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A STUDY ON MILK PRODUCTION AND REPRODUCTIVE PERFORMANCE
OF JERSEY CATTLE BREED AT WOLAITA SODO STATE DAIRY FARM,
SOUTHERN ETHIOPIA

BY

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LIST OF ABBREVIATIONS

AFC	Age at First Service
AFS	Age at First Calving
AI	Artificial Insemination
ARDP	Arsi Rural Development Program
BW	Birth weight
CI	Calving Interval
CSA	Central Statistic Authority
DM	Dry Matter
DRDP	Dairy Rehabilitation and Development Project
EARO	Ethiopian Agricultural Research organization
EPHL	Effective Productive Herd Life
ESAP	Ethiopian Society of Animal Production
FAO	Food and Agricultural Organization
IAR	Institute of Agricultural Research
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
LL	Lactation length
LMY	Lactation milk yield
LTMY	Lifetime milk yield
MOA	Ministry of Agriculture
NAIC	National artificial insemination center
NSC	Number of service per conception
OIE	Office International des Epizootics
PHL	Productive herd life
PPAI	Postpartum Anoestrus Interval
SDDP	Smallholder Dairy Development Program
SNNPR	Southern Nation Nationalities Peoples Region
THL	Total herd life
WADU	Wolaita Agricultural Development Unit
WHO	World Health Organization

WSSDF	Wolaita Sodo State Dairy Farm
WW	Weaning weight
WZFED	Wolaita Zone Finance and Economic Development Department

ABSTRACT

This study was conducted in Wolaita Sodo State Dairy Farm from October 2007 to April 2008 to determine the milk yield and reproductive performance and herd life of Jersey cattle and also potential factors affecting these parameters. The Jersey cattle in the study farm were mainly kept on pasture land and with some supplementary feeds. The data recorded and kept by the farm from 1987 to 2007 were used for the study. Data analysis was performed using descriptive statistics and GLM of SPSS (release 11.05, 2002). The factors considered in the model were year of birth, calving and service; season of birth, calving and service; parity number of dam; source of cattle and sex of calves. The results of this study revealed that the overall mean values of lactation milk yield, lactation length and life time milk yield were 1691.59kg (SE=27.55), 318.42 days (SE=3.92) and 5565.19kg (SE=220.03), respectively. Lactation milk yield and lactation length ($p<0.001$) were significantly affected by year of calving and cattle source. Imported cattle had better lactation milk yield and length than those reared on farm. In addition, lactation length was significantly decreasing with parity number ($p<0.001$). Life time milk yield was also affected by year of calving ($p<0.01$). The overall means of age at first service, age at first calving, calving interval, interval between calving and effective service and number of services per conception were 722.24 days (SE=36.4), 1035.21 days (SE=12.59), 450.09 days (SE=6.60), 174.68 days (SE=8.61) and 1.79 (SE=0.06). All the reproductive performance traits were significantly influenced by year of birth, calving or service depending on the type of trait. In addition, age at first service was significantly lower in imported cattle while calving interval was lower in on-farm raised cattle ($p<0.001$). Calving interval and the interval between calving and effective service were decreasing significantly with parity number ($p<0.001$). Number of services per conception was significantly lower in short rainy season ($p<0.05$). The overall mean values for total herd life, productive herd life and effective productive herd life were 2983.74 days (SE=67.98), 2310.11 days (SE=296.91) and 1663.15 days (SE=55.09), respectively. In this case, year of birth had significant effect on total ($p<0.001$) and effective productive ($p<0.01$) herd life. Imported cattle had significantly longer total ($p<0.01$) and productive herd life ($p<0.05$) than the on-farm reared cattle. The overall mean values for birth and weaning weight were 22.87 kg (SE=0.17) and 108.88 kg (SE=0.67), respectively. Both traits were influenced significantly by year of birth, season of birth, sex of calves and parity number of the dam. Calves born in the long

rainy season had better birth and weaning weight than the others. There was a trend of increased birth weight of calves as the parity number of the dam increased. From this study it can be concluded that Jersey cattle kept in the study farm had poor milk yield and reproductive performance. The herd life, productive herd life, effective productive herd life and birth and weaning weight of Jersey cattle found in this study are in general good. Inconsistency in management and variations in climatic conditions seem to determine the values for the different traits considered in this study suggesting the need to improve the overall herd management at the study farm.

Key words: birth weight, dairy, herd life, Jersey, milk yield, reproductive performance, weaning weight

1. INTRODUCTION

The majority of the Ethiopian population (about 80%) is engaged in smallholder agriculture, which is responsible for 96% of the total agricultural output (Astatke, 1993; Sayers, 1993). Livestock is an important and integral component of the Ethiopian agricultural system and plays a significant and sometimes decisive role in the provision of food, power and income generation both at the household and at national levels (Tsigeyohannes, 2000; Alemu and Zinash, 2001). The livestock population in Ethiopia is estimated to be 44.3 million cattle, 25.6 million sheep, 23.4 million goats, 3.3 million camels and 35.7 million poultry (CSA, 2004). In Ethiopia, the contribution of livestock and livestock products to the agricultural economy is about 30% and to export earnings is about 19 % (Agajie *et al.*, 2002). The majority of the cattle population (85%) in the highlands is two or more years old and 45% of these are cows kept for milk production purposes. However, only 16% of the cows are lactating in a production year (Tsigeyonnes, 2000).

Despite the huge potential, the contribution of livestock in general and cattle in particular to national and household economy is poor. This is evidenced by the low per capita milk production when compared even with neighboring countries such as Kenya, Sudan, Tanzania, Uganda and Somalia (ESAP, 1999). The average corrected annual milk yield of lactating cows is estimated at 427 liters (ILCA, 1993; Adugna, 1994). The per capita milk consumption from domestic source for the country for the year 2000 is 15.3kg from cows alone and 19kg when other milk producing species are considered (Zegeye, 2003). Our annual per capita consumption of 19 liters is 49% below the African coverage (Azage *et al.*, 2006). Thus, Ethiopia imported large volume of milk and products in the form of food aid and commercial imported in order to meet the increased local demand (Alemu and Zinash, 2001).

The major contributing factors that have impeded the full exploitation of the cattle resource in Ethiopia include seasonality in availability (quantity and quality) of nutrition, the low genetic potential for production of the indigenous breeds, the occurrence of diseases and parasites, poor management systems and a range of socio-economic factors (Azage, 1989).

The projection of human population in Ethiopia shows an increasing trend with alarming rate which in turn increases the demand for food especially of animal origin. Thus, the role of livestock in food security and food self-sufficiency is becoming important (Hadera, 2002). The first step to be taken, in seeking a new balance in the development of the livestock, is a careful evaluation of the viability of each breed or type of animal and the production system under which they are maintained in terms of their contribution to the economy, ecological and socio-political sustainability (Girma, 2004). Furthermore, a breeding plan, which takes into account production systems and the merits and demerits of indigenous breeds, is essential (Hegde, 2005). Crossbreeding programs are considered to be better options to combine the adaptability to local conditions of indigenous animals and the high milk production potential of temperate breeds (Tesfaye, 1988; Maule, 1990). However, as the exotic gene level increases, it is presumed that the corresponding management situation should be improved as well in order to maintain the cows and support efficient production and reproduction (Yoseph, 1999).

Generally, most genetic improvement strategies of cattle in Ethiopia has been brought through modifying the breed composition of local populations, either by introducing genes from an external source or through direct importation of exotic cattle from other countries. The immediate increase in production from such types of development programs has a definite attraction (De Leeuwe *et al.*, 1991). During the past four decades, the country has imported considerable numbers of exotic dairy cattle. Obviously, the climate, feeding and management in Ethiopia differ markedly from those in the natural habitat of the imported animals. However, it has been realized that high levels of performances could also be obtained from purebred European cattle in most tropical environments (Vaccro, 1973; FAO, 1979). Cunningham and Syrstad (1987) stated that from the experience obtained throughout the tropics, the Jersey, characterized by small mature size, low maintenance requirement, high milk fat content and good reproductive performance; has often been selected for tropical research and development program, which could have a definite attraction in the Ethiopian highland environments. Encouraged by this fact, the Wolaita Sodo State Dairy Farm was established with the objective of multiplication and distribution of Jersey sires to smallholder farmers. Nowadays the farm also supplies bulls to national artificial insemination center and various organizations for crossbreeding with indigenous cattle.

The Farm has been operating with Jersey cattle for the last 21 years and information on different traits of the breed has been recorded. However, detailed scientific study about the breed was not made on performance parameters (including the lifetime traits).

In view of this the objectives of the present study are:

- To evaluate milk yield, reproductive performance and herd life of Jersey cattle maintained at Wolaita Sodo State Dairy Farm;
- To determine factors affecting the performance of Jersey cattle at Wolaita Sodo State Dairy Farm.

2. LITRATURE REVIEW

2.1. Dairy production systems in Ethiopia

Dairy production is a biologically efficient system that converts large quantities of roughage to milk, which is an important component of human diet as it has essential amino acids that are most likely to be deficient in diets based on vegetable protein. For farmers, peasants and nomads it is one of the fundamental sources of income and subsistence. Improving milk production, therefore, is an important tool for improving the quality of human life (Rehrahie *et al.*, 2002).

Development of the dairy industry in most African countries is crucially dependent on production by smallholders, each owning a small number of cows. Experience throughout the world has shown that the choice of breed for these smallholder enterprises is a key determinant of both biological efficiency and profitability. In a few rural areas where integrated agricultural development projects have been implemented through individuals, producer cooperatives and peasant associations, there is great potential for dairy development (Kiwuwa *et al.*, 1983).

Based on climate, land holdings and integration with crop production as criterion three dairy production systems are recognized in Ethiopia; namely the rural dairy system which is part of the subsistence farming system and includes pastoralists, agro-pastoralists, and mixed crop-livestock producers; the peri-urban; and urban systems (Ketema,2000;Zegeye, 2003;Dereje *et al.*,2005). The first system contributes to 98%, while the peri-urban and urban dairy farms produce only 2% of the total milk production of the country (Ketema, 2000).The rural system is non-market oriented and most of the milk produced in this system is retained for home consumption (Tsehay, 2001).The peri-urban milk system includes smallholder and commercial dairy farmers in the proximity of Addis Ababa and other regional towns. This sector owns most of the country's improved dairy stock (Tsehay, 2001).This production system is now expanding in the highlands among mixed crop-livestock farmers, and serves as the major milk suppliers to urban market (Gebrewold *et al.*, 2000).Urban dairy farming is a system involving highly specialized, state or businessmen owned farms, which are mainly concentrated in major cities of the country. Currently, a number of smallholder and commercial dairy farms are emerging mainly in the

urban and peri-urban areas of the capital (Azage, 2003) and most regional towns and districts (Nigussie, 2006).

2.2. Factors affecting the performances of cattle

2.2.1. Environmental conditions

Agro-climatic conditions

Diverse agro-climatic conditions (temperate, humidity, wind conditions, soil types, variations in feed supply and other factors) have shaped genetic differences among animals with common ancestors and similar origins (Nigatu *et al.*, 2004). Livestock production in all tropical countries is affected by climate in two ways. First, by a direct influence on the animal and second by indirect effects on the animals' environment. Climatic stress depresses appetite, reduces feed intake and grazing time, and then it affects productivity as measured by growth and milk production. For example, temperate-type Holstein cattle have a thermal comfort zone for milk production within the range -5 to 20°C, with optimal production at around 10°C and with a critical temperature range of 21-27°C. However, the critical temperature, after which milk production declines, is somewhat higher in some other temperate type breeds, such as the Jersey (30°C) and the Brown Swiss (35°C) and higher still in tropical breeds. The butterfat content of the milk of temperate cow declines slowly until the ambient temperature reaches 29°C and then rises (Payne and Wilson, 2003). Solar radiation may not only increase the heat load on the animal but also directly affect the skin, causing skin cancers and other photosensitive disorders which have negative impact on animal performances (Azage, 1989; Payne and Wilson, 2003).

The effect of climate on livestock is reflected in their grazing behavior. The length of daytime grazing of cattle apparently varies according to the degree of climatic stress, the breed and type of cattle utilized, and the quantity and quality of the pasture available. When high-grade *Bos taurus* cattle are grazed in a humid tropical climate the length of daylight grazing is radically curtailed and confined almost entirely to early morning and late afternoon periods, and the length of the night grazing period fluctuates according to the degree of climatic stress. High ambient

temperature affects also food and water consumption and rumination. Rumination ceases practically in *Bos indicus* cattle, if the ambient temperature is 40°C or above (Payne and Wilson, 2003).

Management practices

Livestock diversity in developing countries is embedded in traditional livestock rearing practices. Communities manage their livestock based on a wide range of indigenous knowledge, which is in turn determined by socio-economic, cultural and environmental conditions. It requires taking the views and objectives of local people into account; thereby supporting the activation of the social processes involved in decision-making and the adoption of sustainable livestock management solutions (Raintree and Hoskins, 1990). According to Bruke (2003), among the gaps to undertake evaluation of the domestic animal genetic resource are lack of understanding of the traditional husbandry practices in the context of indigenous knowledge; and the availability of very little information on the responses of most local breeds to improved husbandry practices.

Changes in the management of animals bring about change in their biological characteristics and outputs (Nigatu *et al.*, 2003). Therefore, the distribution of crossbred animals to farmers practicing traditional type of management system should be accompanied with a package of improved management knowledge and skills (Weldemeskel and Berhanu, 2000). As the exotic gene level increases, it is presumed that the corresponding management situation should be improved as well (Yoseph, 1999).

Low total milk output, reduced milk production per cow and reduced reproduction performance are among the consequences of inadequate management. An insufficient and unbalanced nutrient supply and disease intensification could be among the major contributing factors (Yoseph *et al.*, 2003). However, as farmers have various coping strategy to different problems, there is scope for improvement and for scaling up the traditional management skills (Alganesh *et al.*, 2004).

Feeds and feeding

Improved livestock production requires the provision of all known essential nutrients in adequate quantity (Dirba *et al.*, 2001). All physiological processes (milk production, reproduction, maintenance and growth) increase the cow's nutrient requirement. Therefore, dairy farmers have to consider production requirements on top of maintenance requirements (Zelalem *et al.*, 2003). The provision of adequate quantities of clean drinking water is also a major prerequisite for satisfactory milk production, growth and animal health (Little and Shaw, 1978), but the minimum amount required is affected by various factors such as ambient temperature, production, weight and type of feed. Heavy temperate breed cows have a higher water intake (60-90 lit/day) than Zebu cows (25 lit /day). As estimated by Andreas *et al.* (2004), crossbred cows consumed daily 52.6 kg water, including the water in feed.

In Ethiopia, 90% of the feed available for animals come from native pasture (Tesfaye *et al.*, 2000) and crop residues (Daniel, 1990). The quality and quantity of native pasture vary with season and seasonality of pasture growth varies according to geographical location, altitude and rainfall pattern (Tesfaye *et al.*, 2000). The feed shortage is particularly apparent during the dry season, when animals have lost weight and productivity. In Ethiopian highlands, the feed requirement to adequately maintain the indigenous livestock population is estimated to be 55 million tones DM, which is much larger than what is estimated to be produced or available (40.1 million tones DM). Young and growing heifers suffer most during periods of feed shortage with severe effects on their body growth, reproductive development and subsequent fertility (Azage *et al.*, 2000). The use of oil seed cakes and other industrial byproducts as livestock feeds is constrained by the cost and availability. Although forage legumes and fodder trees are widely grown, the feeding practices still remain a problem (Tsegaye *et al.*, 2002).

Diseases

Animal disease is one of the important constraints to increased productivity of food animals in all parts of the world (Radostits *et al.*, 1994). The disease situation is worst in countries like Ethiopia, where animal diseases are wide spread in all agroecological zones and complete control

of most epidemic diseases is not yet effected (Sintayehu, 1999; Mekonnen *et al.*, 2000). Out of the 15 OIE List-A diseases known for their rapid spread and serious socioeconomic or public health consequences, and which affect international livestock trade, eight of them are endemic in the country (Foot and Mouth disease, Contagious Bovine Pleuropnumonia, Pest des Petits Ruminants, Rift Valley Fever, Lumpy Skin disease, Sheep Pox, African Horse Sickness and Newcastle Disease). The presence of livestock diseases apart from affecting the efficiency of production hampers export market development as a result of frequent bans by importing countries (Belachew and Jemberu, 2003). Other diseases such as Contagious Caprine Pleuropnumonia,, Antrax, blackleg, haemorrhagic septicaemia, trypanosomiasis, bovine tuberculosis, streptothricosis and brucellosis are also common in the country. External parasites such as lice, keds and ticks are also abundant and are major causes of rejection and down grading of hides and skins in international trade. There are also diseases specific to intensified type of production systems such as mastitis, lameness, infertility, tuberculosis and reproductive wastage (Alemayehu *et al.*, 1999; WHO, 1993). The overall fertility of cattle population can be significantly increased by improving the level of management and control of contagious diseases (Tsegaye *et al.*, 2002).

2.2.2. Genetic make-up

Neither all animals nor all breeds are equal in performance. There are differences between and within breeds in production, fertility, size, disease resistance and the ability to withstand stress. For instance, indigenous cattle in the tropics (*Bos indicus*) are well adapted to the local conditions, but their milk production potential is less than the *Bos taurus* in temperate regions (Norman *et al.*, 1981). Two different types of factors are responsible for the differences between individual animals within a breed. The genetic and environmental factors interact, so that the total variations between animals are equal to the sum of the effects of the entire environment and genetics, and the interaction between them (Syrstad, 1990).

2.3. Cattle breeding in Ethiopia

In Ethiopia, there are a total of 23 recognized indigenous cattle breed types, which are classified into three categories based on their morphological features: Small East African Zebu, Large East African Zebu and Hump less Shorthorn (Workineh *et al.*, 2004). Only 6 of the 23 breed types have a fair description of their physical appearance, indications of their levels of production, reproduction and genetic attributes. Cattle breeds in general are different in production, fertility, size, disease resistance and the ability to withstand stress. However, indigenous cattle in the tropics (*Bos indicus*) are well adapted to the local conditions, but their milk production potential is less than the *Bos taurus* in temperate regions. Therefore, in the tropics, dairying on the basis of indigenous cattle alone would not be a quite and suitable option to meet the increasing demand for milk and milk products. The most favored alternative so far has been crossbreeding to incorporate the hardiness of *Bos indicus* with the productive capacity of *Bos taurus* (Norman and Defilcho, 1980).

Crossbreeding and/or upgrading of cattle in Ethiopia especially for dairy purpose have been done for the last 30 years (Gifawosen *et al.*, 2003). MOA, IAR, ARDP, Alemaya University of Agriculture and ILRI have been involved in crossbreeding activities for the last 20-30 years in Ethiopia. All breeding activities were focused on two-way crossing. From these crossbreeding studies and experiences it was concluded that F₁ crosses were found to be better in performance and adaptation under low standard of management husbandry practices. However, the sustainability of the improvement calls for continuous supply of F₁ crossbred or AI services, which may be difficult for remote areas. This is because backcrossing or inter se mating reduces their heterozygosity (Hohenboken, 1985). Bull service stations would be the better option than AI service in areas where road accessibility is a restriction (SDDP, 1999). Some of the exotic cattle breeds that have been introduced into Ethiopia mainly for crossbreeding purposes include Friesian, Jersey, Simmental, Aberden Angus, Ayrshire Charolais, Hereford, Santa Gertudis, Brahman, and Brown Swiss. Only very few of these or their crosses are seen either in rural or urban area. Some were limited to research stations while others have been and are still being distributed to farmers (Kassahun, 2004). Semen from the Friesian breed is widely used for upgrading the local cattle. Because of certain valuable traits of Jersey, i.e. small body size and

high milk fat content; densely populated areas with shortage of grazing land and feed resources have also started using Jersey semen. Production of semen from crossbred animals including Friesian with Fogera, Boran, Barka and Arsi has also been undertaken and some have been distributed to the different parts of the country. However, this efforts are constrained by poor heat detection, poor follow up on fertility problems and lower culling intensity (Tesfaye *et al.*, 2000).

In situation where the environmental condition is not favorable to keep pure exotic temperate or crossbred animals, developing local breeds is also equally important because an animal that is genetically adapted to its environment will be most productive at the lowest cost and be sustainable in the long term; support food, agriculture and cultural diversity; and be most effective in achieving local food security objectives (Girma, 2004).

2.4. Jersey cattle breed and its crosses

2.4.1. Origin and general characteristics

The Jersey breed originated from the Island of Jersey, a small British island in the English Channel off the coast of France. The breed was known in England as early as 1771 and was regarded very favorably because of its milk and butterfat production. They were first introduced into the United States in 1850, and soon became one of the most popular breeds. They are excellent grazers and perform well in intensive grazing programs. Jerseys are adaptable to many environments and are now found throughout the world. They are more tolerant of heat than larger breeds. With an average weight of 900 pounds, the Jersey produces more pounds of milk per pound of body weight than any other breed. Most Jerseys produce far in excess of 13 times their body weight in milk in each lactation. Jersey cattle are smallest of the dairy breeds. Jersey cows usually have an extreme weight range of between 800 and 1200 pounds, but medium-sized cows are usually preferred. Jersey bulls, while as compared to the other dairy breeds, are extremely masculine. They usually range in weight from 1200 to 1800 pounds, but as in the females, medium weights are usually preferred. The color in Jerseys may vary from a very light gray or mouse color to a very dark fawn or a shade that is almost black. Both the bulls and females are

commonly darker about the lips and about the head and shoulders than on the body. Most breeders slightly prefer the medium shades of color to the extremes, but nearly all of them realize that type and producing ability are far more important than the shade of color or whether the color is solid or broken (Briggs and Brigga, 1980).

Jersey crosses are superior to Friesian crosses on fat corrected milk basis per unit metabolic weight. Further, when the market demand for butterfat (cooking oil) is high in urban areas and in rural areas where marketing of fluid milk is difficult, the Jersey breed has added advantages. By and large, the tropical climate tends to favor smaller animals because of their comparatively larger surface area to lose heat and lower maintenance requirements. In many places reducing the weight of the cow is equally important with increase of milk production. Many comprehensive reviews concluded the superiority of Jersey crosses over Friesian crosses in several of the productive and adaptive traits. A recent report from Assela farm, confirming the overall superiority of Jersey crosses is an eye opener to the planners and animal scientists. When the aim of the breeding plan is optimum milk production and not maximum milk production, the Jersey breed is better than the Friesian to improve the local cows (Hegde, 2005).

2.4.2. Reproductive performance

One measure of productivity is reproductive performance. And various parameters can be used to quantify reproductive performance: age at first service, age at first calving, calving interval, and number of service per conception.

Age at first service (AFS)

AFS is a signal of heifer getting ready for reproduction and production and it is the age at which heifers attain body condition and sexual maturity for accepting service for the first time. It influences both the production and reproductive life of the female through its effect on her lifetime calf crop. Mangurkar *et al* (1985), Rath and Patro (1988) and Bashir *et al.* (2007) found AFS for Jersey cattle to be 556.6 days, 502.61 days and 748.7 days, respectively. The effect of year of birth on age at first service was significant in the findings of Mungurkar *et al.* (1985) and Smith *et al.* (1989). According to management conditions, the average age of Jerseys at which the first heat appears is 13 months (Hafez and Hafez, 2000).

Age at first calving (AFC)

AFC is a better practical indicator of cow reproduction, if animal age is known. It is dependent up on age at successful conception (sexual maturity) and not necessarily on age at puberty (Albero, 1983). Early AFC is very important for any dairy herd; it reduces the cost of rearing, increases productive life and shortens generation interval thereby enabling early progeny (McDowell, 1976). First calving marks the beginning of cows' productive life. The good cows are those that have their first calf at an early age and calve regularly.

Various reports by Arora and Sharma (1983), Mangurkar *et al* (1985) and Jain and Khan (1990), Njubi *et al.* (1992) and Katyega (1988) showed AFC of Jersey cattle to be 835.6, 873.8, and 813 days, 930 days and 987 days respectively.

There was non significant influence of season of birth in the reports of Jain and Khan (1990), Njubi *et al.* (1992), Enyew *et al* (1999), Melaku (1994) and Mekonen and Goshu (1996). On the

other hand, Million *et al.* (2006) and Mekonen (1987) reported significant effect of season of birth on age at first calving. Significant effect of year of birth on age at first calving was found in Jersey cows and Jersey and their crosses by Yazdani *et al.* (1993), Njubi *et al.* (1992), Enyew *et al.* (1999) and Kiwuwa *et al.* (1983). However, Azage (1981) reported that year of birth had no significant effect on the age at first calving in both lowland and highland heifers in Ethiopia.

Calving interval (CI) and calving to effective service Interval (ICES)

The CI is the period between two consecutive parturitions and ideally should be in the region of 12 to 13 months. It is a function of days open (period from calving to next conception) and gestation length. The CI is thus closely matched to a yearly production cycle and influences the amount of milk a cow is likely to produce in a given period (Kiwua *et al.*, 1983). Long CI influences the reproductive efficiency of dairy cows through reduced number of replacement stock and milk production. Calving interval is affected by the length of time it takes the uterus to involute, PPAI (postpartum anoestrus interval), regularity and fertility of oestrus following parturition, the fertility of a bull or semen used, accuracy of heat detection, occurrence of silent ovulations and management decisions on how soon to breed following parturition and gestation length (Igboeli, 1973; Mukasa- Mugerwa and Azage, 1991). To keep the calving interval as short as possible, cows should be served at the first heat period after 40 days provided the cow is physically ready. After that the conception rate will decline (Chamberlain, 1989).

Studies in India reported CI of Jersey cattle to be 422.8 days (Arora and Sharma, 1983), 414.6 days (Mangurkar *et al.*, 1985), 440.33 days (Rath and Patro, 1988), and 453.02 days (Ramachandraiah *et al.*, 1990), 408 days (Njubi *et al.*, 1992), 426.6 days (Katyega, 1988) and 468.4 days (Dutt *et al.*, 1988). There were findings of Enyew *et al.* (1999) (435.9 days) and Million *et al.* (2006) (417.02 days) for F₁ Jersey crosses in Ethiopia.

Year of last calving and parity of dam had significant effects on calving interval while seasonal effect was not significant in the findings by Enyew *et al.* (1999). The significant effect of year of calving was reported by Matsoukas and Fairchild (1975); Njubi *et al.* (1992), Mekonnen and Goshu (1996), Yohannes *et al.* (2001), Million *et al.* (2006) and Kiwuwa *et al.* (1993). On the contrary, significant effects of season of calving were found by (Njubi *et al.* (1992) and

Mangurkar *et al.* (1985). Kefena *et al.* (2006) reported that neither year of calving nor season of calving had significant effect on calving interval. Million (1997) and Kuwuwu *et al.* (1983) reported shorter calving intervals at later parities. Mukasa-Mugerwa and Azage (1991) indicated that ruminants gain weight and improve body condition during the period of feed availability. Cow in better body condition have shorter CI than their thinner contemporaries.

The interval between last calving and the effective insemination was 199.2 days and 285 days by reports of Melaku (1994) and Amene (2006) in Ethiopia respectively. Variation among parity was found by Ashebir (1992) and Enyew (1992). Contrary to this Mekonen and Goshu (1987) found non-significant effect of parity on the trait. Non-significant effect of season on the trait was reported by Mekonen and Goshu (1987) and Enyew (1992). On the contrary, significant seasonal effect was reported by Yimam *et al.* (1997) and Ashebir (1992).

Number of service per conception (NSC)

It is the number of services or inseminations per final pregnancy. A low service per conception is a very important economic factor both in natural breeding and AI. For any AI center a service per conception figure exceeding 2.0 means poor (Sethumadhavan, 2004). The number of services required for a cow to conceive is a better measure of fertility than calving interval, as it is less influenced by the farmer's decisions. It is easy to calculate for controlled mating but gives no information on those cows failing to conceive (Chamberlain, 1989). According to Mangurkar *et al.* (1985) and Niubi *et al.* (1992), an average of 2.20 AI per conception was recorded for Jersey cattle. Lower and higher service per conception was reported by Singh and Mishra, 1980) (2.0) and Sekerden (1996) (3.3) respectively.

The significant effect of year of service and the insignificant influence by parity number was observed by Niubi *et al.* (1992) and Assegid and Birhanu (2004). Enyew *et al.* (1999) reported significant effects of parity on number of services per conception. McDowell *et al.* (1976) suggested reasons such as high environmental temperature and efficiency of inseminators that could contribute to lower values of number of services per conception.

2.4.3. Herd life

Profitability among dairy animals depends upon the lifetime performance, measured in terms of traits like herd life and productive life. Various definitions of longevity or herd life have been used in several studies. Examples are average age at disposal (Hoque and Hodges, 1981) number of lactations initiated in the herd beginning from first lactation (Miller *et al.*, 1967; Hargrove *et al.*, 1969; Norman *et al.*, 1981).

Productive life has been defined in most studies as the difference between date of first calving and date of disposal (Chauhan *et al.*, 1993). Late disposal age or long productive life is advantageous, if good levels of performance in other respects accompany it. Disposal age varies depending on criteria and type of predominant culling, origin of animals and breed differences (McDowell, 1985; Vaccaro, 1990). The success of dairy and/or beef farm is determined by the efficiency of rearing replacement heifers to their reproductive age. Most data suggest that it is advantageous to breed heifers as early as it is physiologically feasible since it results in earlier age at first calving, which in turn result in increased number of calves produced in lifetime. Age at puberty and first calving influence response to selection and lifetime productivity of cows (Singh *et al.*, 1988). Productive lives of 48.25 months by Narasemh and Mohan (1996) and 36 months by Njubi *et al.* (1992) were reported. Since productive herd life does not reflect the length of idle time of the cow after first calving, effective productive herd life is introduced. It is estimated by multiplying the number of calves born per cow by 365 days. There was scarcity of previous works in Jersey cattle in this regard. However, there was a report indicating that year of birth had significant effect on productive herd life of Holstein cattle (Gebeyehu *et al.*, 2007) and effective productive herd life of crosses of Friesian and Boran cattle (Gebeyehu, 2005). On the other hand, non significant effect of year of birth on length of productive life was reported by Njubi *et al.* (1992).

Total herd life (longevity) is the number of years during which bulls and cows maintain a normal reproductive capacity; the factor is of particular importance in dairy cattle. Longevity has been measured by characteristics such as age at last calving; number of lactations initiated or completed length from first calving to disposal, age at disposal and survival to various ages

(Gebreegziabher and Mulugeta, 2006). Long herd life substantially decreases replacement cost per lactation and enables a cow to achieve its maximum capacity of performance when attaining full maturity (Essel, 1998). The potential for a long herd life depends on good health and fertility. It reduces treatment costs and the incidence of involuntary culling, which increase the scope for voluntary culling (Enyew *et al.*, 2000). Genetic and phenotypic correlations of herd life and productive lifetime were higher with first lactation milk yield (Chauhan and Hayes, 1993), indicating that the trait could be improved through improvement of the genetic makeup of the breed. Sadana and Basu (1982) reported herd life and average number of lactation in lifetime of Jersey to be 3.1 years and 2.7, respectively. However, from the same country (India) Narasimha and Mohan (1996) found the herd life, productive life and number of completed lactations to be 6.17 ± 0.18 years, 48.25 ± 0.52 months and 3.08 ± 0.14 . Length of herd life reported by Njubi *et al.* (1992) and Teodoro and Madalena (2005) were 5.6 years and 8.1 years respectively. Year of birth significantly influenced herd life in the report of Melaku (1994).

2.4.4. Calf growth performance

A high growth rate is of economic importance for both beef and dairy enterprises. In the case of dairy animals, culling can be more rigorous and stock can be replaced earlier, if growth rates are higher, as heifers can calve at a younger age and hence increase their lifetime productivity in terms of calves and milk production (Saeed *et al.*, 1987). Pre-weaning performance traits such as birth and weaning weights as well as growth and survival to weaning have important implications on herd productivity, management systems, breeding policies and adaptability (Mekonnen and Goshu, 1996).

Birth weight (BW)

A knowledge of the mean birth weight of cattle is important in that it does not only give an indication of the mature weight of the breed but also enables to make an estimate of the daily weight gain that can be expected on a particular plane of nutrition and the time required to achieve a given stage of maturity (Saeed *et al.*, 1987). It has also association with dystocia and subsequent reduction in productivity (Hailu, 2003). In Jersey cattle, 20.78 and 19.68kg of birth

weight for 50 male and female Jersey calves, respectively, were reported by Bhuyan and Mishra (1985). Pandya *et al.* (1985) noted in their study on 134 male and 139 female Jersey calves, the birth weight averaged 20.36 and 18.79kg, respectively. Zaman *et al.* (1989) reported mean birth weights of 16.89, 17.5, and 15.18kgs over three year intervals, and 17.31 and 15.74 kg for male and female calves, respectively.

Various authors reported about factors affecting birth weight. Significant year effect was reported by Amsalu (2003). A trend of body weight increment with parity was reported by Addisu and Hegde (2002) while Trail and Greory (1981) and Abdinasir (1992) found non-significant influence of parity on calf birth weight. Significant effect of season on birth weight were reported by Addisu and Hegde (2002), Naryanswamy *et al.* (1984), Abdinasir (1992) and Ashebir (1999). Calf sex had significant effect on birth weight in the report of Melaku (1994) and Asheber (1992). On the contrary, Maarof and Arafat (1987a) on Friesian and Abdinasir (1992) on Arsi crosses found that sex of calf and parity had no significant influence on birth weight. However, they have found the non-significant effect of season of calving.

Weaning weight (WW)

Weaning weight is important not only because it is indicative of maternal environment (milk producing ability of cow) but also gains made (growth ability of calf) during the pre-weaning period.

Weaning can be done when the consumption of concentrate is about 1kg per day (SDDP, 1999). Even though there is lack of values for Jerseys in tropical conditions; an experiment in Texas agricultural station found weaned weight of 180kg (Sacco *et al.*, 1991). Demeke *et al.* (2003) reported lesser values of weaning weight (104.5, 99.2 and 102.6kg) for Jersey crosses with Barka, Boran and Horro, respectively.

Mekonen (1987) and Ashebir (1992) observed that parity of dams had significant effect on weaning weight of Boran and their Friesian crosses and Fogera and their Friesian crosses, respectively. A significant effect of parity was also reported for Jersey crosses by Rege *et al.*

(1994a). However, Saeed *et al.* (1987) reported a non-significant effect of parity on weaning weight. There were year effects in the result obtained by Ashebir (1992) for Fogera cattle and Addisu and Hegde (2002). But they also reported non-significant effect of sex. On the contrary, significant effect of sex on weaning weight was reported by Rahnefield *et al.* (1980) and Mekonnen (1987). As of seasonal effects, significant effect of season was obtained by Mekonnen (1987) and Asheber (1992) as opposed to the reports on non-significant effect of season on weaning weight by Agymang and Nkhonjera (1986).

Calf mortality

The future of dairy herds depends mainly on rearing healthy calves to replace culled cows. High mortality among calves lowers the replacement rate affecting the selection intensity and herd economy (Maarof *et al.*, 1987). High mortality in young stock is a major cause of low productivity in many African livestock production systems. Although calf mortality may be mainly attributed to diseases, it is often related to management problems (e.g. feeding and health care) (Ababu *et al.*, 2006). Calf mortality is usually higher in the first 3 months after birth. In well-managed dairy herds, calf mortality doesn't usually exceed 5%, which can be tolerated by the farming community (Maule, 1990). Bhuyan and Mishra (1985) reported a calf mortality of 15.38% in Jersey calves up to 12 months of age, with no significant effect of sex or season. Adeney (1985) reported a calf mortality rate of 11.4% in Jersey herd in Nigeria.

2.4.5. Milk yield

Lactation yield and length

Lactation milk yield is the yield between calving and dry off in one lactation. Lactation length is days in milk from the date of calving to the final drying off or cessation of milking. Lactation length has a genetic basis and is a major limiting factor of milk production in the tropics (Dereje *et al.*, 2005). There have been a number of reports on lactation yield and length by different authors: lactation yield of 1663.15 liters by Bashir *et al.* (2007), 1839.6kg and 280.9 days by Arora and Sharma (1983) and 2815.17kg and 383.85 days by Rath and Patro (1988) in India and

1619kg and 276 days by EARO (2001). Other works in India, Kenya and Tanzania showed lactation yields of 2541kg (Ganuple *et al.*, 1984a), 1788kg (Njubi *et al.*, 1992) and 1892 kg (Katyega, 1988), respectively. The average lactation length were 295days (Njubi *et al.*, 1992) and 293 days (Katyega,1988).Nega and Sendros (2000) and Mureja *et al.* (2002) reported significant effects of year of calving on lactation yield in Holstein Friesian cows. Non-significant effect of season of calving on milk yield was reported by Gupta *et al.* (1990), Njubi *et al.* (1992), Mohammed (2004), Mureja (1994) and Rege and Mosi (1989). According to Gupta *et al.* (1990), first lactation milk yield and the first lactation period were significantly influenced by the year of calving while the influence of season of calving on both the lactation milk yield and the lactation length was non-significant. Njubi *et al.* (1992) found non- significant influence of parity on lactation length. Lactation yield increased with parity number up to third in the reports by Mureja (1994) and Nega and Sendros (2000).

Lifetime milk yield (LTMY)

A total yield of milk up to disposal is regarded as the lifetime milk yield. The economics of milk production of an animal is controlled to a great extent by lifetime producing ability than by one lactation production. Hence, it is essential to predict the lifetime production (up to 4 lactations) of an animal in the initial stages for an effective selection. The lifetime production in turn is dependent on the herd life (Singh *et al.*, 1988). Narasima and Mohan (1996) reported total milk production of 7315.8 ± 480.8 kg and total days in lactation of 978.2 ± 48.4 days for Jersey cattle. Significant effect of year of birth on lifetime milk yield was reported by Gebeyehu (2005) on Friesian-Boran crossbred cows.

3. MATERIALS AND METHODS

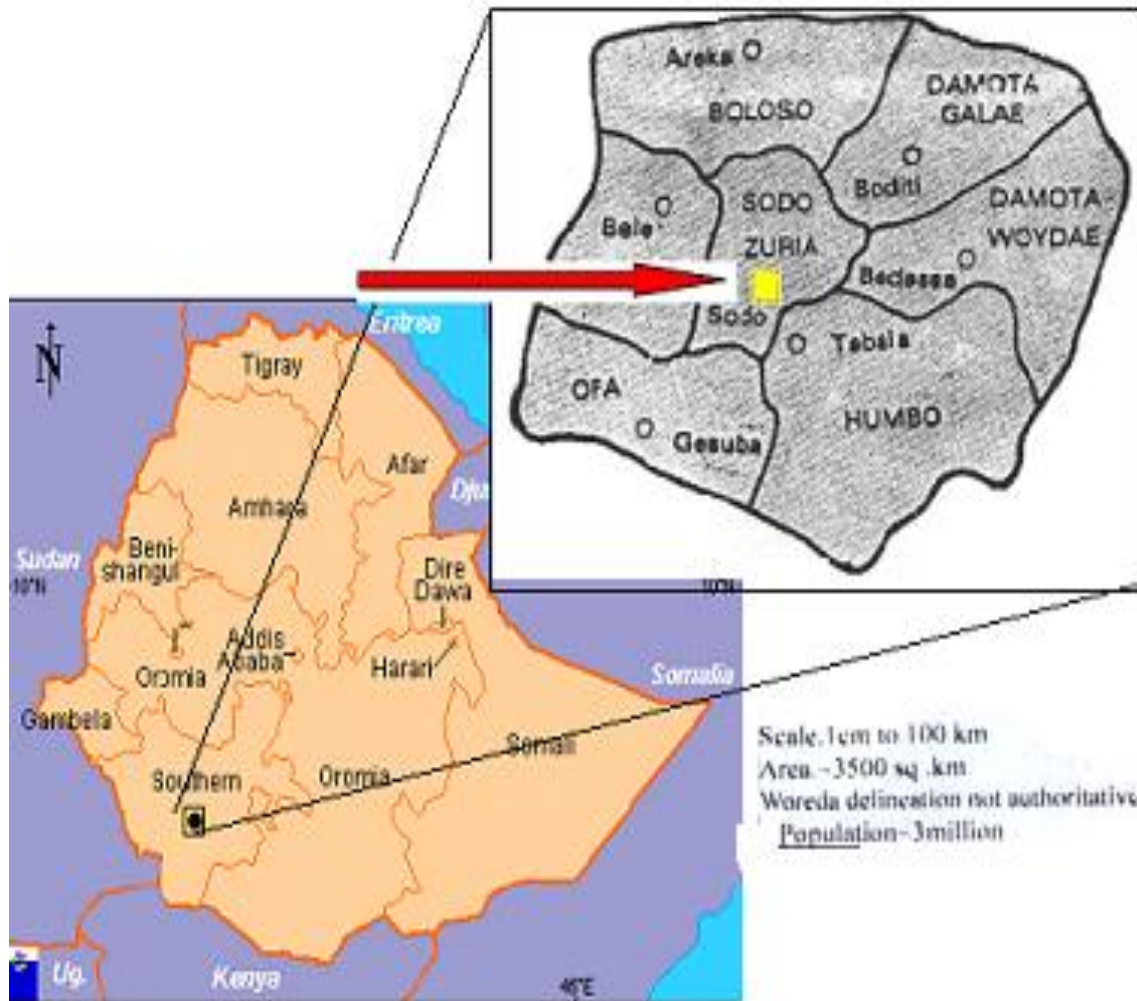
3.1. The study area

This study was carried out in Wolaita Sodo State Dairy Farm which is located in Wolaita Zone of the Southern Nations, Nationalities and People Regional State. The Zone is one of the densely populated areas in the country, having a total human population of 1.65 million. The annual growth rate is estimated to be more than 3%, with population density of about 342 persons per km² and average family size of 7.3 persons per household (WZFEDD, 2004). The administrative town of the Zone is Wolaita Sodo, which is found at 400km distance South of Addis Ababa. It is roughly situated at 6 °49' N latitude and 39° 47' E longitude. It has mean annual temperature of 19°C. Wolaita has a bimodal rainfall pattern. The first and short rainy period (Belg/Boniya) occurs from March to May, while the second main rainy period (Kiremt/Balgua) occurs from July to October. The average annual rainfall is 1014mm (NMSA, 2002). Wolaita Sodo area has moderately drained, acidic red soils (nitosols); it is representative of medium altitude, medium rainfall, and acid soil areas of Western Ethiopia.

Wolaita has an Enset-based Mixed Farming System, where Enset is a co-staple food together with cereals, root and tuber crops (Tesfaye, 2003). Like everywhere in the highland of Ethiopia, livestock is an integral part of farming system. Farmers rear cattle, sheep, goats, equines and chickens in the area.

The Wolaita Sodo State Dairy Farm was started in 1971 by Wolaita Agricultural Development Unit (WADU) with 35 heifers and 22 bulls of Holstein. Later, in 1987, with the financial aid of DRDP, 90 Jersey heifers were imported from Zimbabwe and two Jersey bull was brought from Kenya as an initial foundation stock for the farm. Since the Exotic cattle were first introduced into this region by colonial farmers, probably the stocks were English Jerseys. The main objective of the farm is to produce bulls to be sold for breeding purposes. In addition, surplus heifers or culled cows are sold to some producers.

Figure 1. Map of Ethiopia-indicating the study site/area—Wolaita Zone



According to EARO (1998), the Farm is the only ranch in SNNPR, and also it is peculiar in having only exotic breed; others have local and crossbred cattle. The four major ranches in Ethiopia started off with a pure breeding/genetic improvement and conservation objective and overtime made radical shift towards the production of F₁ crossbred heifers for smallholder dairy improvement (Workineh and Ababu, 2006). The farm is transferred from Federal to regional MOA in 1993. The total land area of the farm is 115 ha, where there are different farmstead structures and cultivated forage plants. The farm lies at an altitude of 1990 m.a.s.l.

The feeding management involves grouping of animals based on age, sex and production pattern as calves, growing bulls and heifers, dry and milking cows, heifers and bulls. Feed resources in

the farm include natural grass, Elephant grass, Rhodes grass, Alfalfa, *Stylo species*, *Siratro*, *Desmodium species* and Lablab. Silage and baled hay are made on the farm. Concentrates are supplemented to breeding bulls, calves and milking cows depending on availability of budget. Tree legumes mainly *Lucania species* and *Sesbania species* are also provided to animals (personal communication, WSSDF).

All animals, except calves and breeding bulls, graze in the field for seven hours during the day. But milking cows are brought to barn after 2:30pm and then left outdoor immediately after milking. Not letting lying in the barn immediately after milking is believed by the farm personnel to control mastitis. There is water trough outside the barn. Milking cows are drinking water after they are milked at 8:30 am. They are again let to drink in return from grazing for milking at 2:00. Calves drink in their pens (personal communication, WSSDF).

Cows are hand-milked twice daily in their barn. After five days, calves are separated from the dam and are provided with 3 liters of milk/day/head by bucket feeding up to eight months (weaning age) (personal communication, WSSDF).

Other management/ husbandry practices include keeping records, barn cleaning, and treatment of diseased animals. Calves are vaccinated after 6 months of age. According to health technician, the most serious diseases resulting in death of animals is heart water followed by bacterial infectious. Calves are affected by internal parasites, pneumonia and coccidiosis (personal communication, WSSDF).

Before two years, both AI and natural mating were used for breeding; but now only AI is used. Natural mating was used whenever there was shortage of semen and when AI-served animals show repeated breeding according to AI technician. Herdsmen carry out the detection of heat and report to AI technician. Reasons for disposal/culling of animals from the farm are age, mastitis, metritis, abortion and fertility problems (personal communication, WSSDF).

3.2. Study population and design

The Jersey cattle kept by the Farm for the last 21 years represented the study population. A retrospective type of study was carried out to evaluate the milk yield and reproductive performances of Jersey cattle on farm.

3.2.1. Number and type of data collected

The study involved all data collected for the last 21 years (1987-2007) on milk yield and reproductive performance of Jersey cattle in the WSSDF. Individual ear tag numbers were assigned to all animals on the farm, which have been kept in the farm for the last 20 years. Only the data of cows with complete information were included in the study. Accordingly, a total of 938,737,947, 697,232, 254, 191,804,564,214,145,119 and 139 data were used to evaluate birth weight, weaning weight, calf mortality, lactation milk yield and lactation length, life time milk yield, age at first service, age at first calving, number of services per conception, calving interval, calving to conception interval, herd life, productive herd life and effective productive herd life, respectively. In addition, age and parity of cows and season and year of calving were also collected from the Farm record.

3.2.2. Data management

The following procedures were used to calculate daily milk yield, lactation length, life time milk yield, average age at first service, age at first calving, number of services per conception, calving interval, herd life, productive herd life and effective productive herd life of each cow:

Lactation milk yield: was computed as the yield between calving and dry off in one lactation.

Lactation length: was computed as days in milk from the date of calving to the final drying off or cessation of milking.

Lifetime milk yield: obtained by adding a total yield of milk up to disposal.

Age at first service: it is the age at which heifers attain body condition and sexual maturity for accepting service for the first time. So, it was calculated by adding days between birth and first service.

Age at first calving: the age at which the heifer calved for the first time and it was computed by adding days between birth and first calving.

Number of services per conception: computed as the number of services or inseminations per final pregnancy.

Calving interval: calculated as the sum of days between two consecutive parturitions (calvings).

Interval between calving to effective service: was taken as the interval in days from calving to the subsequent effective service of a cow.

Herd life: was taken as average age at disposal.

Productive herd life: the difference between date of first calving and date of disposal.

Effective production herd life: It is estimated by multiplying the number of calves born per cow by 365 days.

3.2.3. Data analysis

The collected data was stored in Microsoft Excel spreadsheet and descriptive statistics and GLM of SPSS (release 11.05, 2002) was used to analyze the effects of different factors on the performance parameters.

Models employed for the analysis were as follows:

Reproductive performances

1. AFS and AFC (year and season of birth, source of cattle)

$$Y_{jkq} = \mu + C_q + M_j + R_k + e_{jkq}$$

2. CI and ICES (season and year of last calving/service, parity, source of cattle)

$$Y_{jklq} = \mu + C_q + M_j + R_k + P_l + e_{jklq}$$

3. NSC (season and year of last service, parity, source of cattle)

$$Y_{jklq} = \mu + C_q + M_j + R_k + P_l + e_{jklq}$$

Calf production

- . Birth and weaning weights (year and season of birth, sex, parity, dam source)

$$Y_{jklq} = \mu + C_q + M_j + R_k + P_l + e_{jklq}$$

Longevity and EPHL (year and season, source of cattle)

$$Y_{jkq} = \mu + C_q + M_j + R_k + e_{jkq}$$

Milk yield

1. LMY and LL (year and season of calving, parity, source of cattle)

$$Y_{jklq} = \mu + C_q + M_j + R_k + P_l + e_{jklq}$$

2. Lifetime MY (year and season of birth, source of cattle)

$$Y_{jkq} = \mu + C_q + M_j + R_k + e_{jkq}$$

Where, Y = the observations on each trait

μ = a value common to all animals (overall mean)

B_i = the effect of i^{th} birth weight

C_q = the effect of q^{th} source of cattle

R_k = the effect of the k^{th} year

M_j = the effect of the j^{th} season

P_l = the effect of the l^{th} parity of dam

S_m = the effect of the m^{th} sex of calf

E_{ijklmq} = the random error associated with Y_{ijklmq}^{th} observations which is assumed to be normally and independently distributed with mean zero and variance σ^2_e

4. RESULTS

4.1. Milk yield and lactation length

The overall means for lactation yield and length were 1691.59kg (SE=27.55) and 318.42 days (SE=3.92), respectively (Table 1). Year of calving ($p<0.001$) and cattle source ($p<0.05$) had significant effects on both traits. Parity ($p<0.001$) and cattle source ($p<0.05$) had significant effect ($p<0.001$) on lactation length. There were irregular trends of lactation yield and length throughout the years. The highest mean lactation yield and the longest lactation length were observed in 1994 (2126.97kg) and 1998 (413.08days), respectively. The least lactation yield and the shortest lactation length were seen in 1991 (1327.75kg) and 1988 (263.39 days).

Of the total cows (696) studied 37%, 29.7%, 21.8%, 16% and 9.6% completed first, second, third, fourth and fifth lactations, respectively. On the other hand, lactation length declined towards fourth parity and then increased in the fifth parity. Lactation yield and length were higher for imported cows than those reared on farm.

The overall mean of lifetime milk yield was 5565.19 kg (SE=220.03) (Table 1). From the factors considered in this study, only year of birth ($p<0.01$) had significant effect on lifetime milk yield. There was in general irregular trend of lifetime milk yield in the years included in the study. The highest lifetime milk yield was recorded in those cows born in 1991 (9014.76kg) while the lowest was for those born in 2003 (2683.90kg).

Table 1. Least squares means (LSM) and standard errors (SE) for lactation milk yield, lifetime milk yield and lactation length of Jersey Cattle

Factors	N	Least Squares Means (SE)		N	Least Squares Means (SE)
		LMY(kg)	LL(days)		
Overall	696	1691.59(27.55)	318.42(3.92)	232	5565.19(220.03)
Year of calving/birth		***	***		**
1985	-	-	-	28	6352.53(550.43) ^b
1986	-	-	-	32	5673.86(521.08) ^{bc}
1987/88	18	1903.43(104.29) ^{ab}	289.09(14.85) ^f	10	6378.52(1354.43) ^b
1988	30	1611.03(85.02) ^{dc}	263.39(12.10) ^{fg}		-
1989	38	1486.47(76.46) ^g	292.07(10.88) ^f	13	5391.94(792.27) ^{bc}
1990	32	1464.49(76.32) ^g	277.12(10.86) ^f	8	8065.38(988.53) ^a
1991	18	1327.75(94.25) ^g	306.68(13.42) ^{cd}	8	9014.76(990.38) ^a
1992	27	1632.97(72.15) ^{dc}	307.34(10.270) ^{cd}	10	5728.83(879.40) ^{bc}
1993	23	1588.29(83.39) ^{def}	280.45(11.87) ^e	14	5995.30(744.79) ^{bc}
1994	46	2126.97(58.02) ^a	312.37(8.26) ^{cd}	13	4624.11(782.03) ^{bcd}
1995	53	1639.87(60.02) ^{dc}	327.45(8.54) ^{cd}	10	6676.61(890.69) ^b
1996	45	1723.45(65.85) ^d	348.54(9.37) ^c	12	4992.97(806.01) ^{bcd}
1997	39	1823.60(71.44) ^{abc}	360.94(10.17) ^b	7	4903.09(1056.86) ^{bcd}
1998	35	1819.98(75.82) ^{abc}	413.08(10.79) ^a	13	6293.06(806.46) ^b
1999	22	1777.22(99.48) ^d	366.83(14.16) ^b	10	4994.00(879.54) ^{bcd}
2000	38	1675.84(68.48) ^{dc}	365.75(9.75) ^b	22	4578.13(596.49) ^{bcd}
2001	39	1710.06(71.28) ^d	301.36(10.15) ^{cd}	11	4179.06(840.82) ^{bcd}
2002	39	1535.05(69.14) ^{def}	281.52(9.84) ^e	6	2834.06(1150.52) ^c
2003	49	1630.35(62.97) ^{dc}	305.36(8.96) ^{cd}	5	2683.90(1244.22) ^c
2004	30	1926.29(76.87) ^{ab}	345.09(10.94) ^c	-	-
2005	44	1769.87(66.25) ^d	319.66(9.43) ^{cd}	-	-
2006/07	30	1784.47(149.44) ^d	313.33(21.27) ^{cd}	-	-
Season of calving/birth		NS	NS		NS
Long rain	236	1692.59(35.11)	320.36(4.99)	64	5361.96(436.639)
Short rain	156	1695.44(38.92)	314.59(5.54)	64	5905.52(361.74)
Long dry	304	1686.73(32.29)	320.31(4.59)	103	5719.19(303.78)
Parity		NS	***	-	-
1	258	1656.92(40.59)	344.34(5.78) ^a	-	-
2	207	1683.69(38.29)	330.48(5.45) ^a	-	-
3	152	1741.01(40.64)	320.48(5.78) ^{ab}	-	-
4	112	1682.34(44.75)	297.68(6.37) ^c	-	-
5	67	1693.98(54.95)	299.12(7.82) ^c	-	-
>5	37	1737.87(142.08)			
Cattle sources		*	*		NS
Imported	66	1771.53(53.35) ^a	330.12(7.59) ^a	60	5926.95(408.62)
Farm-bred	630	1611.65(35.79) ^b	306.72(5.09) ^b	172	5397.49(228.88)

LSM with different letters within a factor differ significantly, *** (p<0.001), ** (p<0.01), * (p<0.05), NS=non-significant, LMY=lactation milk yield, LL=lactation length, LTMY=lifetime milk yield

4.2. Reproductive performances

4.2.1. Ages at first service and calving

In this study, the overall average age at first service and age at first calving were 722.24 days (SE=36.4) and 1035.21 days (SE=12.59), respectively (Table 2). There was significant effect of year of birth ($p<0.001$) and cattle source ($p<0.001$) on age at first service while only year of birth ($p<0.001$) had significant effect on age at first calving. The shortest age at first service (606.71 days) was observed in 1985 while the shortest age at first calving (933.88days) was seen in 1993. The longest age at first service (1101.15 days) and age at first calving occurred in 1996.

4.2.2. Calving interval and calving to effective service interval

The overall mean calving interval of the study animals was 450.09 days (SE=6.60) (Table 3). Year of last calving ($p<0.001$), cattle source ($p<0.001$) and parity of dam ($p<0.001$) had significant effects on calving interval while seasonal effect was non-significant ($P>0.05$). There is in general irregular trend of calving interval throughout the years (1988-2007) (Figure 1). The shortest calving interval was recorded in 2006 (372.79 days) while the longest was in 1992 (615.12 days). Farm bred cows had shorter calving interval (474.48 days) than the imported ones (491.35 days). Calving interval in the present study showed consistent decline from the first parity towards the fifth parity.

The overall means of interval from calving to last successful service of Jersey cows was 174.68days (SE=8.61) (Table 3). Year of service ($p<0.01$) and parity ($p<0.001$) had significant effect on the trait. The annual trend is more or less similar with that of calving interval. The longest interval was observed in 1997 (255.41 days) while the shortest was in 1987 (100.59). Calving to conception interval decreased consistently up to fifth parity.

Table 2. Least squares means (LSM) and standard errors (SE) for age at first service and age at first calving of Jersey heifers

Factors	N	LSM (SE)	N	LSM (SE)
		AFS (days)		AFC (days)
Overall mean	254	722.24 (36.4)	191	1035.21 (12.59)
Year of birth		***		***
1985	28	606.71 (164.38) ^d	28	934.64(41.40) ^c
1986	31	749.26 (194.62) ^{ab}	29	1076.24(34.99) ^{ab}
1987/88	9	881.59 (320.13) ^a	4	944.00(109.67) ^c
1988/89	-	-	6	1067.34(71.45) ^{ab}
1989	6	897.00 (278.18) ^{ab}	-	-
1990	7	962.57 (236.83) ^a	7	1197.14(54.63) ^a
1991	8	722.13 (236.56) ^{abc}	6	1035.00(29.35) ^{ab}
1992	7	685.13 (168.14) ^d	6	1042.00(64.34) ^{ab}
1993	9	623.56 (128.09) ^d	8	933.88(54.50) ^c
1994/95	13	725.54 (330.49) ^{ab}	9	1046.93(100.12) ^{ab}
1995	9	1002.78 (234.57) ^a	-	-
1996	13	1101.15 (165.85) ^a	5	1212.60(60.93) ^a
1997	12	951.92 (183.69) ^a	9	1138.22(64.10) ^a
1998	11	652.00 (112.66) ^d	12	974.33(18.55) ^c
1999	9	684.78 (63.21) ^d	7	971.71(25.33) ^c
2000	27	683.52 (168.24) ^d	20	1026.45(25.17) ^{ab}
2001	16	795.38 (108.63) ^{ab}	12	1127.17(32.82) ^a
2002	15	784.80 (83.18) ^{ab}	11	1112.45(32.94) ^a
2003	10	709.60 (83.38) ^{abc}	8	935.80(95.00) ^c
2004	7	789.43 (65.86) ^{ab}	-	1100.33(25.62) ^a
2005	5	722.80 (25.53) ^{abc}	4	1000.25(14.13) ^{ab}
Season of birth		NS		NS
Long rainy season	80	738.79(26.61)	56	1030.72(28.46)
Short rainy season	67	767.05(27.13)	52	1043.39(29.75)
Long dry season	105	720.75(21.73)	82	1034.09(23.45)
Cattle sources		***		NS
Imported	59	685.88(28.21) ^b	57	1022.62(29.32)
Farm-bred	195	798.52(15.53) ^a	134	1049.51(17.39)

LSM with different letters within a factor differ significantly*** (p<0.001), NS=non-significant, AFS= Age at First Service, AFC= Age at First Calving

Table 3. Least squares means (LSM) and standard errors (SE) for calving interval and calving-to-conception interval of Jersey cattle

Factors	N	LSM (SE)	N	LSM (SE)
		CI (days)		ILCEI (days)
Overall	564	450.09 (6.60)	214	174.68(8.61)
Year of last calving/service		***		**
1987	-	-	10	100.59(32.72) ^d
1988	9	499.89 (52.82) ^{ab}	19	114.25(25.26) ^d

1989	22	427.14 (26.55) ^c	14	158.01(28.52) ^{bc}
1990/91	31	449.58 (17.81) ^c	6	205.9(47.43) ^a
1991	26	495.92 (26.53) ^{ab}	-	-
1992	25	615.12 (33.75) ^a	6	206.78(45.89) ^a
1993	24	614.79 (40.62) ^a	22	170.69(17.82) ^b
1994	40	522.48(34.09) ^{ab}	13	138.84(24.72) ^d
1995	46	465.83(21.58) ^c	21	173.49(21.78) ^b
1996	45	408.22(14.21) ^{cd}	15	221.81(27.28) ^a
1997	42	465.43(20.05) ^c	15	255.41(25.61) ^a
1998	37	451.41(20.29) ^c	8	249.44(35.30) ^a
1999	24	481.04(22.78) ^{ab}	12	217.05(27.14) ^a
2000	24	521.54(35.19) ^{ab}	15	169.98(30.07) ^b
2001	31	502.23(40.92) ^{ab}	23	179.40(22.67) ^b
2002	31	466.06(32.35) ^c	14	157.91(24.62) ^{bc}
2003	29	456.41(27.27) ^c	10	157.33(28.22) ^{bc}
2004	27	449.93(23.62) ^c	13	118.08(42.82) ^d
2005	21	447.62(22.96) ^c	-	-
2006	24	372.79(8.58) ^d	-	-
2007	6	467.00942.96) ^c	-	-
Season of last calving/service		NS		NS
Long rain	199	490.54(14.04)	80	174.81(12.17)
Short rain	142	456.25(10.42)	53	174.05(13.42)
Long dry	222	475.65(8.81)	81	175.19(10.32)
Cattle source		***		NS
Imported	48	491.35(19.74) ^a	68	193.05(20.33)
Farm-bred	516	474.48(6.98) ^b	146	156.32(11.47)
Parity		***	NS	***
1	160	500.87910.37) ^a	55	243.36(15.18) ^a
2	144	482.67(14.97) ^b	64	179.14(14.12) ^{ab}
3	118	475.37(16.62) ^{bc}	39	171.99(17.77) ^{ab}
4	76	468.75(17.73) ^{bc}	43	155.73(14.46) ^c
5	42	415.19(13.48) ^d	36	123.19(15.31) ^d

LSM with different letters within a factor differ significantly, *** (p<0.001), ** (p<0.01), NS= not significant, CI= Calving Interval, ILCEI=interval between last calving and effective insemination

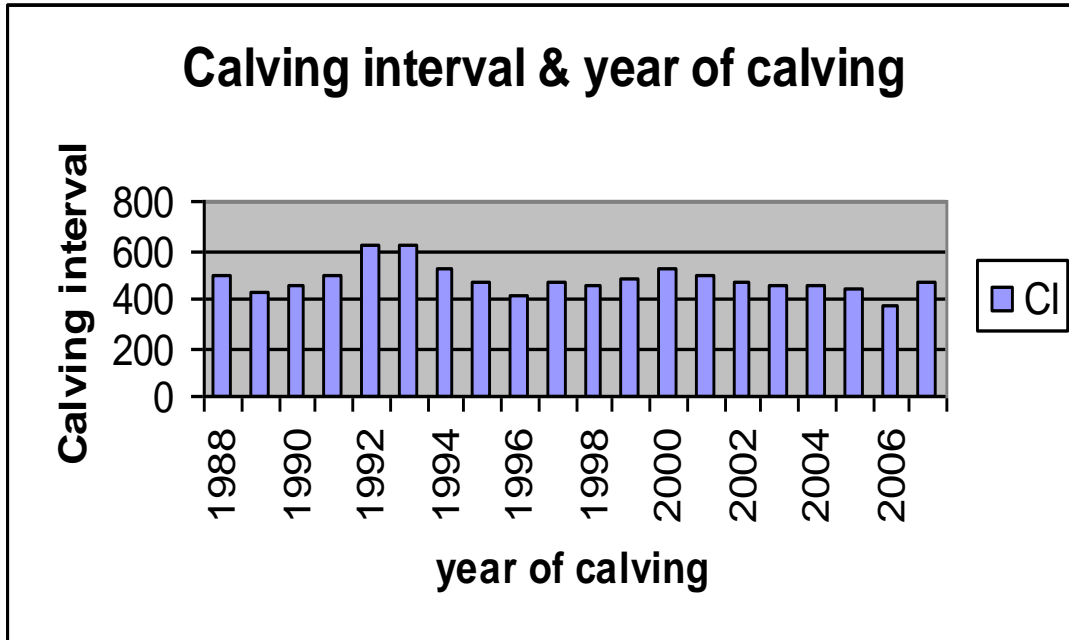


Figure 2. Yearly variation of calving interval

4.2.3. Number of services per conception

The overall means of number of services per conception was 1.79 (SE=0.06) (Table 4). Year of service ($p<0.001$) and season of service ($p<0.05$) showed significant effect where as cattle source and parity of dam had no significant effect ($p>0.05$) on NSC in the present study. In this study out of 804 detected heats, 77.77% conceived in the first insemination and the rest required two or more services per conception. The least number of services per conception were recorded in 1987 (1.00). Cows inseminated in 1993 required the highest number of services per conception (2.70). The number of services per conception was lowest during the short rainy season.

Table 4. Least squares means (LSM) and standard errors (SE) for number of services per conception of Jersey cattle

Variables	N	LSM (SE)
		NSC
Overall	804	1.79(0.06)
Year of service		***
1987	14	1.00(0.32) ^f
1988	30	2.08(0.24) ^a
1989	20	1.33(0.26) ^e
1990	24	1.61(0.24) ^{cd}
1991	12	1.67(0.31) ^{cd}
1992	24	1.89(0.23) ^{ab}
1993	39	2.70(0.18) ^a
1994	45	1.71(0.19) ^c
1995	57	1.75(0.18) ^c
1996	45	1.41(0.20) ^e
1997	44	1.53(0.21) ^{cd}
1998	37	1.84(0.22) ^{ab}
1999	53	1.88(0.19) ^{ab}
2000	39	1.65(0.19) ^c
2001	53	1.76(0.19) ^c
2002	57	1.79(0.18) ^c
2003	57	1.98(0.17) ^{ab}
2004	60	2.05(0.17) ^a
2005	59	1.91(0.18) ^{ab}
2006	19	2.01(0.26) ^a
2007	16	2.15(0.29) ^a
Season of service		*
Long rain	262	1.89(0.09) ^a
Short rain	202	1.63(0.09) ^b
Long dry	337	1.85(0.08) ^a
Cattle source		NS
Imported	33	1.98(0.15)
Farm-bred	771	1.59(0.08)
Parity		NS
1	202	1.78(0.10)
2	202	1.79(0.09)
3	150	1.67(0.10)
4	95	2.02(0.12)
5	75	1.69(0.12)
>5	78	1.57(0.13)

LSM with different letters within a factor differ significantly *** (p<0.001), *(p<0.05), NS=non-significant, NSC=Number of Services per Conception

4.3. Herd life and productive herd life

The overall mean for total herd life or longevity of Jersey cows was 2983.74 days (SE=67.98) (Table 5). Year of birth ($p<0.001$) and cattle source ($p<0.01$) had significant effect while season of birth did not. The maximum longevity (3642.95days) was recorded for cows born in 1987 while the minimum was for those born in 2000 (2239.75days). Higher herd life was recorded for imported cows (3294.25 days) than those raised on farm (2834.91days).

The overall means for productive herd life and effective productive herd life were 2310.11 days (SE=296.91) and 1663.15 days (SE=55.09), respectively (Table 5). The average number of lactations in lifetime was 3.32. Cattle source had significant effect ($p<0.05$) on productive herd life while only year of birth affected effective productive herd life ($p<0.01$). Productive herd life was higher for imported cows (2272.01 days) than those reared on farm (1679.99 days). In case of effective productive herd life, cows born in 1991 had the longest effective productive herd life (2096.69 days) while those born in 1999 had the shortest effective productive herd life (1228.52 days).

4.4. Calf production

The overall mean birth weight of Jersey calves in the farm was 22.87kg (SE=0.17) (Table 6). Year of birth ($p<0.001$), season of birth ($p<0.05$), parity ($p<0.001$) and sex of calves ($p<0.001$) had significant effect on birth weight. The highest mean birth weight (27.49 kg) was recorded in 1989 while the lowest was found in 1998 (20.19 kg). The mean value for males was 23.61kg and that of female calves was 22.03kg. Birth weight of calves increased consistently until parity three and then follows irregular trend.

Table 5. Least squares mean (LSM) and standard errors (SE) of total herd life and effective productive herd life of Jersey cattle

Factors	N	LSM(SE)	N	LSM (SE)	N	LSM (SE)
		THL (days)		PHL (days)		EPHL (days)
Overall	145	2983.74 (67.98)	119	2310.11(296.91)	139	1663.15 (55.09)
Year of birth		***		NS		**
1985	29	3159.72(156.37) ^a	28	2163.93(178.01)	25	1883.02(104.16) ^a
1986	29	3421.17(171.28) ^a	28	2357.32(190.56)	23	1789.15(110.10) ^{ab}
1987	7	3642.95(351.95) ^a	-	-	-	-
1989	8	3265.63(189.11) ^a	-	-		
1990	9	3299.78(199.45) ^a	9	2130.89(218.79)	8	1894.90(175.87) ^a
1991	6	3290.33(283.63) ^a	5	2226.20(365.69)	7	2096.69(190.01) ^a
1992	8	2684.00(172.48) ^b	6	1732.83(183.34)	8	1857.96(174.53) ^a
1993	11	2608.63(257.82) ^b	9	1967.78(293.15)	10	1765.18(155.64) ^{ab}
1994	10	2285.30(96.67) ^{cd}	5	1438.80(179.88)	7	1294.70(190.30) ^c
1995	6	2715.83(208.51) ^b	-	-		
1996	7	2434.86(211.35) ^{cd}	7	1466.84(126.23)	6	1474.26(202.10) ^c
1997	6	2347.67(160.16) ^{cd}		-		
1998	4	2524.25(27.25) ^{cd}	-	-		
1999	-	-	6	1065.13(75.17)	5	1228.52(223.90) ^c
2000	4	2239.75(83.03) ^{cd}	-	-		
Season of birth		NS		NS		NS
Long rain	43	2874.69(137.12)	29	2014.92(162.04)	38	1790.14(90.89)
Short rain	31	3010.00(173.99)	25	2279.04(173.77)	35	1787.36(90.64)
Long dry	71	2755.54(109.41)	65	1973.82(105.62)	66	1680.00(66.42)
Cattle source		**		*		NS
Imported	58	3294.25(106.39) ^a	56	2272.01(119.55) ^a	48	1825.02(79.62)
Farm-bred	87	2834.91(90.03) ^b	63	1906.43(116.33) ^b	91	1679.99(57.08)

LSM with different letters within a factor differ significantly *** (p<0.001), ** (p<0.01), *(p<0.05), NS= not significant, THL=Total Herd Life, PHL= Productive Herd Life, EPHL= Effective Productive Herd Life

Table 6. Least squares means (LSM) and standard errors (SE) for birth weight and weaning weight of Jersey calves

Variable	N	LSM (SE)	N	LSM (SE)
		BW(kg)		WW(kg)
Overall	938	22.87(0.17)	737	108.88(0.67)
Year of birth		***		***
1987	22	23.40(0.85) ^b	17	89.09(3.98) ^e
1988	29	26.31(0.67) ^a	27	90.88(3.29) ^e
1989	43	27.49(0.58) ^a	35	82.67(2.87) ^e
1990	42	24.74(0.55) ^b	38	91.94(2.66) ^e
1991	26	23.52(1.00) ^b	11	104.56(4.82) ^c
1992	41	22.37(0.62) ^{bc}	29	99.47(2.67) ^{cd}
1993	40	23.39(0.59) ^b	33	99.65(2.52) ^{cd}
1994	53	22.47(0.51) ^{bc}	50	111.51(2.16) ^c
1995	67	22.66(0.51) ^{bc}	49	96.43(2.26) ^e
1996	66	22.44(0.56) ^{bc}	37	93.96(2.66) ^e
1997	47	20.57(0.56) ^d	36	107.72(2.72) ^c
1998	49	20.19(0.59) ^d	35	106.56(2.81) ^c
1999	34	21.74(0.65) ^{bc}	27	110.29(3.08) ^c
2000	60	23.1(0.51) ^b	48	139.82(2.42) ^a
2001	53	20.6(0.52) ^d	48	131.57(2.47) ^a
2002	48	22.80(0.53) ^{bc}	44	110.41(2.54) ^c
2003	62	23.58(0.45) ^b	58	124.19(2.20) ^b
2004	36	23.26(0.61) ^b	30	131.39(2.83) ^a
2005	61	22.39(0.52) ^{bc}	46	121.46(2.49) ^b
2006	46	21.11(0.62) ^{bc}	32	123.54(2.92) ^b
2007	13	21.00(1.25) ^{bc}	7	110.92(5.46) ^c
Season of birth		*		***
Long rain	329	23.19(0.24) ^a	265	111.99(0.92) ^a
Short rain	218	22.80(0.28) ^b	166	108.29(1.03) ^b
Long dry	391	22.47(0.22) ^b	306	106.35(1.20) ^c
Sex		***		***
Male	491	23.61(0.20) ^a	391	111.60(0.87) ^a
Female	447	22.03(0.20) ^b	346	106.16(0.87) ^b
Parity		***		**
1	228	21.35(0.26) ^c	208	108.37(1.11) ^{ab}
2	221	22.32(0.26) ^b	192	106.30(1.09) ^c
3	155	23.51(0.29) ^a	139	111.21(1.26) ^a
4	111	23.42(0.36) ^a	93	106.89(1.54) ^c
5	70	23.49(0.45) ^a	60	111.61(1.90) ^a
Dam sources		NS		NS
Imported	213	22.93(0.38)	188	106.57(1.75)
Farm-bred	725	22.82(0.25)	549	110.38(1.15)

LSM with different letters within a factor differ significantly, *** (p<0.001), ** (p<0.01), * (p<0.05), NS= not significant, BW=birth weight, WW= weaning weight

The overall mean of weaning weight was 108.88 kg (SE=0.67). Weaning weight was significantly influenced by year of birth ($p<0.001$), season of birth ($p<0.001$), sex ($p<0.001$) and parity ($p<0.01$). Calves born in 2000 had the heaviest weaning weight (139.82 kg) while those born in 1989 had the least weaning weight (82.67 kg). Male calves were heavier (111.60 kg) than female calves (106.16 kg) at weaning. The highest value of weaning weight (111.99 kg) was also recorded for calves born in the long rainy season followed by those born in the short rainy season (108.29kg). Out of the 795 normal calvings in the farm, 154 calves (16%) died due to various reasons.

5. DISCUSSIONS

5.1. Milk yield

The overall means of lactation yield and length for Jersey cows in this study were 1691.59kg (SE=27.55) and 318.42 days (SE=3.92), respectively. These results are similar with reports of EARO (2001) (1619kg lactation yield and 276 days of lactation length) and Bashir *et al.* (2007) (1663.15kg of lactation yield) for Jersey cattle in Ethiopia and Pakistan, respectively. However, the result is lower than the reports in India by Rath and Patro (1988) who reported mean lactation yield and length of 2815.17kg and 383.85days, respectively. Other works in India, Kenya and Tanzania showed lactation yields of 2541kg (Ganuple *et al.*,1984a), 1788kg (Njubi *et al.*,1992) and 1892 kg (Katyega,1988), respectively, which are all higher than our result. The average lactation length of the present study is higher than 295days found by Njubi *et al.* (1992) and 293 days by Katyega (1988). Year of calving had significant effects on lactation yield in the present study. This is in line with reports by Nega and Sendros (2000) and Mureja *et al.* (2002), who reported significant effects of year of calving on lactation yield in Holstein Friesian cows. Non-significant effect of season of calving on milk yield was reported also by Gupta *et al.* (1990), Njubi *et al.* (1992), Mohammed (2004), Mureja (1994) and Rege and Mosi (1989). The absence of significant seasonal variation on lactation yield and length in this study could be due to the fact that animals are managed on farm and lactating cows were given feed supplementation across season. The finding that parity had significant influence on lactation length is in contrast with the report of Njubi *et al.* (1992). In this study, lactation yield increased with parity number up to third, which is in agreement with the reports by Mureja (1994) and Nega and Sendros (2000). This could probably be due to increment in body weight with maturity, and larger cows have more udder secretory tissue and larger digestive system.

The overall mean of lifetime milk yield in this study was 5565.19kg (SE=220.03). This value is lower than the finding of Narasima and Mohan (1996) (7315kg). Year of birth had significant effect while cattle source and season of birth did not. The significant effect of year of birth on LTMY and non significant seasonal effect in this study agrees with report of Gebeyehu (2005) on Friesian-Boran crossbred cows. The maximum LTMY (9014.76 kg) is recorded for Jersey.

However, the significant effect of year of birth on lifetime milk yield might be due to the poor yields in 2002 and 2003 (though few observations) which were about 50% lower than the overall mean yield. The late age at first calving and the long calving interval found in this study could have contributed to the low lifetime lactation performance.

5.2. Reproductive performance

In this study, the average age at first service was 722.24 days (SE=36.4), which is higher than the reports of Mungurkar *et al.* (1985) (556.6 days), Rath and Patro (1988) (502.61 days) but less than report of 748.7 days by Bashir *et al.* (2007). The effect of year of birth on age at first service was significant which is in line with the findings of Mungurkar *et al.* (1985) and Smith *et al.* (1989). There are a number of factors affecting the sexual maturity of animals including biological and environmental conditions. According to management conditions, the average age of Jerseys at which the first heat appears is 13 months (Hafez and Hafez, 2000). The late age at first service in this study could be due to irregularities in feed supply and changes in management conditions through the years.

The average age at first calving in the present study was 1035.21 days (SE=12.59). This result is higher than the reports of Arora and Sharma (1983) (835.6 days), Mangurkar *et al.* (1985) (873.8 days), Jain and Khan (1990) (813 days), Njubi *et al.* (1992) (930 days) and Katyega (1988) (987 days). Age at first calving was significantly influenced by year of birth while season and cattle source of birth had no significant effect. The absence of significant influence by season of birth in this study is in agreement with reports of Jain and Khan (1990), Njubi *et al.* (1992), Enyew *et al.* (1999), Melaku (1994) and Mekonen and Goshu (1996). On the other hand, Million *et al.* (2006) and Mekonen (1987) reported significant effect of season of birth on age at first calving. Significant effect of year of birth on age at first calving was also found in Jersey cows and Jersey and their crosses by Yazdani *et al.* (1993), Njubi *et al.* (1992), Enyew *et al.* (1999) and Kiwuwa *et al.* (1983). However, Azage (1981) reported that year of birth had no significant effect on the age at first calving in both lowland and highland heifers in Ethiopia. The higher values of age at first calving and the significant variation through the years indicate that the management conditions prevailing in the farm are inadequate and inconsistent. Furthermore, heat detection in the study

farm is done only by herdsmen and there is no veterinarian in the farm in order to monitor reproductive health.

The mean calving interval in this study was 450.09 days (15months) (SE=6.60). The average CI obtained in the present study is in accordance with the work of Ramachandraiah *et al.*, (1990) (453.02days) and Rath and Patro (1988) (440.33days). However, the finding of the present study is higher than reports of Arora and Sharma (1983) (422.8 days) and Mangurkar *et al.* (1985) (414.6 days) in India and Njubi *et al.* (1992) (408 days) in Kenya and Katyega (1988) (426.6 days). This finding is even higher than the findings of Enyew *et al.* (1999) (435.9 days) and Million *et al.* (2006) (417.02 days) for F₁ Jersey crosses in Ethiopia. On the other hand, our finding is lower than the report of Dutt *et al.* (1988) (468.4 days) in India. Generally, the calving interval found in this study is more than the recommended values which are in the range of 12 to 13 months. This is also an indication of poor management conditions with respect to feeding and reproductive management in the farm.

Year of last calving, parity of dam and cattle source had significant effects on calving interval while seasonal effect was not significant. Similar findings were reported by Enyew *et al.* (1999). The significant effect of year of calving was also reported by Matsoukas and Fairchild (1975), Njubi *et al.* (1992), Mekonnen and Goshu (1996), Yohannes *et al.* (2001), Million *et al.* (2006) and Kiwuwa *et al.* (1993). On the contrary, significant effects of season of calving were found by Njubi *et al.* (1992) and Mangurkar *et al.* (1985). Kefena *et al.* (2006) reported that neither year of calving nor season of calving had significant effect on calving interval.

Calving interval in the present study consistently declined from the first parity through the fifth parity. Similar result of shorter calving intervals at later parities were reported by Million (1997) and Kuwuwu *et al.* (1983). The reason for longer calving interval in younger cows might be due to higher nutrient requirement for growth in addition to milk production and maintenance, which could delay the onset of postpartum heat. The significant variation through the years in calving interval observed in this study could be related to climatic (feed availability) and managerial differences such as heat detection and culling practices through the years. Mukasa-Mugerwa and Azage (1991) indicated that ruminants gain weight and improve body condition during the period

of feed availability. Cow in better body condition have shorter CI than their thinner contemporaries.

The overall mean of interval between last calving and the effective insemination in Jersey cows was 174.68 days (SE=8.61). The present result is better than the report 199.2 days by Melaku (1994) and 285 days by Amene (2006) in Ethiopia. Year of service and parity had significant effect on the trait. Variation among parity was in agreement with the report of Ashebir (1992) and Enyew (1992). Contrary to this Mekonen and Goshu (1987) found non-significant effect of parity on the trait. Non-significant effect of season on the trait was also reported by Mekonen and Goshu (1987) and Enyew (1992). On the contrary, significant seasonal effect was reported by Yimam *et al.* (1997) and Ashebir (1992). The higher interval between calving to effective service from the recommended 85-115 days could probably be due to delayed resumption of ovarian activity after calving and management factors such as heat detection, decisions of breeding after parturition, nutrition and disease control.

The overall mean of number of services per conception in this study was 1.70 (SE=0.06). This result is in the range of number of services per conception recommended (1.7-2.2) for efficient reproduction (Radostits *et al.*, 1994). Our result is very close to the reports of Enyew *et al.* (1999) (1.74) for Jersey-Arsi crosses. However, the present result is lower than the value reported by Mangurkar *et al.* (1985) (2.20), Niubi *et al.* (1992) (2.20), Sekerden (1996) (3.3) and Singh and Mishra (1980) (2.0). The significant effect of year of service and the insignificant influence by parity number in this study is in agreement with the observations of Niubi *et al.* (1992) and Assegid and Birhanu (2004). Enyew *et al.* (1999) reported significant effect of parity on number of services per conception. Variation in efficiency of heat detection in the years and other managerial factors might have contributed to the variation in number of services per conception over the years. McDowell *et al.* (1976) also suggested reasons such as high environmental temperature and reduced efficiency of inseminators that could contribute to higher values of number of services per conception.

5.3. Herd life and productive herd life

The average length of herd life in the present study was 2983.74 days (8.29 years) (SE=67.98). Our finding is by far higher than the reports Sadana and Basu (1982) (3.1 years), Njubi *et al.* (1992) (5.6 years) and Narashmh and Mohan (1996) (6.17 years). Higher results of herd life for Boran (8.9 years) and Horro (10.6 years) crosses of Jersey were reported by Gebregziabher and Mulugeta (2006). Studies in Brazil by Teodoro and Madalena (2005) reported a herd life of Jersey cattle which is very close to our finding (8.1 years). Year of birth significantly influenced herd life in this study, which is in accordance with the report of Melaku (1994). The reason for variation among herd life in the early and later years was probably due to criteria and type of culling over all deterioration in management as compared to the previous years. In addition, imported cows had somewhat longer herd life than those raised on farm in this study indicating also disposal age depends on origin of animals.

The mean productive herd life found in the present study was 2310.11 days (77months or 6.33 years) (SE=296.91). The average number of lactations in the lifetime of cows in the farm was 3.32. The result of present study much higher than the reported productive life of 48.25 months by Narasemh and Mohan (1996) and 36 months by Njubi *et al.* (1992). In terms of number of lactations, the result is similar with that of Njubi *et al.* (1992) (3.3) while it is within the range of recommended values for productive indices (greater than 3 lactations) (Radostits *et al.*, 1994). The productive life for Jersey crosses with Boran, Horro and Sahiwal were 5.1, 6.8 (Gebregziabher and Mulugeta, 2006) and 5.7 years (Singh *et al.*, 1988), respectively, of which the result of the present study is closer to Jersey-Horro crosses. Only cattle source had significant effect on productive herd life.

The mean effective productive herd life found in this study was 1663.15 days (SE=55.09). Year of birth had significant effect on effective productive herd life. There was scarcity of previous works in Jersey cattle in this regard. However, there was a report indicating that year of birth had significant effect on productive herd life of Holstein cattle (Gebeyehu *et al.*, 2007) and Fogera cows (Giday, 2001) and effective productive herd life of crosses of Friesian and Boran cattle

(Gebeyehu, 2005) and Fogera cows (Gidey,2001). On the other hand, non significant effect of year of birth on length of productive life was reported by Njubi *et al.* (1992).

The overall mean birth weight Jersey calves in this study was 22.87kg (SE=0.17); the values for males and females being 23.61 and 22.03 kg, respectively. Similar trend and closer values were observed in the result reported by Demeke *et al.* (2003) with Jersey crosses of Barka, Boran and Horro, which had 21.6, 21.5 and 19.9kg of birth weights, respectively. In addition, similar results were also obtained by Bhuyan and Mishra (1985) and Pandya *et al.* (1985). The mean birth weights in the present study are higher than the reports by Zaman *et al.* (1989), who reported mean birth weights of 16.89, 17.5, and 15.18kgs over three year intervals, and 17.31 and 15.74 kg for male and female calves, respectively.

Birth year, calf sex, parity of dam and season of birth showed significant effect while dam sources had no significant effect on birth weight. Similar year effect was reported by Amsalu (2003). The yearly variation in birth weight could be probably due to yearly differences in management and climatic factors. There was a trend of increment in birth weight as parity number increases until three. A trend of birth weight increment with parity was reported by Addisu and Hegde (2003). This variation could be attributed to the good maternal environment provided by the mature cows to developing fetus. Trail and Greory (1981) and Abdinasir (1992) found non-significant influence of parity on calf birth weight. We have found significant effect of season on birth weight; contradictory results are reported by other authors (Addisu and Hegde, 2003; Naryanswamy *et al.*, 1984, Abdinasir, 1992 and Ashebir, 1999). Calf sex had significant effect on birth weight; male calves being heavier than females. This was in agreement with the findings of Melaku (1994) and Asheber (1992). On the contrary, Maarof and Arafat (1987a) on Friesian and Abdinasir (1992) on Arsi crosses found that sex of calf and parity had no significant influence on birth weight. However, they have found non-significant effect of season of calving.

The overall mean weaning weight of Jersey calves in this study was 108.88kg (SE=0.67). Demeke *et al.* (2003) reported lesser values of weaning weight (104.5, 99.2 and 102.6kg) for Jersey crosses with Barka, Boran and Horro, respectively. All factors considered in this study except dam sources had significant effects on weaning weight. Male calves were significantly

heavier (111.60kg) at weaning than female calves (106.16kg) and there was a trend of increment in weaning weight along with parity. Similarly, Mekonen (1987) and Ashebir (1992) observed that parity of dams had significant effect on weaning weight of Boran and their Friesian crosses and Fogera and their Frisian crosses, respectively. A significant effect of parity was also reported for Jersey crosses by Rege *et al.* (1994a). The lower weaning weight recorded for calves born from dams in the first parity could be due to nutritional requirement of the dams for their own growth and maintenance leading to lower milk production. Heifers are also less experienced than cows in maternity care. Saeed *et al.* (1987) reported a non-significant effect of parity on weaning weight. The result of year effect is consistent with that obtained by Ashebir (1992) for Fogera cattle and Addisu and Hegde (2003). But they also reported non-significant effect of sex contrary to our result. Significant effect of sex on weaning weight was reported by Rahnefield *et al.* (1980) and Mekonnen (1987). Similar result of significant effect of season was obtained by Mekonnen (1987) and Asheber (1992) as opposed to the reports on non-significant effect of season on weaning weight by Agymang and Nkhonjera (1986). The overall variation in weaning weight could be due to the difference and sometimes deterioration of overall management as differences in housing, feeding, animal disease control, mineral deficiencies, and other factors.

The 16% crude calf mortality rate up to one year of age found in this study is close to the report made by Bhuyan and Mishra (1985a); but higher than the result of Adeney (1985) working on Jersey cattle in Western Nigeria. This shows supply of colostrums, vaccination program and a clean environment are needed to assist the young calf in getting off to a good start even though the calves get sufficient milk.

6. CONCLUSIONS AND RECOMMENDATIONS

The means of lactation yield and length are in the range reported for Jerseys in Ethiopia and other tropical countries though higher values are reported elsewhere. The life time milk yield found in this study is also low. In general, Jersey cattle in the studied farm had poor reproductive performance in terms of age at first service and age at first calving. The mean values for calving interval and interval between last calving and effective insemination are well beyond the recommended values while the average number of services per conception is within the recommended range. Inconsistency in management and variations in climatic conditions seem to determine lactation yield, lactation length, life time milk yield and all the reproductive performance traits. In addition, cows with high parity number tend to have lower milk yield and longer postpartum period and calving interval. Season was only important in this study in determining number of services per conception, birth and weaning weights.

The herd life, productive herd life and effective productive herd life of Jersey cattle found in this study are in general good and not different from reports elsewhere. There is a big gap between total herd life and, productive and effective productive herd life indicating the presence of times wasted un-necessarily. In these cases too variability in management and climatic conditions through the years seem to affect the traits than any other factor considered. The mean values of birth weight and weaning weight for calves of Jersey cattle in this study are also good and affected by the situations in the year and season of birth, sex and parity of dam. The crude calf mortality rate found in this study is high.

With the above conclusions, the following recommendations were made:

- There is a need to make efforts to reduce age at first calving and calving interval through improved heat detection and balanced feeding which takes into account maintenance and growth requirements;
- Postpartum reproductive health management should be part of the routine activities of the farm to reduce the length of postpartum period and calving interval;

- To improve the productive efficiency of cows, there should be regular monitoring and evaluation of the productivity of cows in the herd and culling of cows with poor milk yield and unacceptable reproductive performance;
- Further investigations like inbreeding depression as some sires from the farm are used for semen production at NAIC and estimation of genetic parameters needs to be carried out in the farm

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8. ANNEXES

Annex 1. Checklist for collection of data from the Wolaita Sodo State Dairy Farm

1. What is the type of the farm?
 - a. Intensive
 - b. Extensive
 - c. Semi-intensive
2. What is the total area of the farm?
3. What is the area of land for?
 - a. Natural pastures
 - b. Improved pastures (for hay, silage etc.)
 - c. Other, if any
4. How was the provision of water to the animals?
5. How frequently were the animals given water?
6. How many hours were the animals allowed to graze per day?
7. What were the sources of feeding of the cows during wet and dry season?
8. Was there supplementary feeding? Please indicate the sources.
9. Was hay and silage provision in ad libitum? Yes or No
10. How was the rearing of the calves?
 - a. Age in days of colostrums feeding
 - b. Method of colostrums feeding
 - c. Amount of milk fed to calves
 - d. Method of milk feeding to calves
 - e. Weaning age
 - f. Weaning weight
11. Calf pens
 - a. Type of housing
 - b. Cleanliness of housing
 - c. Protection of calves from cold
 - d. Bedding material for calves
12. Feeding of heifers after weaning
 - a. Type of feeds provided to calves after weaning
 - b. Amounts of feedstuff provided to calves (feed/day/calf)
13. The most frequent diseases problems affecting calves
14. Prophylactic treatment or vaccination carried out against the common diseases affecting calves
15. Management practices to follow-up heifers for the expression of heat signs

16. Methods of subsequent heat detection
17. Methods of mating
18. Types of data recorded
19. Methods of data recording
20. Purposes of data recording
21. Selection criteria for animals to be used for breeding/mating
22. Sources of information for selection of breeding animals
23. Reasons for disposal/culling of animals from the farm
24. Ways of disposal of animals for different reasons
25. Milking frequency
26. Milking hygiene (cows udder, milker's hand, milk containers etc)
27. Housing of milking cows
28. Major feed resources available in the farm
29. Feeding management of cows (dry, lactating, pregnant and non-pregnant)

Annex 2 -No. of bulls sold by year

Year	number of bulls sold
1989	2
1990	4
1991	4
1992	11
1993	8
1994	8
1995	10
1996	1
1997	29
1998	10
1999	10
2000	19
2001	21
2002	27
2003	25
2004	20
2005	21
2006	8
2007	34

Source: WSSDF, 2007

Annex 3.Data collecting format (WSSDF)
Breeding, production and health record

Sold to _____

Reason _____

Death and reason _____

Animal no. _____ Sex _____ Breed _____

Sire no. _____ Dam no. _____

Date of birth _____ B.weight _____ Weaning date _____ W.weight _____

BREEDING & PRODUCTION RECORD

Service date	2000					
1 st						
2 nd						
3 rd						
Date due						
Calv.date						
Calf sex						
Calf no.						
Birth wt						
Milk start.						
Milk stop.						
Days in milk						
T.prod.						
305d.pro						
B/F %						
B/F %						
B/F kgs						
Protein %						
Pro.kgs						
Remarks						

Cont....

VACCINATION HISTORY

Animal no. _____ Breed _____

Sex _____ Date of birth _____

Blackleg	FMD	CBPP	Rinderpest	Anthrax	Brucellosis	Remarks

CASE RECORD

Date	Diagnosis	Treatment	Prognosis	Remarks

CURICULUM VITAE
PERSONAL INFORMATION

Name: Habtamu Lemma
Sex: Male
Father's Name: Lemma Didana
Marital Status: Married
Nationality: Ethiopian
Date of Birth: October 1970
Language: English, Amharic and Wolaitigna
Correspondence Address:
P.O.Box 128, Wolaita Sodo, Ethiopia
Telephone: +251 0465513025(Home)
+251 0465513062(Office)
+251-0911-735980(cell)

SUMMARY OF QUALIFICATIONS (EDUCATION)

- B.Sc Agriculture (Animal production and Rangeland Management),Addis Ababa University ,Awassa college of Agriculture (1992-1995)
(Thesis Title: The Fate of Salmonella strains in artificially contaminated *Ayib* (Ethiopian Cottage Cheese)
- On the job trainings -Training of trainers for College Instructors (FDRE MOA)
-Participatory Rural Appraisal (FARM Africa-NGO)

JOB EXPERIENCE

- Presently working as Senior Instructor (Animal Science department) in Wolaita Sodo Agricultural Technical Vocational Education and Training(ATVET) College since transferred from zonal MOA(June 2002)
-Give practical demonstrations and teaching in classroom.
-prepared Beef Cattle production training material

- has done Survey on Wolaita Fattening System for use in the training as an example of traditional fattening system.
- served as department head from 1994-95
- served as registrar from 1995-96
- self-initiated and shared experience from other institutions while the college began its work.
- worked for MOA in Livestock and Feeds Extension Department, i.e. giving technical assistance and guidance to farming communities. And established forage demonstration site and with that many farmers are empowered to produce improved forage plants in their plots of lands.

Technical papers (Publications)

1. Forage Adaptability on-farm trial in Ofa (FARM Africa Proceedings – Review of experiences with participatory on farm trials in the Southern Region of Ethiopia)
2. Productive performance of indigenous cattle and their crosses with temperate breeds in Ethiopia. A review AAU, FVM, Debre Zeit. 2008. 22pp.
- 3) Other unpublished materials- Beef Cattle production course training material, survey paper on Wolaita cattle Fattening system

ADDITIONAL ACTIVITIES

- Undertaking extension & Research activities in the surrounding districts.
- Carried out assessment on constraints & potentials of local livestock Production by preparing proposals (Collaborated with FARM Africa, & EARO).
- Given trainings in collaboration with NLDP (Dairy& feeds, Semen production, Breeding) and also with NGO – AFD (on Forage dev't), INTER AIDE FRANCE (livestock production & forage dev't) to AI inseminators, farmers and MOA development agents.
- Worked as a translator & resource person for foreign agric researchers in their study of gathering information on local farming system.

HOBBIES – Documentations (facts & figures), Correspondence, Watching movies, Reading magazines& news paper & etc.

MEMBERSHIP- Ethiopian Society for Animal Production (ESAP),Wolaita Development Association(WODA)

REFERENCES

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- 2/ Dr Kebede Abegaz (Asst . prof) , Debub University, P.O.Box 05,Awassa, Ethiopia
- 3/ Head of MOA, Wolaita zone, Tel. 251-6512114 P.O .Box 42, Wolaita Sodo, Ethiopia
4. Head of Wolaita Sodo ATVET College, Tel.513062.P.O.Box 120
- 5/ Dr Tilahun Amede,(AHI / Tropical soils Biology & Fertility Institute of CIAT) c/o ILRI, P.O.Box 5689,A.A e.mail: T. Amede@ cigar.org. Tel . 463215
- 6/Dr kelay Belihu (Asst. prof)AAU,FVM,Debre zeit, Ethiopia

SIGNED DECLARATION SHEET

This Thesis is my original work, has not been presented for any degree in any other university and that all sources of material used for the Thesis have been duly acknowledged.

Name: HABTAMU LEMMA DIDANNA

Signature: _____

Date of Submission: _____

This Thesis has been submitted for examination with our approval as university advisors

Dr KELAY BELIHU (DVM,PhD) _____

Ato Gebeyehu Goshu (BSc.,MSc.) _____