339.5±27.7^{b}
LL parity2 (Days)	Asela	15	305.9±1.0^{a}
	Agarfa	111	336±8.3^{b}
LLparity3 (Days)	Asela	20	302.5±2.6^{a}
	Agarfa	99	327.3±8.2^{b}
Overall average of LL	Asela	16	334.3±14.7
	Agarfa	92	334.3±14.7
LMY parity1 (Litres)	Asela	13	2525.2±159.3b
	Agarfa	66	2343.8±411.3a
LMYparity2 (Liters)	Asela	15	2663.1±159.6
	Asela	111	2489.4±145.3
LMYparity3 (Liters)	Asela	20	2466.1±146.2
	Asela	99	2466.1±146.2
Overall average of LMY	Asela	16	2505.8±172.7
	Asela	92	2433.1±234.3

N= Number of a sample, SE = Standard Error, LL1= Lactation length for last parity, LL2= Lactation length for 2nd parity, LL3= Lactation length for 3rd parity, LMY1=Lactation milk yield for last parity, LMY2= Lactation milk yield for 2nd parity, LMY3= Lactation milk yield for 3rd parity, B_ weight 1= bodyweight for last parity, B_ weight 2= bodyweight for 2nd parity, B_ weight 3= bodyweight for 3rd parity. Means with different superscript letters in columns are significantly different from each other (P<0.05)

Calves sex ratios

Effect of method of breeding and parity on the sex ratio of dairy calves: The results as presented in Table 14 indicate that there were differences ($p<0.05$) in calf sex ratio both between the calves born from natural mating and artificial insemination. In both cases, it favored the birth of the male calves at parity1. The results of the method of breeding on the calf sex ratio of the 2nd parity indicate that there were no differences in the calf sex ratio of the calves born from artificial insemination, but higher ($P<0.05$) numbers of female calves were born from both artificial and natural mating. There were no differences in sex ratio among the calves born from the two types of mating. The findings of the method of breeding for 3rd parity indicate that there were no differences in calf sex ratio across the two types of mating. while the results of the calf sex ratio on the method of breeding for 4th parity indicate that there were differences ($P<0.05$) in the sex ratio for calves born from artificial insemination and natural mating. The numbers of male calves being higher than the female calves at 1st and 4th parities. Natural mating favored the birth of female calves during the 2nd and 4th parities.

The results as presented in Table 15 indicate that there

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were observable differences in the sex ratio of the calves across the dairy farms too. Higher (P<0.05) numbers of male calves were born in the 3rd and 4th parities (irrespective of the type of mating), with no differences across the types of mating. The results of the method of breeding on the calf sex ratio of the 2nd parity indicate that there were differences in the calf sex ratio of the calves born from artificial insemination, but higher (P<0.05) numbers of female calves were born from artificial insemination.

Effect of district and farm type on the sex ratio of calves: The results as presented in Table 16 indicate that there were differences in the ratio of the male and female calves in the last parity across the studied locations. with higher numbers of female calves born at Kofale, while the reverse was true at Sinana, The numbers of male calves being born were lower at Kofale in comparison to the other two locations. The sex of the calves born from the 2nd parity from the last indicates that there were differences in calf sex ratio with higher (P<0.05) numbers of male calves born in Tiyo district while the reverse was true Sinana. The results regarding the sex ratio of the calves born at Tiyo and Kofale for the 3rd parity from the last parity indicate that the numbers of female calves being born were higher (P<0.05) than the male calves. The calf sex ratio of the 4th parity from the last parity as indicated by the respondents in the studied locations indicates that the numbers of male calves born at Tiyo and Sinana were higher (P<0.05) while the reverse was true for the calves born at Kofale. The results also indicated that the numbers of male calves born at Kofale were higher (P<0.05) than those at Sinana and Tiyo district respectively. The results regarding the sex of the calf born at 5th parity from the last indicate that there were differences among the sex of the calf with the numbers of male calves being higher (P<0.05) at Tiyo district, while the respondents at Kofale could not recall of any male calf born.

Table 14: Effect of method of breeding and parity on calf sex ratio as reported by smallholder farmers in the study area

Description	Total number of calves born	Male (%)	Female (%)	Significance
Method of breeding for parity1				
AI	185	52.4	47.6	*
NM	66	59.1	40.9	*
Total Method of breeding for parity2	251	54.2	45.8	*
AI	184	48.7	51.3	
NM	67	48.0	52.0	
Total Method of breeding for parity3	251	48.5	51.5	
AI	132	47.7	52.3	
NM	54	51.9	48.1	
Total Method of breeding for parity4	186	48.9	51.1	
AI	35	58.3	41.7	*
NM	32	46.7	53.3	*
Total	67	53.8	46.2	*

AI=Artificial Insemination, NM= Natural mating, N =Number of respondents, *(**P<0.05)** values across rows are significantly different

Table 15: Effect of method of breeding and parity on the calf sex ratio of crossbred cattle reared at three institution dairy farms.

Description	Total number of calves born	Male (%)	Female (%)	Significance
Method of breeding for parity1				
AI	275	48.7	51.3	*
NM	33	55.6	44.4	*
Total Method of breeding for parity 2	308	49.7	50.3	
AI	254	42.9	57.1	*
NM	28	54.3	45.7	*
Total Method of breeding for parity3	282	44.3	55.7	*
AI	177	50.8	49.2	
NM	25	48.0	52.0	
Total Method of breeding for parity4	202	50.5	49.5	
AI	120	54.2	45.8	*
NM	11	45.5	54.5	*
Total Method of breeding for parity5	131	53.4	46.6	
AI	90	42.9	57.1	*
NM	8	43.8	56.2	*
Total	98	43.0	57.0	*

AI=Artificial Insemination, NM= Natural mating, N =Number of respondents, *(**P<0.05)** values across rows are significantly different

The results as indicated in Table 17 indicate the calf sex ratio of the cattle reared at the dairy farms and across the parities. It transpires from the table that the sex of the calves from the last parity indicates that higher (P<0.05) numbers of male calves were born at Asela dairy farm, the numbers of male calves born were also higher at Gobe dairy farm though not significantly, however, the reverse was true at Agarfa dairy farm. Differences were also observed among the numbers of calves born at the three dairy farms, while higher numbers of male calves born at Asela while the numbers of female calves were higher among the calves born at Agarfa dairy farm. The results pertaining to the calf sex ratio among those born from the third parity from the last indication that the numbers of male calves were higher at Asela dairy farm while the reverse was true at Gobe farm. The results also indicate that the numbers of male calves were lower at Gobe dairy farm and higher at Asela dairy farm, while the numbers of female calves were higher at Gobe dairy farm.

Furthermore, the sex of the calves born at the different dairy farms and the fourth parity from the last indication that the number of female calves was higher (P<0.05) at Gobe dairy farm while the reverse was true among the calves born at Agarfa dairy farm. Table 17. Effect of farm type and parity on calf sex ratio in the study area.

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Effect of parity, season and year on the sex ratio of calves: The results as indicated in Table 18 indicates that the effect of season on calf sex ratio and across the different parities indicates that higher numbers of male calves were born in the months between March and May, followed by those in the month of September and November. The numbers of female calves born were higher in the months of March to May followed by December and February. The findings further indicate that the season of calving regarding the sex of the calf indicates that more numbers of male calves were born in the month of March to May. The results further indicate that the third parity from the last indicates that more numbers of male calves were born in the months between December – February while more numbers of female calves were born between the months of March and May. The case of the sex ratio of the calves born in the fourth parity from the last indicates that the numbers of males calves being born were higher in the months of September-November and March-May, while higher numbers of female calves were born between the months of December – February.

The results as indicated in Table 19, indicates that the effect of year on calf sex ratio indicates that higher numbers of male calves were born in the years between 2004-2007 G.C. followed by 2000-2003G.C.The result further indicates that higher numbers of female calves were born in the years between 1996-1999G.C, followed by 2008-2012 G.C.

Discussions

Household characteristics

The results as presented in Table 2 indicate that the education status of the respondents was lower than those reported by [78] in the Meket district. Similarly, [79] also indicated that in the Arsi zone, Tiyo, and Bilbilo districts, 52 percent of the households were barely literate. The lower educational levels of the farmers in the area are a bane as it is expected that the farming communities with low education status generally would not be able to manage their

Table 16: Calf sex ratios of the cattle reared at the different district and across the parities.

Description	District			
	Tiyo (%)	Kofale N (%)	Sinana (%)	Total
Parity1				
Male	53.5^{b}	22.7aA	63.2bB	54.2
Female	46.5ab	77.3bB	36.8aA	45.8
Parity2				
Male	58.1bB	50b	35.1aA	48.5
Female	41.9aA	50a	64.9bB	51.5
Parity3				
Male	45.5^{A}	42.9^{A}	51.7	48.9
Female	54.5^{B}	57.1^{B}	48.3	51..1
Parity4				
Male	63.2abB	28.6aA	81.8bB	53.8
Female	36.8abA	71.4bB	18.2aA	46.2
Overall mean				
Male	55.1	36.0	57.9	49.8
Female	44.9	64.0	42.1	50.2

P<0.05 values across rows are significant, $^{A, B}$, P<0.05 values across the columns for a particular trait is significant

Table 17: Effect of farm type and parity on calf sex ratio in the study area.

Description	Farm type			
	Farm type	Gobe	Total	Total
Parity 1				
Male	65.3bB	51.6ab	41.2^{a}	49.7
Female	34.7aA	48.4ab	58.8^{b}	50.3
Parity 2				
Male	53.1^{b}	37.5aA	41.2ab	44.3
Female	46.9	62.5^{B}	58.8	55.7
Parity3				
Male	57.5bB	42.1aA	50b	50.5
Female	42.5 aA	57.9 bB	50b	49.5
Overall mean				
Male	58.6	43.7	44.1	48.2
Female	41.4	56.3	55.9	51.8

^{a,b} P<0.05 values across columns are significant, $^{A, B}$, P<0.05 values across the columns for a particular trait is significant

Table 18: The effect of parity and season on the sex ratio of the crossbred calves born in the smallholder farm.

Description	Sex of calve born			
	Male (%)	Female (%)	Total (%)	X^2
Parity1				
September-November	22.4	15.7	19.3	0.02
December –February	14.2	29.6	21.3	
March-May	45.5	36.5	41.4	
June-August				
Parity 2	17.9	18.3	18.1	
September-November	29.7	29.2	29.4	0.3
December – February	19.8	27.0	23.8	
March-May	38.7	28.5	33.1	
June-August	11.7	15.3	13.7	
Parity 3				0.00
September-November	20.2	25.3	22.8	
December – February	40.4	13.7	26.6	
March-May	31.5	43.2	37.5	
June-August	7.9	17.9	13.0	
Parity 4				0.02
September-November	40	34.4	37.3	
December – February	11.4	40.6	25.4	
March-May	40	25	32.8	
June-August	8.6	0	4.5	
Parity 5				0.4
September-November	50	0	33.3	
December – February	50	100	66.7	
Overall mean				
September-November	32.46	26.15	28.42	
December – February	27.16	42.18	32.76	
March-May	38.9	33.3	36.2	
June-August	11.5	17.16	12.32	

%=Percentage values across columns differ significantly at $X^2<0.05$.

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Table 19: Effect of the year on calf sex ratios of the crossbred and native dairy cow at institution dairy farms in the study area.

Sex	Year of calving			
	1996-1999	2000-2003	2004-2007	2008-2012
Male (%)	46.8	55.2	59.2	54.8
Female (%)	53.25	44.8	40.8	45.2

%=Percentage

herds scientifically. Furthermore, the dissipation of modern husbandry technologies and also their feedback in form of maintenance of farm records would be either inaccurate or they would not be able to maintain scientifically. These observations are in close accordance with those reported by [80] who reported that low levels of education are impediments towards scientific development in the agricultural sector and livestock sub-sector being no exception.

Household size

The household size at study areas was lower than what was reported by [78] from Meket district, who reported that the numbers of members in average sedentary agricultural households were

5.2 persons/ household. While higher numbers of family members are expected in the agrarian households as traditionally it is correlated with higher numbers of available farmhands. This may have been correct in the past but in the present scenario with the fragmentation of land, higher numbers of family members indicate lower per head allocation of the meager resources and therefore can compromise with the overall wellbeing of the family at large. The adverse effects of a large family have also been reported earlier by [81] that associated with the cultural practice of polygamy among most of the pastoralists.

Livestock demography, land holdings, and herd size among the respondents in the study area. The results as presented in Table 4 further indicate that the average livestock ownership per household in the three districts was more or less similar to the values as reported by [81] The livestock holding per household as was observed in this study was lower than those reported by [81] The results also indicate that there was species diversity at the farm, which is a good practice so that they would be able to minimize their risk associated with rearing a particular species alone [81] This also ensures that the feed resources are properly utilized as cattle and sheep are grazers while goats are browsers. This also ensures that there are specified species of livestock for meeting the socio-cultural roles and those to be used for agrarian activities and also for transportation, the findings are in close accordance with those of finding.

The average land holdings as indicated in Table 4 are lower than those reported by [82] from the yerer watershed of adaliben woreda. The low landholding as observed in the study limits the numbers of livestock a family can rear effectively, this also indicates that there was limited scope for improving the dairy sector unless or until modern scientific husbandry methods are put in place. The use of crop residues and other agro-industrial by-products need to be incorporated along with the traditional grazing system to meet the minimum maintenance requirements of the bovines. The respondents need to be empowered with the techniques of hay and silage preparation so that the basic nutritional requirements of the animals are maintained. The use of modern feeding and husbandry management in the maintenance of herds reared in small landholdings has also been reported by [83] while the average herd size varied ($P<0.05$) across the locations with the highest herd size reported from Kofele and lowest at Sinana.

Perception of the respondents regarding factors influencing calf sex ratio and the type of mating

The results as presented in Table 5 indicate that the respondents observed deviation from the normal sex ratio of the calves born from artificial insemination vis-a-vis that of the natural mating. However, the results were not consistent across the locations. While the respondents from the Sinana district indicated that there were no observable differences in the sex ratio, those from Tiyo and Kofale reported differences favoring the particular sex of the calf. The deviation of sex ratio as reported by the respondents is following those of [7] who indicated a deviation in sex ratio among the two systems of mating where cows mated artificially parturaled higher numbers of male calves. There have been several complaints to the authorities by the members of the agrarian community about the sex ratio of the calves, which can be attributable to various reasons perceived by the farmers.

The results as presented in Table 6 further indicate that the perception of the respondents varied significantly while most of them opined that the sex ratio was influenced by both genetic and non-genetic factors, these observations are in close accordance with the findings of [8,16,24,58]. However, as observed in the study the respondents could not attribute the observable differences in the sex ratio of the calves due to any specific factor that may be a fallout of their poor analytical or recording skills as indicated earlier. Lack of education among the husbandry persons can lead to the poor recording of farm data, which is a big impediment to the development of livestock husbandry in the region.

The result as presented in Table 7 indicates the preferred method of breeding cattle varied across the study areas. While artificial insemination (AI) was preferred at Tiyo and Kofale, the respondents preferred natural mating over artificial insemination at Sinana. This may be a fallout of the differences in the AI services available in the studied areas. The AI services have not yet penetrated deep in the country and hence many woredas and kebeles are yet to be benefitted from this bio technique. However, the differences in preference of mating their cattle as observed may also be attributed to the economical advantages/ disadvantages associated with the different methods of breeding, the observations are in close accordance with those of [67] and [68]. The respondents preferred AI over natural mating because of the lack of good bulls in the region and also because of the prestige associated with the rearing of crossbreds at their homestead, the observations are in close accordance with those of [84]. The respondents were also

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aware of the rapid genetic/ economic progress associated with rearing crossbreds over the native cattle and hence preferred AI over natural mating wherever possible similar findings have been reported by [85]. However, care has to be taken by the development agents in the area to ensure that the genetic levels of the crossbreds are such that they are well adapted to the agroecology of the area. The farmers with sub-optimum resources should not be encouraged to rear grade crosses as over time they may not be able to provide adequate nutrition and husbandry requirements associated with rearing such crosses.

The results further indicate that while at Tiyo and Kofale the housing of the cattle is without any individual pens, and that all the age groups of cattle are reared together. The fallout of such housing can have a negative consequence as it may lead to a stampede of the newborn calves and also fighting is among the animals especially if the bulls/ steers are reared alongside the other herd members [51].

Reproductive performance of dairy cattle managed under three Institution and smallholder dairy farms

The results pertaining to the reproductive traits of the cattle as observed in the present study in Table 8 indicates that the age at first calving (AFC) was higher among the F_1 crossbreds when compared to those of the grade crosses (>75% exotic inheritance), the findings are in close accordance with the results obtained by [83]. This may be attributed to inheritance of the HF breed as it has been reported that, the AFC of the Taurus cattle are higher than those of the zebu counterparts [85] The average AFC as was observed among the two genotypes is following the findings of several authors from Ethiopia [86,87].

The results pertaining to the days open (DO) too varied across the genotypes, the average higher values as observed were higher among the graded cattle indicating that the calving interval (CI) too will be higher among such animals. This has a direct consequence on the lifetime production of calves with lower numbers of calves born from cows with longer DO and CI, which is not a desirable trait, similar reports have also been reported by [42]. The higher DO values among the higher crosses may also be attributed to tropical degeneration as have been reported by several authors [5,88], from Egypt, and [77] from Ethiopia where the F_1 crossbreds usually outperform the higher crosses despite lower levels of exotic inheritance. The differences in CI across the parities may be attributed to the age of the cows where studies have indicated that the reproductive traits usually optimize at the second parity and thereafter a decline is usually observed as the animal ages [43]. This difference in the decline in reproductive performance may be also due to hormonal changes across the age of the cows, which show a decline as the animal ages [89].

The findings from Tables 9,10 pertain to the reproductive traits of the cattle as reported by the respondents in the studied district across the organized dairy farms. The findings indicate that most of the traits varied across the studied locations and the farms alike. The differences as observed may be fallouts of the genetic makeup of the cattle reared at the three locations and the farm their management, feeding besides other intrinsic and nonintrinsic factors. The effect of locations on reproductive traits has long been observed by [90] who reported that the differences in reproductive traits can be significantly influenced by environmental differences attributable to a specific location and as the environments may vary across locations it will be observable as location effect. The differences as observed could also be partially correlated with the management of the animals. However, it has also been reported by [77] that in absence of any records the recall method (as employed here) may not be as accurate especially when the periods are too distant as have been observed in the traits pertaining to the CI. The effect of the year on the CI could be due to the temporal environmental effect. where the quality of the forage usually varies between the years and also seasons with a year, similarly incidences of rainfall and diseases can also affect the CI across the seasons and also across the years the observations are in close accordance with those of [91]. However, the average values of the reproductive traits as were observed in this study are following the findings of several authors AFC [92] DO [3,43].

The results as presented in Table 11, indicate that there were differences ($P<0.05$) in the reproductive traits across the two management systems (farmers and the institutional farms). The values for most of the traits being usually higher among the cattle reared under the farmer's management; however, the reverse was true for the NSC. The differences may be attributed to the feed and fodder availability and the management which is expected to be relatively better in the institutional farms, the observations are in close accordance with those of [3,39] who also reported that as the reproductive traits are lowly heritable they respond well to the management of the animals. However the differences in NSC maybe because of the poor oestrus detection in the farms, this may also be partially ascribed to the fact that most of the cattle show signs of oestrus in the night hours when it is very difficult to detect the actual animal amongst the herd, the observations are in close accordance with those of [93,94].

The results as presented in Table 12 also indicate that there was a variation ($P<0.05$) in the reproduction traits across the seasons. The differences as observed may also be ascribed to the genotype by the environmental effect of the cattle and also the managemental program [39]. The AFC is closely correlated with the age at maturity and has been reported to be influenced by the season, the presence of good quality of feed and fodder, and low environmental stress [1]. It was observed to be higher among the dry months when there was a deficiency of fodder and the diurnal temperature was relatively high. High environmental temperatures are associated with the stress of the animals and thereby influence the trait [3]. The calving interval (CI) too varied across the seasons, which may be correlated with the normal behavior of the cows, during the main rainy season when the cows may not be able to graze and hence show their normal estrus behavior [48,91]. Moreover, the incidences of silent heat are also higher especially among the grade crosses in the summer months [49].

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The higher figures for DO and CI also indicates that the overall lifetime productivity in terms of numbers of lactation and calf crop is low have an adverse consequence on the overall economy of the cattle husbandry activities, the findings are in close accordance with those of [95] and [43]. The figures as observed for the reproductive traits viz. AFC is within the range of values reported by [84] while those of CI and DO are in close accordance with the observations of [89].

Production trait of dairy cattle managed under three institution dairy farms

The findings as presented in Table 13 indicate that the birth weight of the calves varied across the three organized farms. The differences may be attributed to several genetic factors, the parity number of the dam, gestation length of the dam, the sex of the calves, genotype/breed of the dam, and the sire, the observations are in close accordance with those of [96]. The birth weight of the calves can also be influenced by several managemental factors viz. the availability of feed and fodder, disease incidences in the dam especially during the last trimester of her gestation, similar [97,98]. The average birth weights of the calves across the different parties are in close accordance with the reports of [88]. The lactation length (LL) and LMY of the cows reared at the dairy farms too varied across the parities, these values are influenced by the gestation length in the previous parity, CI and DO maternal effect, and also on the health and the genotype of the dam [39].

The environmental factors influencing the trait include the management of the cows (feed and fodder), years (seasons across the years), and the outbreaks of diseases or/and parasites [99]. The average values of birth weight of the calves, LL, and LMY as observed are well within the values reported by [100].

Calves sex ratios

Effect of method of breeding and parity on the sex ratio of dairy calves: The findings from Table 14 indicate the respondents have reported the differences in calf sex ratio from the different districts. The findings indicate differences among the sexes of calves born both from natural mating and artificial insemination. These differences in sex ratios varied across the parities, with higher ($P<0.05$) numbers of male calves being born at certain parities and vice versa. The observations are in close accordance with those of [15,16,64] who also reported the differences in the sex ratio of the calves born across the different parities of the cows. The differences as observed may be attributed to the selective abortion of the calves of a particular sex in certain seasons, which is in line with the resource allocation theory of [58] or also due to the deviation in the hormonal levels in (from the normal values) the cow, which can be influenced by several factors including the consumption of phytoestrogenic compounds [71,72].

The availability of feed and fodder usually varies across the seasons and there might be differences in environmental stresses and disease incidences across the seasons, which may lead to selective abortions favoring particular sex over the other [101-103].

Therefore, to minimize incidences of abortion in the herd, it is suggested that the community members be provided training on proper management and husbandry practices of cattle, the suggestions are in close accordance with those of [8,104].

Studies by [105] to have indicated that there is a variation in sex ratio (from the expected) among the cows at an older age which again is influenced by its parity and is in close accordance with those observed in the study [96,106-108]. The differences are attributable to the levels of sex hormone in the cows the levels of which usually diminish with the age, the findings are in close consonance with those of [17, 110,111].

The results as presented in Table 15 indicate that there were observable differences in the sex ratio of the calves across the dairy farms too. The results indicated that higher ($P<0.05$) numbers of male calves were born in the 3rd and 4th parities (irrespective of the type of mating). However, there were no differences among the numbers of male and female calves born due to artificial insemination and natural mating. The observations favor the resource allocation theory [58]. The findings are also in close accordance with those of [15], who reported that there was no significant difference across in the sex ratio of the calves from natural mating and artificial insemination. The observations of the agrarian community regarding more numbers of male calves being born from cows mated artificially vis-a-vis that of natural mating may be attributed to fluctuations due to environmental factors alone, abortions, or loss of memory to recall a particular event [88].

The deviation as observed across the farms may, in turn, be due to differences in the availability of feed and fodder and diseases localized to the farm, which may lead to abortions and fetal deaths, thereby swaying away from the theoretically expected sex ratio [8].

Effect of district and farm type on the sex ratio of calves: The results as presented in Table 16 further indicate that there were differences across locations pertaining to the sex ratio of the calves. The observations are in close accordance with those of [15] who reported localized differences in the sex ratio of the calves that varied across the years. The differences as observed may be attributed to the nutrition received by the cows and during the time of mating as studies have indicated that if the cows received phytoestrogens there can be the selective abortion of the fetus [53,58]. The findings also indicate that there were differences in the sex ratio of the calves across the parities. However, the results were not consistent over the parities and across the locations too. The differences as observed may also be attributed to the causes mentioned ahead, the effect of parity on the sex ratio of the calves born from a cow in different parities have also been reported by several authors [59,82,93,112].

The results as presented in Table 17 indicate the effect of parity and locations (farms) on the calf sex ratio of the calves. The findings indicated inconsistencies favoring particular sex and across the farms. The inconsistencies indicate the presence of localized effects as having been attributed to the causes mentioned ahead. However, it was observed that during certain

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seasons especially during the feed stress the numbers of male calves conceived were less when compared to the female calves. This may be due to the selective allocation of maternal resources favoring the birth of the female calves thereby influencing the sex ratio in favor of particular sex [15,63,108].

Effect of season and year on the sex ratio of calves: The results as presented in Table 18 indicate the influence of seasonal factors on the sex ratio of the calves. The effect of the season can have both a direct and indirect effect on the overall sex ratio of the calves as observed in the study. The direct consequence of the season can be attributed to the differences in feed and fodder availability and the diseases prevalent among the cows during a particular season which is in accordance with the findings of [113]. While the indirect effect can be attributed to the managemental differences during a particular season when the agrarian community may not have enough feed resources to feed their cows or are busy with other farming-related activities. There are also instances of butting of pregnant cows by bulls and steers, especially in the loose housing system such incidences can also lead to abortions especially among the cows at the final months of pregnancy thereby influencing the sex ratio where the chances of a male calf being aborted out are higher than the female calves. Similarly, the tilt in sex ratio can also be due to dystocia-related deaths where the chances of such deaths are higher among the male calves due to their larger size [113]. The hormonal imbalance can selectively abort male fetuses more frequently than those of the female fetus, thereby tilting the sex ratio favoring the numbers of females born [60,114-118]. The differences in the sex ratio of the cattle attributable to non-genetic factors have been observed in the study reported by several authors [27,92].

The effect of year on the calf sex ratio (Table 19) indicates that there were differences in the sex ratio of the calves born at different seasons, which may be a fall out of the differences in management over the years and also on several climatic and seasonal factors discussed ahead [72,119-128].

Summary and conclusion

This study was carried out on three selected institution dairy farms and smallholder dairy farms (n=90) in three districts (Tiyo, Kofale, and Sinana) of Oromia regional state. The result showed that the numbers of oxen were higher than the numbers of cows in the Tiyo district, while the number of cows is higher in the other two districts showing that farmers mainly keep cattle for milk production. From the interviews with smallholder dairy farmers, it was observed that farmers at Tiyo and Kofale districts were concerned about the differences in calf sex ratios (male: female) which they perceived was resulted due to artificial insemination, while it was not the case for Sinana district.

For most of the reproductive traits studied on crossbred cows (F_1 and grade crosses (>75 % exotic inheritance), it was observed significant effects of genetic and non-genetic factors. The Age at First Calving (AFC) and calving intervals were higher for the F_1 crossbreds while the numbers of Days Open (DO) were higher among the grade crosses. AFC was not significantly different ($P<0.05$) between the Gobe and Asela farms, while Agarfa was different from the two farms. The birth weight of the cattle differed ($P<0.05$) across the three dairy farms irrespective of the parities. The AFC was lower in the institutional farms when compared to those managed at farmers' management conditions. The Number 0f Services Per Conception (NSC) too varied ($P<0.05$) across the dairy farms. No significant differences were observed among the sex ratio of the calves born through natural and AI mating systems either at the institutional or smallholder farms. However, differences due to season and year were observed, indicating the effect of non-genetic factors influencing the sex ratio of the calves. The reproduction traits of the cattle differed ($P<0.05$) across the two production systems with lower values observed among the cattle raised at the dairy farms and higher for the F1 crossbred than grade crosses, while production traits of the cattle differed ($P<0.05$) across the three dairy farms.

From the progeny history survey conducted on smallholder dairy farms, it was observed that the numbers of male and female calves born from natural and artificial insemination were different in the three districts. The numbers of male calves being higher than the female calves at 1st and 4th parities. The higher ($P<0.05$) numbers of male calves were born in the 3rd and 4th parities (irrespective of the type of mating), with no differences across the types of mating in the three institutional dairy farms.

Furthermore, there were differences in the sex ratio of the calves born at different seasons, across locations, which may be a fall out of the differences in management over the years and also on several climatic and seasonal factors. However not consistent across the farms, which could be attributed to the causes mentioned. The differences in reproductive traits can be significantly influenced by environmental differences attributable to a specific location and as the environments may vary across locations, it will be observable as location effect. The production traits also varied, this may be due to managements and environments. Therefore, the use of grade-breed cattle in resource-limited areas essentially requires serious preventive procedures. There has been a growing concern about the deviation of the sex ratio of calves born in dairy cattle.

From the overall data, it was observed that there were no significant differences in the sex ratio of the calves born from natural mating vis-s-vis that of artificial insemination. However, the effect of locations/ farms, seasons, and year were observed. It was observed that during certain seasons especially during the feed stress times, the numbers of male calves conceived were less when compared to the female calves. Therefore, management practices should be persistent across the year and season to prevent annul and seasonal variability in the sex ratios of calves. Although farmers complain about calf sex ratio, using the overall data in this study it can be concluded that there are no significant differences in the calf sex ratio of the calves born from natural mating vis-s-vis that of artificial insemination. The lowest reproduction and production performance observed on smallholder dairy farms compared to the three state farms clearly shows the need for improvement on both institution and farmers aspects.

Statement of author

First, I declare that this thesis is my legitimate work and that all sources of materials used for this thesis have been dully acknowledged. This thesis has been submitted in partial fulfillment of the requirement for an advanced MSc. degree at Hawassa University and is deposited at the university library to be readily accessible to borrowers under the rules of the library. I gravely declare that this thesis was not submitted to any other institution anywhere for the award of any other academic degree, diploma, or certificate.

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Appendices

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