Thesis Ref. No. __

COMPARATIVE STUDY OF REPRODUCTIVE AND PRODUCTIVE PERFORMANCE OF HOLSTEIN FRIESIAN DAIRY COWS AT HOLETA BULL DAM STATION AND GENESIS FARMS

MSC THESIS

BY

ALEWYA HEYREDIN

ADDIS ABABA UNIVERSITY COLLEGE OF VETERINARY MEDICINE AND AGRICULTURE

DEPARTMENT OF ANIMAL PRODUCTION STUDIES

JUNE, 2014

BISHOFTU, EHIOPIA

COMPARATIVE STUDY OF REPRODUCTIVE AND PRODUCTIVE

PERFORMANCE OF HOLSTEIN FRIESIAN DAIRY COWS AT HOLETA BULL DAM STATION AND GENESIS FARMS

A Thesis submitted to the College of Veterinary Medicine and Agriculture of Addis Ababa University in partial fulfillment of the requirements for the degree of Master of Science in Tropical Animal Production and Health

By

ALewya Heyredin

June, 2014

Bishoftu, Ethiopia

Addis Ababa University

College of Veterinary Medicine and Agriculture

Department of Animal Production Studies

As members of the Examining Board of the final MSc open defense, we certify that we have read and evaluated the thesis prepared by: Alewya Heyredin entitled: "Comparative study of reproductive and productive performance of Holstein Friesian dairy cows at Holeta Bull Dam Station and Genesis Farms "And recommend that it be accepted as fulfilling the thesis requirement for the degree of: Masters of Tropical Animal Production and Health.

Professor Berhan Tamir ____________________ ____________________
Chairman Signature Date

Dr. Kelay Belihu ____________________ ____________________
External Examiner Signature Date

Dr. Gebreyohanes berhane ____________________ ____________________
Internal Examiner Signature Date

Dr. Gebeyehu Goshu ____________________ ____________________
Major Advisor Signature Date

Dr. Fekadu Regassa ____________________ ____________________
Co- Advisor Signature Date

Professor Berhan Tamir ____________________ ____________________

Department chairperson Signature Date

DEDICATION

This work is dedicated to my family

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my *bona fide* work and that all sources of material used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and deposited at the University/College library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, However permission must be obtained from the author.

Name: Alewya Heyredin Signature: __________________

College of Veterinary Medicine and Agriculture, Bishoftu

Date of Submission: ___________________

ACKNOWLEDGMENTS

First and foremost, I would like to thank the Almighty Allah for blessing invaluable gifts of health, strength, believes, love, hope, patience and protection to me and my families throughout my life.

I am very much indebted to acknowledge my research advisors Dr. Gebeyehu Goshu for his encouragement, genuine guidance, friendly treatment, constructive comments and excellent cooperation and to collect data from Holeta bull dam station. Especially his friendly treatment from the initial conception to the end of this work is highly appreciated. Without him my success is impossible.

I would like to express my thanks Dr. Fekadu Regassa for assistance as co-supervisor and friendly treatment.

I would like to extend my thanks to Holeta Bull Dam Station and Genesis Farms for sponsoring the research component of the postgraduate study. Special thanks also go staff members of tropical animal production and health department for their moral support.

Finally, I would like to thank my family especially Rehima Heyredin and Abdla Heyredin for their valuable encouragement and patience throughout my life.

ABBERVIATIONS

AFC	Age at First Calving
AFS	Age at First Effective Service
CBPP	Contagious Bovine Pleuro Pneumonia
CI	Calving Interval
CSA	Central Statistical Agency
d	Days
df	Degree of Freedom
DO	Days Open
DZARC	Debre Zeyt Agricultural Research Center
FAO	Food and Agriculture Organization
FMD	Foot and Mouth disease
GDP	Gross Domestic Product
GLM	General Linear Model
HARC	Holeta Agricultural Research Center
HF	Holstein Friesian
IBC	Institute of Biodiversity Conservation
LL	Lactation Length
LMY	Lactation of Milk Yield
LSM	Least Square Mean
LSD	Lumpy Skin Disease
NS	Non-significant
NSC	Numbers of Service per Conception
SAS	Statistical Analysis System
se	Standard Error
VWP	Voluntary Waiting Period

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF APPENDICES

ABSTRACT

The study was conducted at Holeta Bull Dam Station and Genesis Farms with the objective of evaluating age at first effective service (AFS), age at first calving (AFC), days open (DO), number of service per conception (NSC), calving interval (CI), lactation milk yield (LMY) and lactation length (LL). Data recorded in the Holeta Bull Dam Station from 1997 to 2003 and in Genesis Farms from1996 to 2005was used for this study. the independent variables considered included location, birth year and season, calving year and season and parity while AFS, AFC, DO, CI, NSC, LMY and LL were the dependent variables. Data were analyzed using The General Linear Models procedure (GLM) of the Statistical Analysis System (SAS 2002). The results indicated that the overall least squares means (± standard error) of AFS, AFC, DO, CI, NSC, LMY and LL were 733 ±16 days, 1001 ± 17days, 202 ± 13 days , 470 ±12days, 2 ± 1, 4097± 1491liters and 301±91days, respectively. Location had highly significant ($p<0.001$) effect on all traits except NSC. Higher LMY and longer DO, LL, CI, were recorded in the Genesis Farms while longer AFS and AFC were recorded in the Holeta Bull Dam Station. Year of calving had significant effect on CI, DO, LMY and LL. Highest and lowest LMY was recorded in 2002 and 2000, respectively. Higher values of LL, DO and CI were observed in 2003, 2001, 2001, respectively while the lowest values of LL, DO and CI were observed in 2000, 2002 and 2001years, respectively. Parity had significant effect on NSC, LMY and LL while non- significant effect on CI and DO. Higher value of LMY, LL and NSC was absorbed in 2nd, 8th and 7th parity, respectively while lower value of LMY, LL and NSC in absorbed was 7th, 7th and 6th parity respectively. Birth year had highly significant ($p<0.001$) effect on AFC and AFS. Longest AFC and AFS were absorbed in cows born in1994 while shortest AFC and AFS were absorbed in those born in 2001 and 2002 birth years, respectively. All the traits were non-significantly influenced by season. The reproductive and productive performance of Holstein Friesian in the study Farms is better than many other states and private owned farm in the country. To improve the reproductive and productive performance of dairy cows by improved nutrition, to give attention in heat detection, health care, timely insemination, proper management of postpartum reproductive problems and early growth heifers, to use new reproductive technology, to minimize voluntary waiting period after calving, establish well planed Breeding poly and Standard Record keeping practice should be applied.

Keywords: Genesis farms, Holeta, Holstein Friesian, reproductive performance, productive performance.

1. INTRODUCTION

Ethiopia is one of the sub-Saharan Africa with a large potential for livestock production. The country is 1st among African countries and the 9th in the world (Hunduma, 2012). The total cattle population for the country is estimated to be about 53.99 million. Out of this total cattle population the female cattle constitute about 55.5 percent (CSA, 2012/13). These are predominantly indigenous zebu cattle, which are well adapted to and distributed among the diverse ecological conditions and management systems of the country. Though not exhaustive cattle breed/type identification and characterization work has been conducted, which suggested that there are over 25 types/breeds of indigenous cattle, the most popular ones including Borana, Horro, Fogera, Arussi, Karayu and Nuer (IBC, 2004).

Ethiopia is a country with a human population estimated to 85 million with annual population growth rate of 3.5% (CSA, 2010). Livestock represent a major national resource and form an integral part of the agricultural production system (Birhanu *et al*., 2013). The agricultural sector in Ethiopia contributes 43 percent of gross domestic product (GDP) and 86 percent of export earnings (CSA 2009). A study by CSA (2009) indicated that the livestock sector contributes 26% of the agricultural GDP and 12% to the national GDP. Among livestock species, cattle have significant contributions to the livelihoods of farmers (Mekonnen *et al*., 2012). They produce a total of 1.5 million tones of milk and 0.331 million tones of meat annually (FAO, 2005).

Dairying is an important enterprise for many countries of the world and is especially important source of income generation for rural families in the developing agricultural countries like Ethiopia. With increase in population size the demand for milk also increases (Usman *et al*., 2013). The development of the dairy sector in Ethiopia could contribute significantly to poverty alleviation and improvement in health and nutritional status of the whole community at large (Jan *et al*., 2010).

Milk production and reproductive performance are two major determinants of dairy cow profitability. There is much debate among dairy producers and researchers about possible antagonism between high milk production and reproductive performance. Good reproduction performance is important not only for the improvement of milk production but also for a better genetic progress. Therefore, recently many countries have performed genetic evaluations for reproductive traits (Abe *et al*., 2009).

In spite of the presence of large and diverse animal genetic resources, the productivity (i.e., meat and milk) of livestock remains low in many developing countries including Ethiopia, for various reasons, such as inadequate nutrition, poor genetic potential, inadequate animal health services and other management related problems (Fikre, 2007). Livestock productivity in Ethiopia is said to be poor due to a number of reasons among which is the low genetic capacity of the indigenous cattle. In Ethiopia, the poor genetic potential for productive traits, substandard feeding, poor health care and management practices are the main contributors to low productivity (Belay *et al* ., 2012).

In order to improve the low productivity of local cattle, selection of the most promising breeds and cross breeding of these indigenous breed with high producing exotic cattle has been considered as a practical solution. The productivity of dairy cattle breeds depends mainly on their reproductive performance and efficiency of service per conception. Reproductive performance is a characteristic of outstanding importance in dairy cattle business (Gabriel *et al*., 1983).

Holstein-Friesian breed is the highest yielding dairy breed as compared to other dairy breeds although it produces low butterfat content compared to the Jersey breed. Pure breeds produce average of 6 000 to 7 000 liters of milk per lactation (Makuza *et al*., 1999). Genetic and non-genetic factors influence milk production potential. Therefore, it is necessary to have corrections or adjustments for these factors when analyzing for performance verifications (Nyamushamba *et al*., 2013).

In Ethiopia, crossbred cattle mainly cross of zebu with Holstein- Friesian cattle have been used for milk production for decades. Accurate evaluation of the performance of cross breeds contributes much to the development of appropriate breeding strategies.

One measure of productivity is reproductive performance. Reproductive and productive performance is vital for the profitability of many animal production systems. Especially, the economics of dairy enterprise is based on an efficient reproductive and performance of dairy animals (Nibret, 2012).

However, only few research works have been conducted on reproductive and productive performances that compare different location. Thus, studying reproductive and productive performance will generate baseline information primarily to the livestock owners, the extension agents and researchers. Moreover, it can assist in the development of strategies and prioritization of possible intervention options for performance improvement.

Therefore, objectives for this thesis were;

- To estimate reproductive and productive performance; and,
- To study factors affecting reproductive and productive performance of Holstein-Friesian cows at Genesis Farms and Holeta Bull Dam Station

2. LITERATURE REVIEW

2.1. Reproductive Performance of Dairy Cattle

Reproductive efficiency of a herd is an important component of dairy cattle productivity in the world. Economic losses because of poor fertility can be attributed to the cost of prolonged calving interval, increased insemination costs, reduced returns from calves born and forced replacements in the event of culling. A delay in conception because of poor fertility increases calving interval mostly due to the increase in the number of days from calving to conception (Nishida *et al.*, 2006).

2.1.1. Age at first effective service (AFS)

Age at first effective service is one of the most important fertility properties in dairy cattle. It has direct impact on age at first calving since duration of gravidity has physiologically constant value. Age at first effective service includes the period from the birth of heifer to first insemination at the age when animal has reached breeding maturity enabling it normal gravidity. Age when animal reaches sexual and breeding maturity for long time was in the centre of attention of expert and scientific public in regard to the possibility for shortening of the generation interval. Age at first effective service is determined within defined time limits. Bottom limit is date of birth, and top limit date of conception (Novaković *et al.*, 2011).

Age at first breeding coupled with reproductive efficiency to first and subsequent breeding determines age at first calving because gestation length is a fixed interval (282 days) once conception occurs. Thus, the major reproductive challenge for breeding age heifers is to achieve conception by 14 to 16 months of age. Rearing heifers to initiate puberty by 11-13 months so that breeding can occur in a timely fashion is critical to the overall success of a heifer rearing program (Head, 1992). Habib (2011) and Amin *et al.* (2013) reported that average age at first effective service was 40.2 months and 42 months respectively.

Age at onset of puberty is related to body weight and Holstein heifers normally exhibit their first estrus at a body weight of between 550 to 650 pounds. Nutritional management resulting in poor body weight gain early during development causes reproductive problems because it delays onset of puberty, age at first breeding and ultimately age at first calving. By contrast, research has consistently shown that nutritional management resulting in excessive pre pubertal weight gain reduces milk yield during first and subsequent lactations due to subnormal development of mammary secretory tissue (Head, 1992). Thus, nutritional management of pre pubertal heifers profoundly influences age at puberty, age at first breeding and hence age at calving (Head, 1992).

2.1.2. Age at first calving (AFC)

Age at first calving is the earlier measure of reproductive performance in dairy cattle; only after first calving production cycle commences (Dabdoub, 2009). The age at first calving changes the heifer from a non-producing expensive item into an income generating cow. Early AFC reduces unproductive period and higher the AFC will be the additional rearing cost of the animal (Panja and Taraphder, 2012).

Age at first calving is closely related to generation interval and, therefore, influences response to selection. Under controlled breeding, heifers are usually mated when they are mature enough to withstand the stress of parturition and lactation. This increases the likelihood of early conception after parturition. In traditional production systems, however, breeding is often uncontrolled and heifers are bred at the first opportunity. This frequently results in longer subsequent calving intervals (Dayyani *et al.,* 2013). Sarkar *et al.* (2007) studied that the effect of different agro climatic zones on age at first calving was not significant. Estimates of AFC reported by some authors summarized in Table 1.

Table 1. Estimates of age at first calving and calving interval

Breed	Country	AFC (d)	CI (d)	Source
Holstein-Friesian cows	Pakistan	987	505	Sattar *et al*. (2005)
Friesian cows	Sudan	870	433	Abdel *et al*. (2007)
Holstein-Friesian cows	Cameron	927	399	Gwaza *et al*. (2007)
Holstein-Friesian cows	Ethiopia	1272	478	Besufekad (2008)
Friesian cows	Egypt	921	403	Hammoud *et al*. (2010)
Jersey cows	Ethiopia	1035	450	Habtamu *et al*. (2010)
Jersey cows	Pakistan	1010	487	Suhail *et al*. (2010)
Holstein–Friesian	Ethiopia	1265	561	Amene *et al*. (2011)
Red Chittagong cattle	Bangladesh	1491	422	Habib (2011)
Friesian X zebu cattle	Ethiopia	1041	419	Nuraddis *et al*. (2011)
Holstein-Friesian	Pakistan	894	408	Sandhu *et al*. (2011)
Crossbred dairy cows	Ethiopia	1044	372	Belay *et al*. (2012)
Zebu X Holstein-Friesian	Ethiopia	1115	640	Belay *et al*. (2012)
Friesian X zebu cattle	Ethiopia	972	402	Nibret (2012)
Red Chittagong cattle	Bangladesh	1518	454	Amin *et al*. (2013)
crossbred dairy cattle	Pakistan	1300	543	Hassan and Khan (2013)

d=days, CI=calving interval, AFC=age at first calving

2.1.3. Days open

Days Open measures overall reproductive performance for the previous 12 months. This is the interval in days between calving and successful insemination. This is more reliable parameter when determining the reproductive efficiency of a dairy herd to attain an optimal calving interval of 12-13 months, cow should conceive within 85-110 days after parturition (Malik, 1977).

Reproductive parameter is influenced by Feed shortage, silent estrus and lack of proper heat detection might have contributed considerably to the long days open (Belay *et al*., 2012). Also influenced by estrus detection rate, conception rate, VWP (voluntary waiting period) and culling (Bailie, 1982). Estimates of DO reported by some authors summarized in Table 2.

Table 2. Estimates of days open and number of service per conception

Breed	Country	DO (d)	NSC	Source
Holstein–Friesian	Egypt	120	1.95	Oudah *et al*. (2001)
Holstein cattle	Turk	114	2.01	Turkyilmaz (2005)
Holstein–Friesian	Ethiopia	174	2.01	Yosef (2006)
Friesian cows	Ethiopia	177	1.72	Gebeyehu *et al*. (2007)
Holstein–Friesian	Ethiopia	206	2.1	Besufekad (2008)
Friesian cows	Egypt	130	2.1	Hammoud *et al.*(2010)
Holstein–Friesian	Ethiopia	285	1.69	Gizaw *et al*. (2011)
Friesian X zebu cattle	Ethiopia	171	1.29	Nuraddis *et al*. (2011)
Horro x Friesian	Ethiopia	123	1.97	Gizaw *et al*. (2011)
Horro x Jersey	Ethiopia	109	1.92	Gizaw*et al.*(2011)
Horro (Zebu)	Ethiopia	134	2.00	Gizaw *et al.*(2011)
Tunisian Holstein cows	Tunisia	150	2.55	M'Hamdi *et al*. (2011)
Hcrossbred dairy cows	Ethiopia	85	1.52	Hunduma (2012)
Zebu X Holstein Friesian	Ethiopia	155	1.56	Belay *et al.* (2012)
Friesian X zebu cattle	Ethiopia	87	1.3	Nibret (2012)
Iranian dairy cattle	Iran	111	2.1	Motlagh *et al.* (2013)

d=Days, DO=Day open, NSC=Numbers of service per conception

2.1.4. Number of service per conception (NSC)

NSC is one of the measurements for reproductive efficiency. It expresses the fertility level of the dairy herds. It is simple and easy to calculate and understand and it is a good measure of reproductive status, but still, it usually does not indicate reasons on heifers and cows that fail to conceive. The NSC depends largely on the breeding system used. It is higher under uncontrolled natural breeding and low where hand-mating or artificial insemination is used. The NSC was significantly affected by herd, season, placenta expulsion time, lactation length and milk yield (Abdel and Alemam, 2008).

The number of service per conception is directly related to the conception rate in a herd. Conception rate or the proportion of cows inseminated which actually become pregnant, is often reported as "percent successful services". As previously mentioned, estrus detection accuracy may significantly influence conception rate. It should be noted that even though estrus detection accuracy plays a major role, it is not the only thing that affects conception rate. Physiological stress from increased milk production or heat stress, disease (i.e. retained placenta, metritis, mastitis, cystic ovaries (Whittier *et al*., 2002).

Motlagh *et al*. (2013) found that the number of service per conception tends to increase significantly with increase age (47 to 48 month). The possible cause of the low NSC for younger cows was not clear. Razi *et al.* (2010) absorbed that the conception rate of parity 3 and 4 was 77% and 75%, respectively. Cows with parity 3 and 4 have several times increased conception rate than nulliparous. Among the age group, the highest conception rate was in between 4 and 5 years, 71% and 74%, respectively and lowest conception rate was in cows of 9 years of age or above. Animals with 1-2 services showed conception rate 61% and animals with 3 and more than three services showed conception rate was 50%. Conception rate was significant Increased in both parity 3 and parity 4 than nulliparous, but cows with age group more than 9 have significantly decreased conception rate than other age group.

However, Habtamu *et al.* (2010) working with Jersey cows observed that there is insignificant effect of parity number on number of services per conception. Similar results also were reported by Hammoud *et al*. (2010) study on reproductive performance of Friesian cows under semiarid conditions in Egypt, Who reported that Parity had no significant effect on NSC. The NSC was highest at the third lactation followed by the first lactation. Estimates of NSC reported by some authors summarized in Table 2.

2.1.5. Calving interval (CI)

Calving interval is a time elapsed between two consecutive successive parturitions (Arthur, 2001; Gebrekidan *et al*., 2012 and Yifat *et al.*, 2012). Yifat *et al.* (2012) reported that cross breeds have slightly shorter calving intervals than indigenous Cattle. Another study supporting this verdict reported in North Showa zone indicated that indigenous breeds have larger calving interval than crossbreds (Mulugeta and Belayneh, 2013). Calving interval can be divided into three periods: gestation, postpartum anoestrus (from calving to first estrus) and the service period (first postpartum estrus to conception). Days open is the part of the calving interval that can be shortened by improved herd management (Malik, 1977).

Calving interval closely matched to a yearly production cycle and influences the amount of milk a cow is likely to produce in a given period. Calving interval is an important index of cow productive performance and calving interval of 365 days is desirable for efficient production (Esslemont and Peeler, 1993). Longer calving interval affects overall life time production and reproduction performance through reduced milk production and less number of calves being born. The shorter the length of calving interval in turn the higher will be life time productivity. Length of calving interval depends on reproduction management of the herd (Suhail *et al*., 2010). Estimates of CI reported by some authors summarized in Table 1.

2.2. Milk Production in Ethiopia

Dairy production, among the sector of livestock production systems, is a critical issue in Ethiopia where livestock and its products are important sources of food and income, and dairying has not been fully exploited and promoted in the country. Despite its huge numbers, the livestock subsector in Ethiopia is low in production in general, and compared to its potential, the direct contribution it makes to the national economy is limited (Sintayehu *et al.,* 2008). The national average milk yield per cow per day is 1.54 liters for indigenous cows per capita/year milk consumption in the country is about 16 kg/year, which is much lower than African and world per capita average of 27 kg/year and 100 kg/year, respectively (Belay *et al*., 2012).

Unlike Kenya, the large cattle population of Ethiopia has relatively limited numbers of exotic dairy cattle and their crosses (Muriuki and Thorpe, 2001). According to the report of the Central Statistical Agency (CSA, 2010) the indigenous cattle breeds accounted for 99.19 percent, while the hybrids and pure exotic breeds were represented by 0.72 and 0.09 percent, respectively. Despite its large livestock resource base and an ecological setting suitable for dairy production, is not yet self sufficient in milk production. Although it was difficult to trace the ownership of improved dairy animals, it is estimated that state and private farms own a total of 128,745 grade and pure female dairy animals of which the small holders sector owns 32,204 crosses and improved female dairy cattle. Consequently, milk productivity in Ethiopia is low. The indigenous zebu breed produces about 400-680 kg of milk/cow per lactation period compared to grade animals that have the potential to produce 1,120-2,500 liters over 279-day lactation (Mohamed *et al.,* 2004).

Milk production systems can be broadly categorized into urban, peri-urban and rural milk production systems. Both the urban and peri-urban systems are located near or in proximity of Addis Ababa .The urban milk system consists of 5,167 small, medium and large dairy farms producing about 35 million liters of milk annually. The peri-urban milk system includes smallholder and commercial dairy farmers in the proximity of Addis Ababa and other regional towns. This sector controls most of the country's improved dairy stock. The rural dairy system is part of the subsistence farming system and includes pastoralists, agro pastoralist, and mixed crop livestock producers mainly in the highland areas (Mohamed *et al.,* 2004).

Also the dairy sector in Ethiopia can be categorized based on market orientation, scale, and production intensity. Doing so identifies three major production systems: traditional small holders privatized state farms, and urban and peri urban systems (Gebre *et al.,* 2000). The traditional smallholder system, roughly corresponding to the rural milk production system described above, produces 97 percent of the total national milk production and 75 percent of the commercial milk production. This sector is largely dependent on indigenous breeds of low-productivity native zebu cattle, which produce about 400-680 kg of milk per cow per lactation period.

The 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 concentrated within 100 km distance around Addis Ababa. The urban and peri-urban milk production system, the third production system, includes small and large private farms in urban and peri-urban areas concentrated in the central highland plateaus (Felleke and Geda, 2001). This sector is commercial and mainly based on the use of grade and crossbred animals that have the potential to produce 1120-2500 liters over 279-day lactation. This production system is now expanding in the highlands among mixed crop-livestock farmers, such as those found in Selale and Holetta, and serves as the major milk supplier to the urban market (Gebre *et al*., 2000; Holloway *et al.,* 2000).

2.3. Factors Affecting Milk Yield

Performance of dairy animal is judged from the milk it produces during a specified period of lactation. Variation observed in lactation milk yield from lactation to lactation in the same animal. The main reason of variation attributed to the physiology of lactation is the given set of genes and their reaction with non-genetic factors. The lactation performance of dairy cattle is usually measured by determining total milk yield per lactation or per year, average daily milk yield, lactation length (Zewdu *et al*., 2013).

Management, nutrition, lactation turn or the age, year and season in which lactation started are the leading environmental factors affecting lactation performance in cattle (M'hamdi *et al*., 2012). Also, lactation performance in dairy cattle depends upon genetic and environmental factors. Genetic background, climate, diseases, feeding, year and season of calving, Breed, age, stage of lactation, parity and milking frequency have been reported to affect milk production and lactation length (Msanga *et al*., 2000 and Epaphras *et al*., 2004).

2.3.1. Location

The climate in a certain geographical area, particularly temperature and relative humidity, greatly influence the production potential of the animals (McManus *et al*., 2011). In lactating cows body heat production is associated with increases milk yield because metabolic processes, feed intake and digestive requirements increase with yield (West, 2003). The heat stress to which a lactating cow is exposed is a combination of heat accumulated from an environment and a failure to dissipate heat associated with metabolic process (Usman *et al*., 2013).

According to West (2003) the temperature (28°C) at a high humidity (80%) showed more effect on the cows' feed intake, milk yield, milk composition, heat production, evaporative heat loss and time spent lying down than when humidity was low (40%). The effects of humid hot conditions are more severe than the dry hot. High temperature and relative humidity reduces evaporative cooling, so under hot and humid conditions the dairy cattle cannot dissipate sufficient body heat to avert a rise in body temperature. The dry hot condition can be relieved by providing sprinklers and fans, whereas, in the humid hot case the cows solely rely upon evaporative cooling in the form of sweating and panting (West, 2003).

2.3.2. Lactation length

Table 3. Estimates of lactation of milk yield and lactation length

Breed	Country	LMY (kg)	LL (d)	Source
Holstein- Friesian	Ethiopia	3183	362	Million and Tadelle (2003)
Sahiwal cattle	Pakistan	1475	248	Bajwa *et al*. (2004)
Friesian cows	Pakistan	3391	278	Javed *et al*. (2004)
Friesian cows	Sudan	3475	294	Abdel *et al*. (2007)
Imported Friesian	Sudan	5468	332	Amasaib *et al*. (2008)
Locally born Friesian	Sudan	4222	321	Amasaib *et al*. (2008)
50% Friesian blood	Sudan	2645	402	Amasaib *et al*. (2008)
56.5% Friesian blood	Sudan	2052	375	Amasaib *et al*. (2008)
62.5 Friesian blood	Sudan	2564	376	Amasaib *et al*. (2008)
Holstein-Friesian Cattle	Pakistan	3977	314	Sandhu *et al*. (2011)
Holstein-Friesian cross	Ethiopia	2314	274	Belay *et al*. (2012)
Tunisian Holstein cows	Tunisia	5807	309	M'hamdi *et al*. (2012)
Holstein Friesian	Pakistan	3438	366	Usman *et al*. (2012)
Brown Swiss	México	3564	348	Utrera *et al*. (2013)
Holstein cows	México	3825	358	Utrera *et al*. (2013)
Indigenous cow	Ethiopia	403	204	Niraj *et al*. (2014)
Holstein Friesian cross	Ethiopia	2123	325	Niraj *et al*. (2014)

LMY=lactation of milk yield, LL=lactation length

Lactation length is defined as the period between two consecutive calving during which are capable of producing milk or lactating (Amasaib *et al*., 2008). Lactation length is an important production trait as it influences the total milk yield. In most modern dairy farms, a lactation length of 305 days commonly accepted as a standard. This standard allows for calving every 12 months with a 60-day dry period. The 12-month interval has considered "Ideal" for many years. If a cow milked longer than 305 days, her yield for the first 305 days taken as the lactation yield. Some cows are not milked for a full 305 days because they go dry or the lactation terminated for any of several reasons (Zewdu *et al.*, 2013).

Lactation length classes were significant source of variation for milk yield. Among imported Holstein Friesian cows, maximum milk yield was observed in cows with lactation length of >400 days (Lateef *et al.*, 2008). Under the traditional system of management milk yield is about 700 kg per lactation, while under improved management milk yield is about 2254 kg per lactation. Holstein-Friesian milk yield is significantly affected by ambient temperature under tropical conditions (Amasaib *et al.*, 2008).

Although, milk yield increased with increase in lactation length, yet it did not seem advantageous to have lactations exceeding one year. The daily milk yield in the later stages of lactation decreases and hence affects the lifetime production. Moreover, longer lactations prolong the calving interval, thereby decreasing the number of calves that could be obtained during the life span of a cow. Therefore, attempts should be made to select cows on the regularity in breeding so that they should produce calves each year with a lactation period of about ten months (Javed *et al.*, 2004).

2.3.3. Parity

Parity is one of the major sources of variation in milk yield (Mulindwa *et al.*, 2006). The finding tallies with other studies and may be partly explained by highest milk production capacity coupled with greater feed intake in older cows than young ones. However, cows in 4^{th} and more lactations were no longer better producers compared to those in their 3^{rd} lactation. The older age may contribute to reduced milk production through turnover rate of secretory cells, with higher numbers dying compared to the newly produced active secretory cells. Fat tissue cells usually replace dead secretory cells. More data are needed to support this suggestion, since only 70 and 33 cow months were registered for 3^{rd} and 4^{th} and more lactation, respectively (Epaphras *et al.*, 2004).

Thakur and Singh (2001), Javed *et al.* (2004), Sattar *et al*. (2004a), Komatular *et al*. (2010) and Zewdu *et al.* (2013) reported that the lactation milk yield was significantly affected by parity. First lactation cows had lowest milk production, and highest production occurred in 5th parity. Also Sattar *et al*. (2005) observed that the highest and the lowest milk yield were in cows during 3rd and 6th lactation, respectively. The lactation milk yield during 7th lactation was significantly lower when compared with that of 3rd lactation. The lactation milk yield during 6th lactation was also significantly lower as compared to that of 3rd, 4th and 5th lactations. However, Gadmade (1999) have reported non-significant effect of parity on lactation milk yield.

2.3.4. Lactation season

Various reports indicated that season of calving play an essential role in most of the productive traits in dairy animals (Amasaib *et al*., 2008). Zewdu *et al*. (2013) reported that the LMY was affected by season of calving. Lateef *et al.* (2008) found higher lactation milk yield in autumn than those which calved during winter, spring and summer seasons .The difference in milk yield among winter, spring and summer calvers was non-significant. Stadnik and Louda, (1999), Abdel *et al. (*2007), Gaur (2007) and Mishra and Joshi (2009) reported that milk production was highest in winter than the other seasons. Whereas Bilal *et al.* (2008) and Usman *et al. (*2011) found non-significant effect of season of calving on lactation of milk yield.

Seasonal variation in animal performance in tropics is expected to be primarily a manifestation of variation in feed quality and quantity (Javed *et al*., 2004). Afridi, (1999) suggested that milk yield was sensitive to seasonal variation. Generally, the cows calving in autumn produced the maximum milk, apparently due to low environmental temperature and availability of good quality fodder. The animals that calved in spring were next in order of merit. The cows calving in dry hot and humid hot seasons were the poorest producers. The cows calving during summer season would have gone through the last trimester of the gestation period during the scarcity period of fodder and severe dry and humid hot season and were immediately confronted with the dry and second scarcity of fodder period (November- December) as they approached peak lactation.

2.3.5. Calving year

Milk yield showed much fluctuation in different years. Year of calving significantly influenced LMY as reported by Atil (2000), Bajwa *et al.* (2004), Javed *et al*. (2004), M'hamdi *et al*. (2012) and Hassan and Khan (2013). The variation in milk yield from one year to other could be attributed to changes in herd size, age of the animals and good management practices introduced from year to another (M'hamdi *et al*., 2012). Stadnik and Louda (1999), Javed *et al*. (2004), Abdel *et al*. (2007), Sandhu *et al*. (2011) and Usman *et al*. (2011) found that milk production was higher in cooler part of the year and was adversely affected by hot weather. The variation in milk yield observed in different years reflected the level of management as well as environmental effects (Javed *et al.,* 2004).

3. MATERIALS AND METHODS

3.1. Study Area

Holeta Bull Dam Station

Holeta Bull Dam Station is located in West Shoa Zone of Oromia Regional State and is situated at 33 km west of Addis Ababa, The Station lies at longitude 38º 30' E and latitude 9º 3' N and at about 2400 meters above sea level. The site is characterized by cool sub-tropical climate with mean maximum and minimum temperatures of 22.3ºC and 6.16ºC, respectively with mean relative humidity of 59%. The mean annual rainfall ranged from 818 to 1247 mm with an average of 1014 mm. regarding season, there are three seasons : short rainy season (March to May), long rainy season (June to September) and dry season (October to February) (HARC, 2008).

Genesis Farms is located in Debre Zeit town Ethiopia. Debre Zeit is located at 45 km south east from Addis Ababa. It is found at 8°44'°N latitude and 38°58'E longitude and at an altitude of 1900 meters above sea level in the central high lands of Ethiopia. It experiences a bimodal pattern of rainfall with the long rainy season extending from June to September and a short rainy season from March to May and dry season from October to February with an average annual rainfall of 851mm. The mean annual minimum and maximum temperatures are 8.9°C and 28.3°C, respectively, with an overall average of 19°C. The mean relative humidity is 61.4% (DZARC, 2008).

3.2. Herd Management

Holeta Dull Dam Station

Holeta Bull Dam Station keeps Holstein–Friesian cattle whose blood level was above 75 %. Milking cows are allowed to graze on native pasture from 8:00 am to 3:00 pm and supplied with native grass hay and green vetches (*Vicia dasycarpa*) on return to the barn. Milking cows were grouped according to their milk production classes as high (>14 liters), medium (8 to 14 liters) and low (< 8 liters) yielding and each milking cow is provided with additional 0.5 kg concentrate per liter of milk, while pregnant dry cows are supplied with 3 kg of concentrates in the last two months of pregnancy. The concentrate mix is composed of (30%) wheat middling, (30%) noug cake *(Guizeta abysinica*), (25%) wheat bran, (10%) corn, (4%) limestone and (1%) salt. All animals had free access to water.

Most of the cows were served at first observed heat after calving. Heat detections were routinely followed three times a day, that is, early in the morning after milking; in the resting period at noon; and in the afternoon before milking. Calves were separated from their dams immediately after birth and allowed to receive 5, 4, 3, and 2 liters of milk per day from 5 to 65; 66 to 85; 86 to 105; and 106 to 120 days of ages, respectively. Regular vaccinations against contagious bovine pleura-pneumonia, lumpy skin disease, anthrax, blackleg, foot and mouth disease and pasteurellosis were given and treatments provided when incidence of cases were observed.

The Genesis Farms consisted of Holstein–Friesian cattle whose blood level was above 75%. Animals were provided grass hay supplemented with concentrate feeds and mineral licks as major proportion of the feed supply. At times, waste vegetables from the Farm's field along with concentrate mix are also fed. In many instances however, there was feeding irregularities over the years. Cows were hand-milked twice daily. In the farm maximum and minimum milk yield per day was 32 and 6 liters respectively and cows received concentrates before each milking at the rate of 0.58 kg of concentrate per 1kg of milk produced while pregnant, dry and open cows are supplied with 2 kg of concentrates for maintenance. Concentrate mix was composed of maize (20%), wheat bran (33%), wheat short (25.6%), soya bean (5%), noug cake (*Guizotia abyssinica*) (12%), salt (2%), limestone (2.4%). Hay was produced from the farms particularly Alfalfa and Napier grass which are supplied to dairy cows depending on their availability. Calves were fed colostrums immediately after birth and there after allowed to consume 520 liters of milk before weaning at the age of 120 days. Water was available anytime. Newborn calves were taken away from their dams after 5-8 days of birth and use bucket-fed. They were managed in individual pens.

Breeding was controlled using artificial insemination and/or natural mating by means of known bulls. Most of the cows were served at first observed heat after calving. Detection of estrus was carried out twice a day, early in the morning and late in the afternoon. Pregnant cows were managed separately during the trimester; they calved in well-constructed calving pens. Animals on the farm were regularly vaccinated against foot and mouth disease (FMD), lumpy skin Disease (LSD), blackleg, anthrax, CBPP and bovine pasteurellosis. Culling was practiced as a result of fertility failures, chronic mastitis, tuberculosis, old ages and low daily milk production.

3.3. Study Design

A retrospective study was carried out to estimate age at first effective service (AFS), age at first calving (AFC), days open (DO), number of service per conception (NSC), calving interval (CI), lactation milk yield (LMY) and lactation length (LL) using data recorded from1997 to 2003 in Holeta Bull Dam Station and from1996 to 2005 in Genesis Farms.

3.4. Data Analyses

Data were analyzed using The General Linear Models procedure (GLM) of the Statistical Analysis System (SAS 2002). The dependent variables were age at first effective service (AFS), age at first calving (AFC), days open (DO), number of service per conception (NSC), calving interval (CI), lactation milk yield (LMY) and lactation length (LL). The fixed effects considered were calving year and season, location, birth year and season and parity. All data were entered into Microsoft Excel spreadsheets and after deleting incomplete records, a total of 492 records for AFS and AFC and, 563 records for DO, NSC and CI and 875 records for LMY and LL were used for analyses. Due to few observations of AFS and AFC recorded in Genesis Farms birth year of 1994 and 1995; 2001 and 2000; 2002 and 2003 were merged. Also, calving year 1996 and 1997; parity 6 and 7 were merged for LMY and LL. Calving year 1996 and1997; 2004 and 2003; parity 5, 6 and 7 were merged for NSC, CI, DO for data analysis.

Table 4. Number of records used in each location

Traits	Holeta	Genesis farms
LMY and LL	614	261
AFC and AFS	426	66
NSC, CI, DO	377	186

Model 1

$Y_{ijkm} = \mu + B_i + S_j + L_k + e_{ijkm}$

Where:

Y_{ijkm}= Single observation on Age at first calving and Age at first effective conception

μ=Overall mean

B_i =Effects due to i^{th} Birth year

S_j=Effects due to j^{th} Birth season

L_k=Effects due to k^{th} location

e_{ijkm}= Random error

Model 2

$Y_{ijklm} = \mu + Y_i + S_j + Pk + L_l + e_{ijklm}$

Where:

Y_{ijklm} = Single observation on milk yield, lactation length, calving interval, days open and number of service per conception

μ =overall mean

Y_i = Effects due to i^{th} year of calving

S_j= Effects due to j^{th} season of calving

P_k=Effects due k^{th} parity

L_l= Effects due to l^{th} location

e_{ijklm}= Random error

4. RESULTS

4.1. Age at First Effective Service (AFS) and Age at First Calving (AFC)

Table 5.Variance analysis for the effect of fixed factor (location, birth year, birth season) on Age at First effective service and age at first calving

	Mean square and significant level		
Source	df	AFS	AFC
Location	1	2151710***	2054155 ***
Birth year	9	341136 ***	316839***
Birth season	2	18546^{NS}	32077^{NS}

***=p<0.001; NS=Not significant; df=degree of freedom; AFS= Age at First Effective Service; AFC=Age at first calving,

The results of variance analysis showed that the effect of location and birth year on AFS and AFC were highly significant while birth season was non-significant on AFS and AFC (Table5).

Table 6. Least square means (LSM) and standard errors (se) for the effect of location, birth year and birth season on Age at First effective service and age at first calving

		AFS	AFC
Source	N	LSM ± se	LSM ± se
Over all mean	492	733 ± 16	1001 ± 17
Location		***	***
Holeta	426	759 ± 33[a]	1026 ± 33[a]
Genesis farms	66	566 ± 39[b]	838 ± 40[b]
Birth season		NS	NS
Long rainy	157	734 ± 18	1008 ± 18
Short rainy	137	724 ± 19	989 ± 19
Dry season	198	739 ± 20	1003 ± 20
Birth year		***	***
1994	37	853 ± 42[a]	1105 ± 42[a]
1995	65	781 ± 37[abc]	1055 ± 38[ab]
1996	61	699 ± 38[de]	960 ± 38c[d]
1997	45	767 ± 40[bcd]	1032 ± 40[abc]
1998	42	760 ± 41[bcd]	1017 ± 41[bc]
1999	74	807 ± 36[ab]	1076 ± 37[ab]
2000	76	722 ± 36[cd]	995 ± 37[bcd]
2001	22	574 ± 47[f]	839 ± 48[e]
2002	41	573 ± 41[f]	848 ± 41[e]
2003	29	640 ± 40[ef]	924 ± 41[d]

[abc.....] Within variable groups, means followed by the same letter do not differ significantly (P>0.05); AFS= Age at First effective service; AFC=age at first calving; N= number of observation

The overall means for AFS and AFC were 733 ±16 and 1001 ±17 days, respectively (Table 6). Location and birth year had higher significant ($p<0.0001$) effect on AFS and AFC while birth season had non-significant effect on AFS and AFC. Highly significant ($p<0.0001$) variability in the AFS and AFC were observed for the two location

4.2. Days Open (DO), Number of Service per Conception (NSC) and Calving Interval (CI)

Table 7. Variance analysis for the effect of fixed factor (location, calving year, calving season and parity) on days open, number of service per conception and calving interval

		Mean square and significant level		
Source	Df	DO	NSC	CI
Location	1	701489.9***	3.1^{Ns}	362817.8***
Calving year	6	49820.8*	1.3^{Ns}	54658.6**
Calving season	2	56027.6^{Ns}	1.2^{Ns}	24766.4^{Ns}
Parity	6	14756.1^{Ns}	6.4**	13860.0^{Ns}

*=P<0.05; **=p<0.01; ***=p<0.001; NS=Not significant; df=degree of freedom; DO= days open; NSC= number of service per conception; CI= calving interval;

The results of variance analysis showed that the effect of location and calving year had significant effect on DO and CI and non-significant effect on NSC. Calving season had non- significant effect on all traits. Parity was non- significant effect on DO and CI and had effect on NSC (Table 7).

Table 8. Least square means and standard errors for the effect of location, calving year, calving season and parity on days open, Number of service per conception and calving interval

		DO	NSC	CI
source	N	LSM ± se	LSM ± se	LSM ± se
Over all mean	563	202 ± 138.3	2.05 ± 1.47	470 ± 125.4
Location		***	NS	***
Holeta	377	176 ± 48.6[b]	2.00 ± 0.52	449 ± 44.1[b]
Genesis farms	186	255 ± 47.7[a]	2.15 ± 0.51	512 ± 43.3[a]
parity		NS	**	NS
1	218	216 ± 43.3	1.75 ± 0.50[ab]	479 ± 39.3
2	158	202 ± 43.7	2.31 ± 0.46[ab]	471 ± 39.7
3	94	189 ± 44.4	2.17 ± 0.47[ab]	472 ± 40.3
4	49	169 ± 46.6	2.06 ± 0.49[ab]	439 ± 42.3
5	26	220 ± 50.7	2.30 ± 0.54[ab]	452 ± 45.9
6	7	157 ± 67.5	1.71 ±0.72[b]	428 ± 61.3
7	11	170 ± 78.2	2.72 ± 0 .95[a]	451 ± 70.7
Calving season		NS	NS	NS
Long rainy	187	186 ± 13.46	2.14 ± 0.14	462 ±12.2
Short rainy	125	207 ± 15.38	1.94 ± 0.16	467 ± 13.9
Dry season	251	212 ± 17.3	2.03 ± 0.17	477 ±14.8
Calving year		*	NS	**
1997	95	190 ± 28.50 [b]	2.17 ± 0.30	463 ± 25.6b[c]
1998	94	208 ± 28.274[ab]	2.09 ± 0.30	473 ± 25.4b[c]
1999	97	185 ± 28.05 [b]	1.83 ± 0.30	446 ± 25.4[c]
2000	87	187 ± 27.87 [b]	1.91 ± 0.29	443 ± 25.3[c]
2001	77	253 ± 27.50[a]	2.11 ± 0.29	526 ± 24.9[a]
2002	69	183 ± 28.16[b]	2.07 ± 0.30	460 ± 25.5[bc]
2003	44	224 ± 27.83[ab]	2.27 ± 0.30	500 ± 25.2[ab]

abc Within variable groups, means followed by the same letter do not differ significantly (P>0.05); DO= days open; NSC= Number of service per conception; CI=calving interval ; N= number of observation

The overall mean for DO, NSC and CI were 202 ± 138.3 days, 2.05 ± 1.47, 470 ± 125.4 days, respectively (Table 8). The findings showed that location and year of calving had a significant effect on CI and DO while season of calving and parity had non-significant effects on DO and CI. Location, year and season of calving did not significantly (P>0.05) affect NSC while parity had a significant (p<0.01) effect on NSC.

Longest days open (255 ± 47.7 days) and calving interval (512±43.3 days) were recorded in Genesis Farms while the shortest days open (176 ± 48.6 days) and calving interval (449±44.1days) were recorded in Holeta Bull Dam Station. Higher values of DO (253 ±27.5 days) and CI (526 ± 24.9days) were observed in 2001 while the lowest values of DO (183 ± 28.1days) and CI (443.30days) were observed in 2002 and 2000, respectively. The maximum NSC (2.72±0.95) was absorbed in 7th parity while minimum NSC (1.71±0.72) was found in 6th parity.

4.3. Lactation Milk Yield (LMY) and Lactation Length (LL)

Table 9.Variance analysis for the effect of fixed factor (location, calving year, calving season and parity) on lactation milk yield and lactation length

		Mean square and significant level	
Source	DF	LMY	LL
Location	1	268656990.5 ***	2153869.2***
Calving year	8	16145554.5***	48015.1***
Calving season	2	1576107.9^{Ns}	2256.2 ^{Ns}
Parity	7	7545952.7**	22184.7*

*=P<0.05;**=p<0.01; ***=p<0.001; NS=Non-significant; df=degree of freedom
LMY=lactation of milk yield; LL=lactation length

The results showed that variance analysis for the effect of location, calving year and parity had significant effect on LMY and LL while season of calving had non-significant effects on LMY and LL (Table 9).

Table 10. Least squares means (LSM) and standard errors (se) for the effect of location, calving year, calving season and parity on lactation of milk yield and lactation length

		LMY	LL
Source	N	LSM ± se	LSM ± se
Over all mean	875	4097 ± 1491.2	301±91.4
Location		***	****
Holeta	614	3716 ± 602.9[b]	271 ±36.9[b]
Genesis farms	261	4994 ± 592.6[a]	389 ±36.3[a]
parity		**	*
1	337	3852 ± 506.2[ab]	316 ±31.0[ab]
2	215	4503 ± 510.4[a]	317 ± 31.3[ab]
3	162	4272 ± 513.3[a]	301 ± 31.5[abc]
4	86	4015 ± 524.5[ab]	277 ± 32.1[abc]
5	39	3868 ± 555.3[ab]	270 ± 34.0[abc]
6	20	3549 ± 603.5[ab]	260 ±37.0[bc]
7	7	3189 ± 752.4[b]	251 ± 46.1[c]
8	9	4113 ± 850.9[ab]	324 ± 52.1[a]
Calving season		NS	NS
Long rainy	306	4187 ± 116.3	308 ± 7.1
Short rainy	198	3985 ± 133.3	303 ± 8.1
Dry season	371	4083 ± 144.9	305 ± 9.2
Calving year		***	***
1997	123	3903 ± 368.4[cde]	295 ± 22.5[de]
1998	122	4036 ± 366.7[cde]	291 ± 22.4[de]
1999	154	3775 ± 362.3[de]	292 ± 22.2[de]
2000	157	3640 ± 358.2[e]	270 ± 21.9[e]
2001	93	4375 ± 363.6[bc]	339 ± 22.3[abc]
2002	98	4937 ± 364.6[a]	329 ± 22.3[bc]
2003	59	4705 ± 371.4[ab]	365 ± 22.7[a]
2004	46	4282 ± 386.1[bcd]	354 ± 23.6[ab]
2005	23	4103 ± 396.7[cde]	308 ± 25.0[cd]

[abcde] Within variable groups, means followed by the same letter do not differ significantly (P>0.05); NS=Non significant; LMY=lactation of milk yield; LL=lactation length ; N= number of observation

The overall mean for LMY and LL were 4097 ± 1491.2 liters and 306±91.4 days, respectively (Table 10). Location, year of calving and parity were found to have significant effect on LMY and LL while season of calving had non-significant effect on LMY and LL. Milk yield between locations, among 2000, 2001, 2002 years of calving and 2nd and 7th lactations showed highly significant difference. Difference in milk yield among long rainy season, short rainy season and dry season calvers were non-significant (Table 10). Average LMY was highest in Genesis Farms (4994 ±592.6 liters) than in Holeta Bull Dam Station (3716 ± 602.9 liters). Holstein Friesian cows that calved during 2002 year showed highest average LMY (4937 ± 364.6 liters) while the lowest LMY(3640 ±358.2liters) calved during 2000 years. 2nd Parity had the highest average LMY (4503 ± 510.3 liters) while 7th parity had lowest LMY (3189 ±752.4 liters).

Lactation length between location, among 2000 and 2003 years of calving and 7th and 8th lactations showed significant difference. The difference in lactation length among long rainy season, short rainy season and dry season calvers were non-significant. Cows in Genesis Farms had significantly higher average LL (389 ± 36.3days) than those in Holeta Bull Dam Station (270 ± 36.9 days). The highest LL was recorded in 2003 (365 ± 22.7days) year while the lowest LL was recorded in 2000 (270 ± 21.9 days) year. The average LL was longest in the 8th parity (324 ± 52.1days) while it was lowest LL in 7th (251 ± 46.1days) parity.

5. DISCUSSION

5.1. Age at First Effective Service (AFS) and Age at First Calving (AFC)

The average age at first effective service or conception in the present study was 733 ±167 days (Table 6). Sattar *et al*. (2005) reported almost similar estimates (714.74 days) in Holstein-Friesian heifers in Pakistan. Higher age at first effective service as compared to the present study was 1206 days and 1260 days as reported by Habib (2011) in Red Chittagong heifers in Bangladesh and Amin *et al*. (2013) in Red Chittagong heifers in Bangladesh. On the other hand, Ali *et al.* (2011) and Sandhu *et al.* (2011) reported lower age at first effective service of 633.82 and 655.10±10.44 days for Holstein-Friesian heifers in Pakistan respectively. These differences might be due different breeding management, breed, environmental states like temperature and humidity and feeding management at different farms.

Location and birth year had significant effect on age at first effective service. The longer AFS was recorded in Holeta Bull Dam Station. Shorter AFS found in Genesis Farms might be due to nutritional statuses like supplying enough concentrate feed, good calf management, good heifer rearing practice and give attention for heifer rearing, timely insemination and breeding decisions. Significant effect of birth year on age at first effective service as case in the present study was reported by Novaković *et al*. (2011). This could be due to management change and irregular feed supply in each year. Season of birth had non-significant effect on age at first effective service in the present study. Non- significant effect of season on AFS might be due to the long time gap between birth and AFS was too long and similar managements like feeding, watering and health care which had hidden the effect of season on AFS. Similarly, Rafique *et al*. (2000), Sattar *et al*. (2005) showed non-significant effect of season on AFS. However Novaković *et al*. (2011) reported that season of birth had significant effect on age at first effective service.

In the present study, the overall mean for AFC was 1001 ±170 days (Table 6). This value of AFC was consistent with earlier reports of 1010.73 days observed for Jersey cattle in Pakistan by Suhail *et al. (*2010) and 1278 days reported by Besufekad (2008) in Holstein-Friesian heifers in Ethiopia. Some reported even higher AFC values like 1749 days in crossbred dairy heifers in Zimbabwe by Masama *et al*. (2003), 1518 days in Red Chittagong cattle in Bangladesh by Amin *et al*. (2013). Reports of lower age at first calving compared to the present study were 810 days in Egypt and 892 days in Sudan by Oudah *et al. (*2001) and Abdel *et al*. (2007) respectively. These differences might be due to differences in feeding management, breeding decision, environmental statuses and health care. The better managed and well-fed heifers grew faster, served earlier and resulted in more economic benefit in terms of sales of pregnant heifers and/or more milk and calves produced during the lifetime of the animal.

Location and birth year had significant effect on age at first calving while season of birth had non-significant effect on AFC in this case. The shorter AFC was reported in Genesis Farms could be attributed mainly due to well management of heifers, enough supply of concentrate feed and milk and the economics associated with reducing AFC in the farms. The significant effect of year of birth on AFC might be due to changes in climatic conditions and feeding regimes during different year of birth. Similar results were observed by Abdel *et al.* (2007), Besufekad (2008), Ansari-Lari *et al*. (2009), Hammoud *et al.* (2010) and Suhail *et al*.(2010) who showed significant effect of the year of birth on AFC. Season of birth had non- significant effect on AFC as present reported by Besufekad (2008), Hammoud *et al.* (2010) and Suhail *et al.* (2010).

5.2. Days Open (DO), Number of Service per Conception (NSC) and Calving Interval (CI)

The overall means of days open in the study animals were 202 ± 138.3 days (Table 8). The value of DO obtained in this study in agreement with that of Besufekad (2008) who reported 206 days for Holstein-Friesian at Holeta Bull Dam Station in Ethiopia. The overall mean of DO reported in this study was longer than estimates of Oudah *et al.* (2001), Abdl *et al*.(2007), Bahonar *et al*.(2009), Mwatawala and Kifaro(2009), Nuraddis *et al*. (2011), Belay *et al.(*2012*)* and Nibret (2012) who reported DO of 120, 167, 123, 183, 171, 155 and 90 days for Holstein-Friesian in Egypt, Friesian cows in Sudan, Holstein dairy cattle in Iran, Boran heifers and cows in Tanzania, Friesian X zebu cattle in Ethiopia, Zebu X Holstein-Friesian in Ethiopia and Friesian X zebu cattle respectively.

Feed shortage, silent estrus and lack of proper heat detection might have contributed considerably to the long days open (Belay *et al*., 2012). McNamara *et al*. (2003) had reported that nearly half of the oestrus periods in large-scale dairy enterprises were undetected.

In the present study DO was significantly shorter in Holeta Bull Dam Station than in Genesis Farms. Wide variations might be due to differences in breeding management and health care. Year of calving showed significant effect on days open as the present study in the reportes by Yohannes *et al*. (2001) and Gifawosen *et al*. (2003), Gebeyehu *et al.* (2007), Besufkad (2008) and Amene *et al.* (2011). But Abdel *et al*. (2007) reported that year of calving had non-significant effect on DO.

Season of calving had non- significant effect on DO in this study. Similar findings were reported by Gebeyehu *et al.* (2007) and Besufkad (2008) But, Hammoud *et al.* (2010) reported that calving season was significant effect on DO. Parity had non-significant effect on DO in the present study. Similar results were reported by Mureda and Mekuriaw (2007) but significant effect was reported by Abou-Bakr *et al.* (2006) and Besufkad (2008)

The over all mean value for NSC was 2.05 ± 1.47 (Table 8). Similar estimates were reported by Asseged and Birhanu (2004; 2.0) in commercial dairy farms in Ethiopia, Turkyilmaz (2005; 2.01) in private dairy farms in AydÝn and Ngodigna *et al*. (2009; 2.0±1.0) in Holstein Friesian X Bunaji crossbreed cows in Nigeria. The results of this study were lower than over all mean value for service per conception (2.3) for Holstein-Friesian in Sudan by Abdel and Alemam (2008) and 2.55±1.7 by M'Hamdi *et al.* (2011)in Tunisian Holstein cows while result was higher than the service per conception (1.56±0.57) reported by Belay *et al.* (2012) in Zebu X Holstein-Friesian crossbred dairy cows in Ethiopia, Hunduma (2012) 1.52±0.9) in crossbred dairy cows in Ethiopia and Nibret (2012) 1.3 ±0.6 in crossbred dairy cows Ethiopia. Two and more number service per conception might be due to lack of semen quality, insufficient nutrition, reproductive disorder, use of improper inseminating techniques, the presence of repeat breeders in the herd and problems of heat detection.

Location, year and season did not significantly (P>0.05) affect number of service per conception in this study while parity was significantly affected number of service per conception. Number of service per conception was higher in parity 7^{th} compared to others. The increasing number of service per conception with age was reported by Motlagh *et al*. (2013). The possible cause of the low NSC for younger cows was not clear (Motlagh *et al*. 2013). Gebeyehu *et al.* (2007) concluded that the possible cause of the low NSC for younger cows is not clear and whether that was due to physiological or differential treatment needs to be established. Sattar *et al* (2005), Gebeyehu *et al.* (2007), Besufkad (2008) and Avendaño-Reyes *et al*. (2010) reported significant effect of parity on number of service per conception. However, Asseged and Birhanu (2004), Turkyilmaz (2005) and Habtamu *et al. (*2010) reported non-significant effect of parity number on number of service per conception.

According to the results of the study, year of calving had a statistically non-significant (P>0.05) effect on number of services per conception. This result was in agreement with studies performed by Nega and Sendrose (2000) and Turkyilmaz (2005) However, Besufkad (2008), Ngodigna *et al*. (2009), Avendaño-Reyes *et al*. (2010), Hammoud *et al*.(2010) and Motlagh *et al*. (2013) reported that year of calving had significantly affected number of service per conception. Non-significant effect on number of service per conceptions might be due to regular breeding practice from year to year.

The season of calving had a non-significant effect on number of services per conception in this study. The non-significant effect of season of calving was also reported by Ngodigna *et al*. (2009) and Turkyilmaz (2005) However, Gifawosen *et al*. (2003), Besufkad (2008), Avendaño-Reyes *et al*. (2010) , Hammoud *et al*.(2010) and Motlagh *et* *al*. (2013) reported that the trait was significantly affected by season. According to Gebeyehu *et al.* (2007), season of conception had non- significant effect on NSC. Probably due to the zero grazing practice in the farm which makes the effects of seasonal variation in forage developments and feed availability minimal.

The overall mean value of CI was 470 ± 125.4 days (Table 8).This finding was consistent with Mwatawala and Kifaro (2009) in Boran heifers and cows in Tanzania and Besufkad (2008) in Holstein- Friesian dairy cows in Ethiopia But, our finding was lower than the reports of Sattar *et al*. (2005) in Holstein Friesian in Pakistan, Amene *et al*. (2011) in Friesian dairy cows in Ethiopia and Hassan and Khan (2013) in Holstein–Friesian in Ethiopia who reported CI of 463, 478 ,505, 561 and 543 days, respectively. Longer values of CI were reported by Abdel and Alemam (2008), Hammoud *et al.* (2010) and Hunduma (2012) who reported CI 433, 403, 372 days for Holstein-Friesian in Sudan, Friesian cows in Egypt and crossbred dairy cows in Ethiopia respectively. These differences might be due to differences in herds, breeding management and feeding regimes. The long CI observed could be due to the higher NSC and DO in the farm (Gebeyehu *et al.,* 2007). Longer calving interval could be related to extended lactation length, poor management and inadequate artificial insemination service.

Shiferaw *et al.* (2005) found that cows with reproductive disorders require more services per conception and had longer intervals from calving to first service and to conception. Proper and accurate heat detection is a key to efficient reproduction, and four to five checks each day to determine the onset of true standing heat gives a better idea when to inseminate.

Significant difference of CI between Genesis Farms and Holeta Bull Dam Station was obtained in the present study. Longer calving interval was recorded in Genesis Farms. This could be related to extended lactation length, long days open and fertility status of breeding cows. Significant effects of year of calving on calving interval were also reported by Gebeyehu *et al.* (2007), Haile *et al*., 2009, Mwatawala and Kifaro (2009), Hassan and Khan (2013)) and Motlagh *et al*. (2013). This significant variation might be due to change in feeding system, environmental condition, management system and occurrence of disease from year to year.

Parity of calving had non-significant effect on calving interval the present study. Yohannes *et al.* (2001) reported the same but Sattar *et al*. (2004), Sattar *et al*. (2005), Gebeyehu *et al.* (2007), Besufekad (2008), Sandhu *et al. (*2011) and Motlagh *et al*. (2013) reported significant effect of parity on calving interval. Season of calving had non- significant effect on calving interval in present study. Similar result was reported by Gebeyehu *et al.* (2007) but Sattar *et al*. (2005), Sandhu *et al* (2011) and Hassan and Khan (2013) observed significant effect of season on calving interval.

5.3. Lactation Milk Yield (LMY) and Lactation Length (LL)

The overall means LMY reported in the present study was 4097 ± 1491.2 liters (Table 10). This value is in close agreement to the finding of Amasaib *et al.* (2008) (4222 liters) in locally born Friesian cattle in Sudan, Sandhu *et al*. (2011) (3977 liters) in Holstein Friesian cattle in Pakistan and Utrera *et al*. (2013) (3825 liters) in Holstein cows in México. Higher yield than that noted in the present study has been reported by Abdel and Alemam (2008; 4605 liters) in Holstein-Friesian in Sudan, Amasaib *et al*. (2008) (5468 liters) in Imported Friesian in Sudan and M'hamdi *et al. (*2012) (5807 liters) in Tunisian Holstein cows in Tunisia. However, lower than the present study has been reported by Javed *et al*. (2004) (3339 liters) in Friesian cows in Pakistan, Abdel *et al*. (2007) (3475 liters) in Friesian cows in Sudan, Amasaib *et al*. (2008) (2564 liters) in 62.5 Friesian blood in Sudan, Belay *et al .(*2012) (2314 liters) in Zebu X Holstein Friesian in Ethiopia , Usman *et al*. (2012) (3438 liters) in Holstein Friesian in Pakistan, Zewdu *et al.* (2013) (1661 liters) in Holstein Friesian×Deoni cows in India and Niraj *et al*. (2014) (2123.43 liters) in Holstein Friesian crossbred dairy cattle in Ethiopia. Ecological zone, environmental status, poor feeding, in adequate health care might be possible reasons for reducing LMY.

In this study, lactation milk yield was higher in Genesis Farms than in Holeta Bull Dam Station. This higher value might be due to enough supply of concentrate feed to the cow, high availability and quality of feed resources, regular feeding management of the herd and access to proper health services.

Parity had a significant effect ($p<0.01$) on lactation milk yield. High milk yield was recorded in 2nd parity followed by 3rd parity. Similar results were reported by Nyamushamba *et al.* (2014) in Red Dane and Jersey cattle in Zimbabwe. Lactation milk yield was significantly ($p<0.01$) lower during 7th lactation compared to other lactation. Lactation milk yield during 6th lactation was also significantly ($P<0.01$) lower as compared to that of 1st, 2nd, 3rd, 4th, 5th lactation. The decline is due to decline in body condition and degeneration of the body system over the recurring pregnancies (Nyamushamba *et al.,* 2014). However, 8th lactation had higher milk yield as compared to that of 4th, 5th, 6th, 7th lactation. This discrepancy may be due to the small data recorded in 8th lactation. Significant parity effect as in the present study was also reported by Bajwa *et al*. (2004) in Sahiwal cattle in Pakistan, Javed *et al*. (2004) in Friesian cows in Pakistan, Sattar *et al*. (2004a) in Jersey cows in Pakistan , Sattar *et al.* (2005) in Holstein Friesian in Pakistan, Tadesse *et al.* (2010) in Holstein Friesian dairy cows in Ethiopia, Usman *et al*. (2012) in Holstein Friesian in Pakistan, Niraj *et al.* (2014) in indigenous and HF crossbred dairy cows in Ethiopia and Nyamushamba *et al.* (2014) in Red Dane and Jersey cattle in Zimbabwe. In contrast, the result differed from that of Habib *et al.* (2003), Amasaib *et al*. (2008), Jemila and Achenef (2012) in Red Chittagong cattle in Bangladesh, 62.5 Friesian blood in Sudan and cross of Holstein Friesian cows in Ethiopia, respectively. The significant effect of parity on lactation milk yield may be due to differences in size of the udder, body weight of cows, feed requirement related to the development of gastro intestinal tract and environmental conditions among lactation.

Year of calving highly influenced LMY ($P<0.0001$).The significant effect of year of calving on LMY observed in this study agrees with the reports of Atil (2000) in Holstein Friesian cattle in Turkey, Bajwa *et al*. (2004) in Sahiwal cattle in Pakistan, Javed *et al*. (2004) in Friesian cows in Pakistan and Hassan and Khan (2013) in crossbred dairy cattle in Pakistan. The variation in milk yield observed in different years may be related to the availability of quantity and quality of forage, feeding system, size of herd, management system and environmental status like temperature, humidity and disease which varies from year to year.

The season of calving had non-significant effect on lactation milk yield in this study as reported by some authors Bilal *et al*. (2008), Usman *et al.* (2011) and Hassan and Khan, 2013). However, Bajwa *et al*. (2004), Javed *et al*. (2004), Gaur (2007), Mishra and Joshi (2009), Koc (2011), M'hamdi *et al*. (2012), Usman *et al*. (2012), Zewdu *et al*. (2013) and Niraj *et al.* (2014) reported significant effect of season of calving on LMY. This non-significant effect on LMY is likely due to better feeding and management of dairy cows which reduce the effect of season on LMY.

Overall average lactation length in the present study was 306±91.4 days (Table10). M'hamdi *et al*. (2012) reported almost similar findings (309 days) in Tunisian Holstein cows in Tunisia. Javed *et al*. (2004) reported an average lactation length of 278 days in Friesian cows in Pakistan, Sattar *et al*. (2005) reported an average lactation length of 293 days in Holstein-Friesian cows in Pakistan, Abdel *et al*. (2007) reported an average lactation length of 294 days in Friesian cows in Sudan and Zewdu *et al*. (2013) reported an average lactation length of 296 days in Holstein Friesian × Deoni cows in India,which were slightly shorter than the LL in present study. But Abdel and Alemam (2008) in Holstein-Friesian in Sudan, Sandhu *et al*. (2011) in Holstein-Friesian cattle in Pakistan, Utrera *et al*. (2013) in Holstein cows in México. Niraj *et al*. (2014) in HF crossbred in Ethiopia observed an average lactation length of 322, 314, 358, 325 days, respectively, which were higher than results of the present study. The management practice of dairy cattle might be to differ in days of lactation length.

Holstein-Friesian cows at Genesis Farms had significantly longest lactation length (389.2±36.32 days), than those in Holeta Bull Dam Station. This different lactation length between the two farms might be due to management system of the farms as well as different production capacity of the herd.

Lactation length was significantly affected by parity in this study. similar finding were reported by, Kaya *et al*. (2003) in Holstein-Friesian cows in Turkey, Sattar *et al.* (2005)

in Holstein-Friesian cows in Pakistan, Gader *et al*. (2007) in Friesian cows in Sudan, Komatular *et al*. (2010) in Holstein Friesian × Sahiwal crossbreds in India, Usman *et al*. (2012) in Holstein Friesian in Pakistan and Hassan and Khan (2013) in crossbred dairy cattle in Pakistan But, Carvajal-Hernández *et al*. (2002) in Holstein Friesian cows under tropical conditions of Mexico, Ahmed *et al*. (2004) in local Zebu×Holstein Friesian cross, Sattar *et al*. (2004a) in Jersey cows in Pakistan, Utrera *et al*. (2013) in dairy cows under subtropical conditions and Zewdu *et al*. (2013) in Holstein Friesian × Deoni crossbred cows in Ethiopian reported that parity did not affect lactation length. The reason for significant effect of parity on Lactation length might be the difference production set up and management systems.

In the present study, year of calving also had significant effect on lactation length as reported by Bajwa *et al*. (2004) in Sahiwal cattle in Pakistan and Hassan and Khan (2013) in crossbred dairy cattle in Pakistan. Change in management condition and age of cow from year to year effect on lactation length.

Season of calving had a non-significant effect on lactation length in this study. Non-significant effect of season of calving on lactation length was also observed by Ahmed *et al.* (2007), Bilal *et al*. (2008), Hassan and Khan (2013) and Zewdu *et al. (*2013) However, Bajwa *et al*. (2004, Lateef *et al*. (2008) and Komatular *et al.* (2010) reported significant effect of season on lactation length.

6. CONCLUSION AND RECOMMENDATIONS

The study was conducted at Holeta Bull Dam Station and Genesis Farms. The overall least squares means and standard error of AFS, AFC, DO, CI, NSC, LMY and LL were 733 ±167days, 1001 ± 17days, 202 ± 13days , 470 ±12 days, 2 ± 1, 4097± 1491liters and 301±91 days, respectively. Based on the results of this study the highly significant effect of location on all traits except NSC indicates that management practice may be varies between the farms. Variability in the management and climatic conditions through the years seem to affect CI, DO, LMY and LL. Cows with 2nd and 3rd parity number have higher LMY and with high parity number tend to have longer LL. All the traits were non-significantly influenced by season. Reproductive and productive performance of Holstein Friesian in the study area is better than many other states and private owned farm in the country. However comparing in other tropical country, values are lower. These lower values could be due to environmental factors like in adequate supply of feed, lack of quality feed, poor health care, Heat detection problem, lack of breeding policy and insufficient use of new reproductive technology.

Based on the above conclusions, the following recommendations were forwarded:

- Standard Record keeping practice on reproductive and productive traits should be established.
- Improve the reproductive and productive performance of dairy cows by improved nutrition, to give attention in heat detection, health care, timely insemination, proper management of postpartum reproductive problems and early growth heifers and use of new reproductive technology.
- Management should focus on minimizing the voluntary waiting period after calving which reduces day's open and calving interval of dairy cattle.
- Herd life and life time productivity is one of the influences of overall productivit y of dairy cattle there for the future study on factors affecting herd life and life time productivity should be assessed very well.

7. REFERENCE

Abdel G. A. Z., Ahmed M. K. A., Musa L. M. A. and Peters K. J. (2007): Milk yield and reproductive performance of Friesian cows under Sudan tropical conditions. *Archiva. Tierz. Dumm.* , **50**(2): 155-164.

Abdel R. I. M. K. and Alemam T. A. (2008): Reproductive and productive performance of Holstein-Friesian cattle under tropical conditions with special reference to Sudan- a review. *Agric. Rev.,* **29** (1): 68 – 73.

Abe H., MasudaY. and Suzuki M. (2009): Relationships between reproductive traits of heifers and cows and yield traits for Holsteins in Japan. *J. Dairy Sci.*, **92**:4055-4062.

Abou-Bekir S., Alhammad H. O. A., Sadek R. R. and Nigm A. A. (2006): The productive and reproductive characteristics of Holstein cows raised under intensive farming system in Egypt. *Egypt J. Anim. Prod*., **43**: 91-98.

Afridi R. J. (1999): Productive and reproductive performance of Holstein Friesian cattle in North West Frontier Province. *Pak. Vet. J.,* **19**(4): 192- 196.

Ahmed A. R., Islam, Khanam S. S. and Ashraf A. (2004): Genetic and phenotypic parameters of milk production traits of crossbred cattle in a selected farm of Bangladesh. *J. Bio. Sci*., **4**(4): 452-455.

Ahmed M. A., Teirab A. B., Musa L. M. A. and Peters K. J. (2007): Milk production and reproduction traits of different grades of zebu x Friesian crossbreds under semi-arid conditions. *Archva. Anim. Breed.,* **50** (3):240-249.

Ali I., Tariq M. M., Bajwa M. A., Abbas F., Isani G. B., Soomro G. H., Waheed A., Khan A. K. (2011): Study on Performance Analysis of Holstein-Friesian Cattle Herd under Semi-Intensive Management at Pishin Dairy Farm Balochistan. *J. Inst. Sci. Tech.* **1**(1): 53-57.

Amasaib E. O., Abu Nikhaila A. M., Fadel Elseed A. N. M. A. and Mohamed H. E. (2008): Effect of season of calving and parity on some productive traits in pure and crossbred cattle in Sudan. *Res. J. Dairy Sci*., **2** (1): 5-8.

Amene F., Tesfu K. and Kelay B. (2011): Study on reproductive performance of Holstein–Friesian dairy cows at Alage dairy farm, Rift Valley of Ethiopia. *Trop. Anim. Health Prod.*, **43**:581–586.

Amin M. R., Habib M. A. and Bhuiyan A. K. F. H. (2013): Reproductive potential of red Chittagong cattle in Bangladesh. *J. Trop. Reso. Sus. Sci.,* **1**: 71-86.

Ansari-lari. M., Rezagholi M. and Reiszadeh M. (2009): Trends in calving ages and calving intervals for Iranian Holsteins in Fars province, southern Iran, *Trop. Anim. Health Prod.,* **41**: 1283–1288.

Arthur H. G. (2001): veterinary reproduction and obstetrics 8th ed., w. b. sounders company, Philadelphia.

Asseged B. and Birhanu M. (2004): Survival analysis of calves and reproductive performance of cows in commercial dairy farms in and around Addis Ababa, Ethiopia. *Trop. Anim. Health Prod., **36**: 663-672.*

Atil H. (2000): Genetic relationship between days open and days dry with milk yield in a herd of Holstein Friesian cattle. *Archva. Tierz., Dumm.,***43** (6): 583-590.

Avendaño-Reyess L., Fuquay J. W., Moore R. B., Liu Z., Clark B. L. and Vierhout C. (2010): Relationship between accumulated heat stress during the dry period, body condition score, and reproduction parameters of Holstein cows in tropical conditions. *Trop. Anim. Health Prod.*, **42**: 265–273.

Bahonar A. R., Azizzadeh M., Stevenson M. A., Vojgani M. and Mahmoudi M. (2009): Factors Affecting days open in Holstein Dairy Cattle in Khorasan Razavi Province, Iran; A Cox Proportional Hazard Mode. *J. Anim. Vet. Adv*., **8**: 747-754.

Bailie J. H. (1982): Management and economic effects of different levels of oestrus detection in the dairy herd. *Vet. Record*, **110**(10): 218-221.

Bajwa I. R., Khan M. S., Khan M. A. and Gondal K. Z. (2004): Environmental factors affecting milk yield and lactation length in Sahiwal cattle. *Pak. Vet. J*., **24**(1):23-27.

Belay D., Yisehak K. and Janssens G. P. J. (2012): Productive and reproductive performance of Zebu X Holstein-Friesian crossbred dairy cows in Jimma town, Oromia, Ethiopia. *Global Vet*., **8** (1): 67-72.

Besufekad j. (2008): Reproductive and lactation performance of Holstein –Friesian cows at Holeta bull dam station. MSc thesis submitted to the school of graduate studies of Addis Ababa University.

Bilal M., Younas M., Babar M. E. and Yaqoob M. (2008): Productive performance of Holstein Friesian kept in Baluchistan, Pakistan. *Pak. J. Agric. Sci.,* **45**(2): 254-258.

Birhanu A., Diriba L. and Iyob I. (2013): Study of bovine mastitis in Asella government dairy farm of Oromia Regional state, South Eastern Ethiopia. *Int .J. Crr. Res. Aca. Rev*., **1** (2):134-145.

Carvajal- Hernández M., Valencia H. E. R. and Segura C. J. C. (2002): Duración dela lactanciay producción deleche devacas Holstein en el Estado deYucatán, México. *Rev. Biom*., **13**(1): 25-31.

CSA (Central Statistical Agency) (2009): Agricultural Sample Survey. Addis Ababa, Ethiopia.

CSA (Central Statistical Agency) (2010): Livestock and livestock characteristics. Agricultural sample survey. *Stat. Bull*. **2**(468):107

CSA (Central Statistical Agency) (2012/13): Report on efficiency of cattle and buffalo in and around Darbhanga, livestock and livestock characteristics. Agricultural sample survey.

Dabdoub S. A. M. (2009): Milk production and reproductive efficiency in Friesian and Friesian X Sharabi Cows. *Al. Anbar J. Vet*. Sci., **2**: 48-54.

Dayyani N., Karkudi K., Bakhtiari H. (2013): Reproductive performance definition in dairy cattle: affective factors. *Int. J. Adv. Bio. Biom. Res*., **1**(11):1392-1396.

DZARC (Debre Zeyt Agricultural Research Center): Debre Zeyt Agricultural Research Center 2008 Annual Report.

Epaphras A., Karimuribo E. D. and Msellem S. N. (2004): Effect of season and parity on lactation of crossbred Ayrshire cows reared under coastal tropical climate in Tanzania. *Livest. Res. Rur. Dev*., **16**(6). Available at http://www.lrrd.org/lrrd16/6/epap16042.htm

Esslemont R. J and Peeler E. J. (1993): The scope for raising margins in dairy herds by improving fertility and health. *British J. Vet*., **149**: 539.

FAO (Food and Agriculture Organization of the United Nations) (2005): Rome, Italy.

Felleke G. and Geda G. (2001): The Ethiopian dairy development policy: a draft policy document. Addis Ababa, Ethiopia: Ministry of Agriculture/ AFRDRD/AFRDT Food and Agriculture Organization/SSFF.

Fikre L. (2007): Reproductive and lactation performance of dairy cattle in the Oromia Central highlands of Ethiopia with special emphasis on pregnancy period. Doctoral thesis Submitted to Department of Clinical Sciences, Swedish University of Agricultural Sciences.

Gabriel H. K, John C. M, Trail M.Y, Kurtu G.W, Frank M. A and Jeffrey D. (1983): Crossbred dairy cattle productivity in Arsi Region, Ethiopia. ILCA .Research Report 11.

Gadmade S. S (1999): Studies on factors affecting performance of Tharparkar, Jersey and Jersey × Tharparkar crossbred cows. M.Sc. Thesis submitted to Marathwada Agricultural University, Parbhani.

Gaur G. K (2007): Environmental Factors affecting various performance traits of Holstein Friesian × Sahiwal Cattle. *Ind. J. Dairy Sci*., **54**:209 -213.

Gebeyehu G., Kelay B. and Abebe B. (2007): Effect of parity, season and year on reproductive performance and herd life of Friesian cows at Stella private dairy farm, Ethiopia. *Livest. Res. Rur. Dev*., **19**(7). Avlable at http://www.lrrd.org/lrrd19/7/gosh19098.htm

Gebre W. A., Alemayehu M. S. Demeke S. D., and Tadesse A. (2000): Status of dairy research in Ethiopia. In The role of village dairy co-operatives in dairy development. Smallholder Dairy Development Project (SDDP) Proceeding, Ministry of Agriculture (MOA). Addis Ababa, Ethiopia.

Gebrekidan T. W., Zeleke M. Z. and Gangwar S. K. (2012): Reproductive and productive performance of dairy cattle in central Zone of Tigray, northern Ethiopia. Int. *J. Adv. Bio. Res*., **2**(1):58-63.

Gifawosen T., Alemu G., Azage T., Diediou M. L. and Hegde B. P. (2003): Study on reproductive efficiency of Boran and its crosses at Holetta research farm: Effect of genotype, management and environment. *Ethop. J. Anim. Prod*., **3**: 89-108.

Gizaw K., Mulugeta K., Tesfaye M. and Sisay E. (2011): Comparative reproductive performance of Horro (Zebu) with Horro x Friesian and Horro x Jersey females in sub humid environments of Bako. *Livest. Res. Rur. Dev.*, **23** (8). Available at http://www.lrrd.org/lrrd23/8/Kebe23171.htm

Gwaza D. S., Okwori A. I., Abu A. I. and Fombah E. M. (2007):Retrospective study on reproductive and dairy performance of Holstein-Friesian on zero grazing in the western high land regions of Cameroon. *Livest. Res. Rur. Dev*., **19**(57). Available at http/www.cipav.org.co./irrd/19/4/gwaz19057.htm

Habib M. A, Bhuiyan A. K. F. H., Bhuiyan M. S. A., Khan A. A. (2003): Performance of Red Chittagong Cattle in Bangladesh Agricultural University Dairy Farm. Bangladesh. *J. Anim. Sci*., **2**:101-108.

Habib M. A. (2011): Analysis of Red Chittagong Cattle Genotype in Nucleus Breeding Herd. Ph.D. Dissertation, submited to Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh.

Habtamu L., Kelay B., and Desie S. (2010): Study on the reproductive performance of Jersey cows at Wolaita Sodo dairy farm, Southern Ethiopia. *Ethop. Vet. J.,* **14**: 53-70.

Haile A, Joshi B. K, Ayalew W., Tegegne A., Singh A. (2009): Genetic evaluation of Ethiopian Boran cattle and their crosses with Holstein Friesian in central Ethiopia: reproductive traits. *J. Agric. Sci*., **147**: 81–89.

Hammoud M. H., El-Zarkouny S. Z. and Oudah E. Z. M. (2010): Effect of sire, age at first calving, season and year of calving and parity on reproductive performance of Friesian cows under semiarid conditions in Egypt. *Archiva. Zoo. Technica.,* **13:** 60-82.

HARC (Holeta Agricultural Research Center) (2008): Holeta Agricultural Research Center 2008 Annual Report.

Hassan F. and Khan M. S. (2013): Performance of crossbred dairy cattle at military dairy Farms in Pakistan. *J. Anim.* Plant. Sci., **23**: 705-714.

Head H. H. (1992): Heifer performance standards, rearing systems, growth rates and lactation. In: Large Herd Dairy Management. Van Horn HH, Wilcox CJ (eds). American Dairy Science Association, Champaign, IL, p. 422.

Holloway G., Nicholson C., Delgado C., Staal S. and Ehui S. (2000): How to make a milk market. A case study from the Ethiopian Highlands. Socio- economic and Policy Research Working Paper 28. Addis Ababa, Ethiopia: International Livestock Research Institute (ILRI).

Hunduma D. (2012): Reproductive performance of crossbred dairy cows under smallholder condition in Ethiopia. *Int. J. Livest. Prod.,* **3**(3): 25-28.

IBC (Institute of Biodiversity Conservation) (2004): The state of Ethiopia's Farm Animal Genetic Resources: A contribution to the first report on the state of the world's animal genetic resources. May 2004, Addis Ababa, Ethiopia.

Jan V., Abebe T., Mengistu N. and Mekdes A. (2010): A capacity needs assessment of dairy chains in the Addis Abeba Milk shed. Wageningen UR Centre for Development Innovation, Wageningen, the Netherlands in collaboration with SNV Ethiopia, Addis Abeba, Ethiopia.

Javed K., Afzal M., Sattar A. and Mirza R. H. (2004): Environmental factors affecting milk yield in Friesian cows in Punjab, Pakistan. *Pak. Vet. J*., **24**(2): 4-7.

Jemila G. and Achenef M. (2012): Effect of lactation stage, pregnancy, parity and age on yield and major components of raw milk in bred cross Holstein Friesian cows. *World. J. Dairy Food Sci*., **7** (2): 146-149.

Kaya I., Uzmay C., Kaya A. and Akbas Y. (2003): Comparative analysis of milk yield and reproductive traits of Holstein-Friesian cows born in Turkey or imported from Italy and kept on farms under the Turkish-ANAFI project. *Ital. J. Anim. Sci*., **2**: 141-150.

Koc A. (2011): A study of the reproductive performance, milk yield, milk constituents and somatic cell count of Holstein-Friesian and Montbeliarde cows. *Turk J. Vet. Anim. Sci*., **35**(5): 295-302.

Komatular S. J., Deshpande A. D., Kulkarni M. D., Kulkarni A. P., Yadau G. B., Ulemale A. H. and Shisode M. G. (2010): Study on the production traits in Holstein Friesian × Sahiwal crossbreds. *Ind. J. Anim. Prod. Mgmt*., **26**(4):177-181.

Lateef M., Gondal K. Z., Younas M., Sarwar M., Mustafa M. I. and Bashir M. K. (2008): Milk production potential of pure bred Holstein Friesian and Jersey cows in subtropical environment of Pakistan. *Pak. Vet. J.,* **28**(1): 9-12.

M'hamdi N., Bouallegue M., Frouja S., Ressaissi Y., Brar S. K. and Hamouda M. B. (2012): Effects of environmental factors on milk yield, lactation length and dry period in Tunisian Holstein cows. Available at http://dx.doi.org/10.5772/50803

Makuza S. M, Mandizha S .M .and Mhlanga F. N. (1999): Environmental factors affecting milk protein yields in Zimbabwean Holstein dairy cattle. *J. Anim. Sci*., **80**: 101-115.

Malik B. S. and Ghei G. C. (1977): some production characteristics of Gir cattle. Indian J. Anim. Sci., **47**: 587.

Masama E., Kusina K. T., Sibanda S. and Majoni C. (2003): Reproduction and lactation performance of cattle in a smallholder dairy system in Zimbabwe. *Trop. Anim. Health Prod.,* **35**: 117-129.

McManus C., Castanheira M., Paiva S. R., Louvandini H., Fioravanti M. C., Paludo G. R., Bianchini E. and Correa P. S. (2011): Use of multivariate analyses for determining heat tolerance in Brazilian cattle. *Trop. Anim. Health Prod*., **43**: 623-630.

McNamara S., Butler T., Ryan D. P., Mee J. F., Dillon P., OÕMara F. P., Butler S. T., Anglesey D., Rath M., Murphy J. J. (2003): Effect of offering rumen-protected fat supplements on fertility and performance in spring-calving Holstein-Friesian cows. *Anim. Reprod. Sci*., **76**: 45-56.

Mekonnen A., Haile A., Dessie T. and Mekasha Y. (2012): On farm characterization of Horro cattle breed production systems in western Oromia, Ethiopia. *Live. Res. Rur. Dev*., **24**(6). Avelable at http://www.lrrd.org/lrrd24/6/meko24100.htm

Million T. and Tadelle D. (2003): Milk production performance of Zebu, Holstein Friesian and their crosses in Ethiopia. *J. Livest. Res. Rur. Dev*., **3**(15). Available at www.lrrd.org/lrrd15/3/Tade153.htm

Mishra S. S and Joshi B. K. (2009): Genetic and non-genetic factors affecting lactation milk constituents and yield traits in Holstein Friesian × Karan crossbred cows. *Ind. J. Dairy Sci*., **57**:69-72.

Mohamed A. M. A., Simeon E. and Yemesrach A. (2004): Dairy development in Ethiopia. EPTD Discussion Paper 123. Pp. 1-58.

Motlagh M. K., Roohani Z., Shahne A. Z. and Moradi M. (2013): Effects of age at calving, parity, year and season on reproductive performance of dairy cattle in Tehran and Qazvin Provinces, Iran. *Res. Opin. Anim. Vet. Sci*., **3**(10): 337-342.

Msanga Y. N., Bryant M. J., Rutam I. B., Minja F. N., Zylstra L. (2000): Effect of enviro nmental factors and of the proportion of Holstein blood on the milk yield and lactation length of crossbred dairy cattle on smallholder farms in north-east Tanzania. *Trop. Anim. Health Prod*., **32**(1): 23-31.

Mulindwa H. E, Ssewannyana E. and Kifaro G. C. (2006): Extracted milk yield and reproductive performance of Teso cattle and their crosses with Sahiwal and Boran at Serere, Uganda. *Uganda. J. Agric. Sci*., **12**(2): 36-45.

Mulugeta A., and Belayeneh A. (2013): Reproductive and lactation performances of dairy cows in Chacha Town and nearby selected kebeles, North Shoa Zone, Amhara Region, Ethiopia. *World J. Agric. Sci*., **1**(1): 8-17

Mureda E. and Mekuriaw Z. (2007): Reproductive Performance of Crossbred Dairy Cows in Eastern lowlands of Ethiopia. *Livest. Res. Rur. Dev*., **19**. Available at http://www.cipav.org.co/lrrd/lrrd19/11/mure19161.htm

Mwatawala H. W. and Kifaro G. C. (2009): Reproductive performance of artificially and naturally bred Boran heifers and cows under ranch conditions in Tanzania. *J. Anim. Plant Sci.,* **4**: 267 – 275.

Nega T. and Sendrose D. (2000): Effect of calving year, season, age and parity classes on production and reproduction performance of Holstein-Friesian cows at Holetta state farm. Pastoralism and agro pastoralism: which way forward. Proceedings of the 8th annual conference of the Ethiopian Society of Animal Production (ESAP), 24-25 August (2000), Addis Ababa, Ethiopia.

Ngodigha E. M., Etokeren E. and Mgbere O. (2009): Evaluation of age at first calving and number of services per conception traits on milk yield potentials of Holstein Friesian x Bunaji crossbred cows. , *Res. J. Anim. Sci.,* **3**(1): 6-9.

Nibret M. (2012): Study on reproductive performance of crossbred dairy cows under small holder conditions in and around Gondar, North Western Ethiopia. *J. Reprod. Inf*., **3**: 38-41.

Niraj K., Alemayehu E., Abreha T. and Hailelule A.Y. (2014): Productive performance of indigenous and Holstein-Friesian crossbred dairy cows in Gondar, Ethiopia. *Vet. World,* **7**(3): 177-181.

Nishida M., Aziz A., Nishida S. and Suzuki J. (2006): number of services per conception of Japanese Black cattle by random regression. *Anim Breed Gent.*, **123**: 56-63.

Novaković Ž., Sretenović L.j., Aleksić S., Petrović M. M., Pantelić V.and Ostojić-Andrić D. (2011): age at first conception of high yielding cows. *Biot. Anim. Hus.,* **27** (3): 1043-1050.

Nuraddis I., Ashebir A. and Shiferaw M. (2011): Assessment of reproductive performanc e of cross breed dairy cattle (Holstein Frisian xZebu) in Gonder Town. *Global Vet*., **6**:56-566.

Nyamushamba G. B, Tavirimirwa B. and Banana N .Y. D. (2013): Non-genetic factors affecting milk yield and composition of Holstein Friesian cows nested within natural ecological regions of Zimbabwe. *J. Anim. Sci*. **2**(5): 102-108.

Nyamushamba G. B., Halimani T. E., Imbayarwo-Chikosi V. E. and Tavirimirwa B. (2014): Comparative evaluation of non-genetic factors affecting milk yield and composition of Red Dane and Jersey cattle in Zimbabwe. *Livest. Rur. Dev.* Available at http://www.springerplus.com/content/3/1/88

Oudah E. S. Z. M., Shalaby N. A. and Mostefa M. A. (2001): Genetic and non genetic factors affecting days open, number of service per conception and age at first calving in a herd of Holstein- Frisian cattle's. *Pak. J. Bio. Sci*., **4**(6):740-744.

Panja P. K. and Taraphder S. (2012): Optimization of age at first calving in Faran Fries cattle. *Explor. Anim. Med. Res*., **1**: 124-130.

Rafique M., Chohan K. R. and Chaudhry Q. Z. (2000): Factors affecting age at maturity and age at first conception in Holstein-Friesian x Sahiwal crossbreds. *Pak. Vet. J.*, **20**(1): 40-42.

Razi K. M. A., Bag M. A. S., Parvez M. M., Kabir M. H. and Asgar M. A. (2010): A study on estimation of conception rate and service per conception in cattle after artificial insemination. *Int. J. Bio. Res*., **2** (7): 25-29.

Sandhu Z. S., Tariq M. S., Balochand M. H., Qaimkhani M. A. (2011): Performance Analysis of Holstein-Friesian Cattle in Intensive Management at Dairy Farm Quetta, Balochistan, Pakistan. *Pak. J. life. Soc. Sci*., **9**(2): 128-133.

Sarkar A., Dhara K. C., Ray N., Goswami A. and Ghosh S. K. (2007): Physical characteri stics, productive and reproductive performances of comparatively high yielding Deshi Cattle of West Bengal, India. *Livest. Res. Rur. Dev*., **19**(9). Available at http://www.lrrd.org/lrrd19/9/sark19122.htm

Sattar A., Mirza R. H. and Ahmad I. (2004): Reproductive efficiency of Jersey cows under subtropical conditions of the Punjab. *Pak. Vet. J*., **24**(3): 129-133.

Sattar A., Mirza R. H. and Latif M. (2004a): Studies on some production traits in Jersey cows. *J. Anim. Plant Sci*. 14: (In press).

Sattar A., Mirza R. H., Niazi A. A. K. and Latif M. (2005): Productive and reproductive performance of Holstein Friesian cows in Pakistan. *Pak. Vet. J*., **25**(2): 75-81.

Shiferaw Y., Merga B. and Tesfu K. (2005): Reproductive disorders of crossbred dairy cows in the central highlands of Ethiopia and their effect on reproductive performance. *Trop. Anim. Health Prod*., **37**: 427-441.

Sintayehu Y., Fekadu B., Azage T. and Berhanu G. (2008): Dairy production, processing and marketing systems of Shashemene–Dilla area, South Ethiopia. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 9. ILRI (International Livestock Research Institute), Nairobi, Kenya. 62 p.

Stadnik L. and Louda F. (1999): The effect of genetic parameters of sire in France on the performance and reproduction of daughters imported to the Czech Republic and calving here. *Czech J. Anim. Sci*., **44**: 433-439.

Suhail S. M., Ahmed I., Hafeez A., Ahmed S., Jan D., Khan S. and Rehman A. (2010): Genetic study of some reproductive traits of Jersey cattle under subtropical conditions. *Sarhad. J. Agri.,* **26**:88-91.

Tadesse M., Thiengtham J., Pinyopummin A., Prasanpanich S. (2010): Productive and reproductive performance of Holstein Friesian dairy cows in Ethiopia. *Livest. Res. Rur. Dev.*, **22** (2):21.

Thakur Y. P., Singh B. P. (2001): Performance evaluation of Jersey × Sindhi crossbred cows. *Ind. Vet. J.* **78**(1):62-63.

Turkyilmaz M. K. (2005): Reproductive Characteristics of Holstein cattle reared in a private dairy Cattle Enterprise in AydÝn. *Tur. J. Vet. Anim. Sci.* **29**: 1049-1052.

Usman T., Guo G., Suhail S. M., Ahmed S., Qiaoxiang L., Qureshi M. S. and Wang Y. (2012): performance traits study of Holstein Friesian cattle under subtropical conditions. *J. Anim. Plant. Sci.*, **22**(2): 92-95.

Usman T., Guo G., Suhail S.M., Ahmed S., Qiaoxiang L., Qureshiand M.S., Wang Y. (2011): Performance traits study of Holstein Friesian cattle under subtropical conditions. *J. Anim. Plant. Sci*., **21**(1): 961-964.

Usman T., Qureshi M. S., Yu Y. and Wang Y. (2013): Influence of various environmenta l factors on dairy production and adaptability of Holstein cattle maintained under tropical and subtropical conditions. *Adv. Environ. Bio.,* **7**(2): 366-372.

Utrera Á. R., Robles R. C. C. and Rodríguez. J. R. G. (2013): Effects of breed, calving season and parity on milk yield, body weight and efficiency of dairy cows under Subtropical Conditions. *Int. J. Anim . Vet. Adv*., **5**(6): 226-232

West J. W. (2003): Effects of heat-stress on production in dairy cattle. *J. Dairy Sci.,* **86**:2131-2144.

Whittier D., Elvinger C. F., Hovingh E., McGilliard M. (2002): Factors influencing the reproductive efficiency of dairy herds in the Dominican Republic. MSc thesis Submitted to Veterinary Medical Science. Angela Renea Billings University.

Yifat D., Bahilibi, W. and Desie S. (2012): Reproductive performance of Boran cows at Tatesa cattle breeding center. *Adv. Bio. Res*., **6** (3): 101-105.

Yohannes A., Azage T. and Tesfu K. (2001): Reproductive performance of crossbred dairy cows at Asella Livestock Research Station, Arsi, Ethiopia. *Ethop. J. Anim. Prod*., **1**: 1-12.

Yosef T. (2006): Genetic and non genetic analysis of fertility traits in holetta and ada'a berga dairy herds Ethiopia. MSc thesis submitted to facility of agriculture .Alemaya University.

Zewdu W., Thombre B. M. and Bainwad D. V. (2013): Effect of non-genetic factors on milk production of Holstein Friesian × Deoni crossbred cows. *Int. J. Livest. Prod.,* **4**:106-112.

8. APPENDICES

Appendix I. Individual Lactation Record Format

NAME OF FARM……………………………………………………………………..

ID NO. ………………………………………………………………………………

Cow's name/ID No. ……………………………………Date of birth.…………………

Breed.

Sire's Name.ID. …………………….Breed………………………………………………

Dam's Name………………………………..ID NO.…………………………Breed……

Date of purchase………………………………Cost of Purchased(Birr)…………………

Date of sold……………………………………To whom………………..Price…Left side

Date of death……………………………………………………

First lactation Second lactation Third lactation Forth lactation

From…………………………. From……………………….. TO…………………………….. TO…………………………… Milked Milked Month Days Liter Month Days Liter SEP OCT NOV DEC JAN FEB	From…………………………. From…………………………… TO………………………………. TO……………………………….. Milked Milked Month Days Liter Month Days Liter
MAR APR MAY JUNE JULY AUG	
TOTAL	

Appendix II . Breeding Record Format

Name of farm…………………………ID NO…………………………Cow's ID NO……………………………………………

Id	Breeding Rest		Breeding Record						Date			Calf		R
No	Date Calved	In heat but Not breed 1 2 3	AI Date	AI No.	AI Date	AI No	AI ate	AI No	Dry off	Due Calf	Date Calved	Sex	I d N O	E M A R K

Appendix III . Daily Insemination Record Format

Serial No	Ear tag	Calving date	Dam No.	Sire code	Date of AI	Semen code	No. of Service	Calving To 1st Service	Body condition score	Remark

Appendix IV . Health record format

Name of farm……………………………………ID NO…………………………………………Cow's ID NO……………………………

VACCINATION							
Rinder pest DATE	CBPP DATE	Anthrax DATE	Black Leg DATE	FMD DATE	Others DATE		
					Diagnosis	Treatment	Observation