ADDIS ABABA UNIVERSITY

FACULTY OF VETERINARY MEDICINE

# A STUDY ON REPRODUCTIVE PERFORMANCE OF CROSSBRED DAIRY COWS IN SMALLHOLDER DAIRY FARMS IN SOUTH EAST SHOA ZONE OF OROMIA REGION, ETHIOPIA

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**A thesis submitted to the school of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the degree Master of Sciences in Tropical Veterinary Medicine**

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| | |
|---|---|
| AI | Artificial Insemination |
| AFC | Age at First Calving |
| CI | Calving interval |
| DO | Days Open |
| FSH | Follicle Stimulating Hormone |
| LH | Leutinizing Hormone |
| NSC | Number of Services Required per Conception |

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# ABSTRACT

Retrospective and follow-up studies were conducted from October 2004 to February 2005 to study the reproductive performance of crossbred dairy cows in urban and rural smallholder dairy farms in Adami Tulu Jido Combolcha Wereda, South East Shoa Zone of Oromia Region. A total of 141 rural and 146 urban smallholder dairy farms keeping 2-5 crossbred dairy cows per farm were included in the sample for the retrospective study. The total numbers of animals sampled from the rural and urban area were 244 and 259 dairy cows, respectively. For the follow-up study a total of 128 post-partum crossbred cows (68 cows from urban area and 60 cows from the rural area) from 68 urban and 60 rural smallholder dairy farms were sampled from those cows included in the retrospective study. Retrospective data on reproductive performance indicators (AFC, CI, DO, GL and NSC), cow attributes (age, breed, and parity) and general farm management practices were collected from the farms by questionnaire method and/or individual record. In the follow-up study postpartum dairy cows were followed for about 90 days to collect information on DO and NSC. The over all mean values (n=503) for AFC, CI, DO, GL and NSC were 32.11 months, 411.61 days, 134.77 days, 277.62 days and 1.67, respectively. In the urban areas, the mean values (n=259) of AFC, CI, DO, GL and NSC were 31.85 months, 406.05 days, 129.54 days, 277.59 days and 1.62, respectively. In the rural areas, the mean values (n=244) of AFC, CI, DO, GL and NSC were 32.38 months, 417.52 days, 140.32 days, 277.64 days and 1.71, respectively. Only CI and DO significantly varied between the two production systems ($p<0.001$). In the urban area, parity status had significant effect on DO ($p<0.05$) and NSC ($p<0.01$).DO and NSC decreased as the parity number increased. In addition, season of previous calving had significant effect on CI ($p<0.001$), DO ($p<0.05$) and NSC ($p<0.05$). The best values for CI (403.33 days) and DO (130.46 days) and NSC (1.55) were recorded in the dry season and short rainy season, respectively. In the rural area too, party had significant effect on DO ($p<0.05$) and NSC ($P<0.001$). Both parameters decreased with increment of parity number until the 3$^{rd}$ parity. Season of previous calving had significant effect on CI ($p<0.001$), DO ($p<0.001$) and NSC ($p<0.05$) in the rural area. The best values of CI (411.79 days) were found in the long rainy season while the best values of DO (131.15 days) and NSC (1.56) were found in the short rainy season. AFC was significantly affected by breed of cows only in the rural areas ($p<0.01$). None of the factors breed, parity number and season had significant ($p>0.05$) influence on the length of gestation period of the cows in both areas.

Key words: dairy cow, crossbred, AFC,CI,DO,GL,NSC, breed, parity, season, urban and rural smallholder dairy farms, Adami Tulu Jido Combolcha Wereda

# 1. INTRODUCTION

Ethiopia is a country with large livestock resource, however, livestock productivity is said to be poor due to a number of reasons among which the low genetic capacity of indigenous cattle for milk and meat production is one of the major constraints of a successful dairy development in the country (Mukasa-Mugerwa *et al*., 1989a; Negussie *et al*., 1998; Shiferaw *et al*., 2003). The most suitable cow for dairy production in tropical area is a crossbred animal with a proportion of genes from high producing cattle of temperate origin and a proportion from adapted, but low producing indigenous cattle; in many cases $F_1$ with the advantage of hetrosis (Mason, 1974). In Ethiopia, crossbred cattle mainly crosses of zebu and Holstein-Friesian cattle have been used for milk production (Alberro, 1983; Mukasa-Mugerwa *et al*., 1991; Bekele *et al*., 1991; Negussie *et al*., 1998; Shiferaw *et al*., 2003). For an effective crossbreeding programme, the reproductive efficiency of female and male animals has been found to be an essential factor. Low reproductive efficiency hinders genetic improvement efforts and causes direct economic loss in tropical regions (Mukasa-Mugerwa *et al*., 1991).

According to various authors (Alberro, 1983; Agyemang and Nkhonjera, 1990; Hafez, 1993; Haile-mariam *et al*., 1993; Bekana *et al*., 1994a; 1994b; 1996a; 1996b; Bekana 1997; Kindahl *et al*., 1999; Negussie *et al*., 1998; Shiferaw *et al*., 2003; Masama *et al*., 2003; Lyimo *et al*., 2004) main indicators of reproductive efficiency in the female animal are age at puberty, AFC, DO,CI  and NSC. Reproductive efficiency of dairy cows is influenced by different factors including genetic, season, age, production system, nutrition, management, environment and disease (Alberro, 1983; Agyemang and Nkhonjera, 1990; Mukasa-Mugerwa *et al*., 1991; Bekele *et al*., 1991; Negussie *et al*., 1998; Dobson and Smith, 2000; Sheldon and Dobson, 2003; Shiferaw *et al*., 2003).

The post-partum period has been reported to be a crucial event in the life of dairy cows, during which the animal should reestablish normal uterine and ovarian activities (Bekana *et al*., 1996b). Prolonged interval to first ovulation, retained fetal membranes and uterine infections and low level of progesterone are the main factors that impair post-partum reproductive performance (Bekana *et al*., 1994b; 1996b; Bekana, 1997). Poor reproductive performance in smallholder dairy farms in Malawi evidenced by long open period and CI, which was attributed to lapses in AI services and deficiency in animal feed supply (Agyemang and Nkhonjera, 1990).

An over all superiority of $F_1$ crosses over the indigenous cows was reported in Ethiopia in that the crossbred cows had shorter AFC, less NSC, and reduced DO and CI (Negussie *et al*., 1998). Accurate evaluation of the reproductive efficiency of indigenous stocks and their crossbred in different production system is essential for the development of appropriate breeding strategies (Negussie *et al*., 1998). A number of research works have been conducted on reproductive performance of indigenous and cross bred cows under a relatively controlled condition at research centers, government owned institutions and in some urban and periurban dairy cows in central highland of Ethiopia (Swensson *et al*., 1981; Alberro 1983; Mukasa-Mugerwa *et al*., 1989a; Mukasa-Mugerwa *et al*., 1989b; Mukasa-Mugerwa *et al*., 1991, Bekele *et al*., 1991; Haile-mariam *et al*., 1993; Haile-mariam and Kassa-mersha, 1994; Negussie *et al*., 1998, Shiferaw *et al*., 2003). In spite of all those studies, studies on reproductive performance of smallholder dairy cows in the rift valley of South East Shoa Zone of Oromia Region are limited. In view of this, the objectives of present study are:

- Assessing the reproductive performance of urban and rural smallholder dairy cows in the study areas

- Determining factors affecting the reproductive performance of urban and rural smallholder dairy cow in the study areas

# 2. LITERATURE REVIEW

## 2.1. Bovine oestrous cycle

The time interval between the beginnings of oestrus in the absence of successful mating, which is the expression of repeated series of ovarian changes, particularly in secretion of steriod hormones and the animal sexual behaviour, is referred as the oestrous cycle (Hunter, 1980). According to the author, it is divided into two main phases the luteal phase and the follicular phase. The former comprises of metoestrus and dioestrus while the later includes the proestrus and oestrus. The luteal phase follows the formation of the corpus luteum after ovulation during which progesterone secretion is the principal ovarian event. The follicular phase is a rapid follicular development phase that begins when the corpus luteum regresses and involves secretion of estrogen from one or more maturing follicles and ends with oestrus and ovulation of one or more giraffian follicles (Hunter, 1980; McDonald, 1980; Peters, 1985; Roberts, 1986; Graverick and Smith, 1993; Hafez, 1993).

The length of oestrous cycle has been known to be affected by different factors. There has been a breed difference in the length of oestrous cycle, that $F_1$ crosses of Friesian and zebu have shorter cycle period than zebus (Alberro, 1983). A short oestrous cycle with short luteal phase is proved to occur in post-partum cows (Bekana, 1997). Generally, the normal interovulatory period of oestrous cycle in cows is about 21 days. The luteal phase occupies approximately 14 days followed by a follicular phase of 4-5 days. The short oestrous cycle in post-partum cows lasts 10-11 days having about 6 days of the luteal phase and 4-5 days of follicular phase (Bekana, 1997). The period of oestrus ranges from 18-19 hrs, while the time of ovulation is 10-11 hrs after end of oestrus in cows (Hafez, 1993). The mean oestrous cycle length of Ethiopian highland Zebu is about 18-21 days (Mukasa-Mugerwa *et al*., 1989a). On the other hand, the Arsi zebu in Ethiopia showed a period of 25 days of oestrous cycle while their contemporary $F_1$ Friesian crosses showed 23 days (Alberro, 1983).

### ***2.1.1. Hormonal control of oestrous cycle***

Various hormones have been known to stimulate or inhibit each other and accordingly have their effects on the animals' reproductive organs that are responsible for regulation of reproductive processes (McDonald, 1980; Peters, 1985). The hypothalamus secretes releasing hormones into the hypothalamic-hypophyseal portal system. These releasing hormones act in specific cells in the adenohypophysis and result in the release of gonadotropine hormones, namely, Follicle Stimulating Hormone (FSH), Leutinizing Hormone (LH) and Prolactin. The cyclicity of gonadotropine hormones is a characteristic property of the oestrous cycle. Follicle stimulating hormone is secreted into the circulation and transported to the ovary where it stimulates follicular development, while LH is secreted and acts synergistically with FSH to stimulate secretion of estrogen by ovarian follicles.

Progesterone has been reported to be a key hormone for the assessment of cyclicity of post-partum oestrus (Bekana *et al*., 1996a; Bekana, 1997; Kindahl *et al*., 1999). Progesterone exerts a negative feed back on the hypothalamus and/or adenohypophysis to decrease gonadotropine secretion (McDonald, 1980; Hunter, 1980; Peters, 1985; Hafez, 1993). The corpus luteum reaches its maximum weight at about day 11 of oestrous cycle and begins to regress after about 14-16 days of oestrous cycle (McDonald, 1980; Peters, 1985). The hormonal control for the regression of corpus luteum is by prostaglandin ($PGF_{2\alpha}$) release from the uterus, which will be followed by increased level of estrogen during the luteal phase when the endometrium is primed with progesterone (Bekana *et al*., 1996a; Bekana, 1997; Kindahl *et al*., 1999).

### *2.1.2. Factors affecting the oestrous cycle*

**Breed**

Different researchers (Plasse *et al*., 1970; Sewensson *et al*., 1981; Alberro, 1983) have investigated the effect of breed on oestrous cycle phenomenon. According to these authors, there is a clear manifestation of breed differences in oestrus cycle that crossbred heifers showed better demonstration of oestrus than pure zebu heifers and the duration of oestrous cycle and oestrus is lower in zebu than crossbred cows.

**Season**

Seasonal variation in oestrus activity have been reported by many authors (Swensson *et al*., 1981; Mukasa-Mugerwa *et al*., 1991; Obese *et al.,* 1999; Alnimer *et al.,* 2002). Seasonal effects on oestrous cycle of Arsi cows in Ethiopia showed that the number of cows coming into oestrus rises with the rainy season. Seasonal differences in oestrus characteristics may be associated with fluctuations in nutrition, level of relative humidity, ambient temperature and sunshine intensity (Swensson *et al*., 1981; Mukasa-Mugerwa *et al*., 1991).

**Lactation/Suckling**

Lactation has been reported to influence oestrous cycle through inhibition of the ovaries and delayed ovulation in suckling animals. Suckling delays onset of oestrous activity most and thus cows come in to oestrus after weaning of the calf (Swensson *et al*., 1981). The extended interval from calving to resumption of ovarian activity is reported to be due to the suckling stimulus (Obese *et al*., 1999). Lactating dairy cows have been found to have poor reproductive performance because of low fertility and low rates of oestrus detection (Pursley *et al*., 1997).

**Nutrition**

The effects of nutrition on oestrous cycle events have been investigated by a number of research works (Roche *et al*., 2000; Boland *et al*., 2001; Formingoni and Trevisi, 2003; Diskin *et al.*, 2003). Acute nutrition deprivation of heifers has immediate deleterious effect on follicular growth and ovulation (Roche *et al*., 2000). Long term moderate or chronic dietary restriction results in a gradual reduction in dominant follicle growth rate, maximum diameter and persistence. In contrast, acute dietary restriction to 40% of maintenance requirements rapidly reduces dominant follicle growth rate and maximum diameter and induces anoestrus in a high proportion (60%) of heifers within 13-15 days of dietary restriction (Diskin *et al*., 2003). In lactating diary cows, negative energy balance or reduced dietary in take in the early post-partum period, while not affecting the population of small to medium size follicles, adversely affects the size and ovulatory fate of the dominate follicle. Fat supplementation at a rate of about 3% of dietary dry matter has often positively influenced the reproductive status of the dairy cow including increased size of ovulatory follicle, increased number of ovarian follicles, increased plasma progesterone concentration, reduced secretion of prostaglandin metabolite, increased life span of corpus luteum and improved fertility (Staples *et al*., 1998).

A serious of energy deficit is known to suppress pulsatile secretion of gonadotropines that causes ovarian dysfunction and/or smaller follicles (Formingoni and Trevisi, 2003). During period of inadequate nutrition or stress, the intensity of oestrus is reduced by inadequate exposure to oestradiol (Sheldon and Dobson, 2003).

## Intrauterine infection

Retained fetal membranes have been reported to prolong the resumption cyclical ovarian activities and the time required for the completion of uterine involution (Bekana *et al*., 1994b). The authors have also described decreased ovarian activity and occurrence of endometeritis in cows with retained fetal membranes due to mixed infections of *Actinomyces pyogenes*, *Bacteriodes species* and *Fusobacterium necrphorum.*

## Managerial factors (Oestrus detection and optimum time of insemination)

Poor oestrus detection has been reported to be the single most important factor limiting high reproductive efficiency in dairy herd (Heersche and Nebel, 1994; Senger, 1994; Nebel *et al.,* 2000). Lower reproductive efficiency in dairy herds because of poor detection of oestrus is due to failure to detect oestrus or erroneous diagnosis of oestrus (Senger, 1994).The goal of an oestrus detection programme should be to identify oestrus positively and consequently to identify animals not cycling. The ultimate goal should be to predict time of ovulation, thus allowing for insemination that will maximize the opportunity for conception (Nebel *et al.,* 2000). The ability of management to detect oestrus efficiently and accurately in cows and heifers profoundly influences reproductive performance and profitability of dairy herds (Heersche and Nebel, 1994). Cows in oestrus usually stand to be mounted by herd mates. Therefore, visual observation of the herd for this type of behaviours has been found to be an effective method of oestrus detection (Hafez, 1993; Rorie *et al*., 2002; Nebel *et al*., 2000). Even though visual observation is accurate at detecting animals in oestrus, its efficiency has been reported to be about 50 to 70% (Rorie *et al.,* 2002). To alleviate such problem several other methods have been developed in the past to increase the efficiency of oestrus detection. Among the other methods teaser bulls fitted with china balls or marking balls have been used for detection of oestrus (Hafez, 1993). Recently, new technologies like electronic devices (pedometer, intravaginal resistance probes, mount monitor oestrus watch, stand alone mount monitor and pressure sensing radiotelemeteric systems) have been developed to solve problems of oestrus detection, and thus, are expected to be more effective than visual observation (Senger, 1994; Rorie *et al.*, 2002). These commercially available devices for oestrus detection function based on physical activity (pedometers), changes in electrical resistance of reproductive tract secretions (intravaginal resistance probes) or detection of mounting activity (Rorie *et al.*, 2002). The new technologies are expected to provide adequate information on continuous 24 hr/day surveillance of the cow, accurate and automatic identification of cows in oestrus, operation of the productive life time of the cow, minimize labor requirements, and high accuracy in identifying the appropriate physiologic or behavioural events that correlate highly with ovulation (Senger, 1994).

Very recently, the application of ultrasonography has been found to be an important aid for oestrus detection through measuring ovarian follicle growth, an increase in size of cervical diameter, increase in uterine wall thickness and change in shape of uterus (Pierson and Ginther, 1984a; Pierson and Ginther, 1984b; Bekana *et al*., 1994a). Oestrus detection by the use of progesterone assay has been widely applied (Lamming and Bulman, 1976; Mukasa-Mugerwa *et al*., 1989b; Bekana, 1997).

Synchronization of oestrus behaviour through pharmacological control has been used to improve reproduction efficiency (Nebel and Jobst, 1998). The systematic use of hormones for synchronization of oestrus and ovulation has been propagated (Stolla *et al.,* 1998). Recent developments in prostaglandin based oestrus synchronization programmes for post-partum dairy cows increase the efficiency of controlled breeding even for cows with abnormal ovarian conditions (Yaniz *et al*., 2004). A double prostaglandin protocol applied 11-14 days apart seems to be capable of bringing cows to oestrus (Bekana *et al.,* 2004). The administration of oestradiol or human chorionic gonadotropines or both after prostaglandin treatments improves synchrony of oestrus but yet does not enhance the conception rate.

Observing cows in oestrus and inseminating them at the optimum time are necessary steps for effective reproductive management (Nebel and Jobst, 1998). The oestrus period takes

12-24 hrs in the cow and ovulation occurs at about an average of 12 hrs or 10-15 hrs after the end of oestrus (Roberts, 1986). For cows, which normally ovulate after the end of oestrus, the best insemination time is from 6 to 24 hr before ovulation (Hunter, 1980; Roberts, 1986; Hafez, 1993).

## 2.2. Pregnancy diagnosis

The objective of pregnancy diagnosis is to determine whether animals have or not have conceived (Hafez, 1993). The principal characteristics of an ideal method of pregnancy diagnosis are that it should be accurate, inexpensive, quickly performed and give an immediate result to avoid secondary handling of animals (Hunter, 1980).

The rectal palpation method has been used for several years to determine whether the uterus is pregnant or not according to the procedure described earlier (Hunter, 1980; Roberts, 1986; Hafez, 1993). Asymmetry of the two uterine horns and prominent fluctuation between the thumb and forefinger and thin uterine wall in the gravid horn, have been used as indicators of early pregnancy (Hunter, 1980; Roberts, 1986; Hafez, 1993). Moreover, plasma and milk progesterone assays are becoming more attractive means of diagnosing pregnancy (Lamming and Bulman, 1976; Mukasa-Mugerwa *et al*., 1989b; Bekana, 1997). The applications of ultrasonography have been best used as the recent technology for pregnancy diagnosis (Pierson and Ginther, 1984a; 1984b).

## 2.3. Reproductive performance indicators

### *2.3.1. Days open*

Involution of the uterus and recyclicity of the ovarian function to prepare the animal for new pregnancy period characterize the post-partum period (Kindahl *et al.,* 1999; Bekana, 1997). The post-partum period as an indicator of reproductive performance of cows have been reported to be the major event from a practical and economic point of view by a number of research works (Bekana *et al.,* 1994a; 1994 b; 1996a; Bekana *et al.,* 1996b; Bekana, 1997; Negussie *et al.,* 1998; Kindahl *et al.,* 1999; Obese *et al.,* 1999; Shiferaw *et al.,* 2003; Lyimo *et al.,* 2004).The characteristic of post-partum period in cow is slow uterine involution during 4 to 5 week post-partum (Bekana *et al.,* 1994a). During the first short post-partum oestrus cycle period, the magnitude of progesterone concentration is lower which result in refractoriness of the developing corpus luteum needing several $PGF_{2\alpha}$ release to induce luteolysis (Bekana, 1997). This short luteal phase increases the period from calving to conception due to misleading nature of the phenomenon that observable oestrous can be possibly missed.

Generally, the post-partum period interval under different management, location, breed and climatic condition on dairy cows has been reported by a number of investigators (Bekana *et al.,* 1994a; 1994b; 1996a; 1996b; Bekana, 1997; Negussie *et al.,* 1998; Kindahl *et al.,* 1999; Obese *et al.,* 1999; Shiferaw *et al.,* 2003; Lyimo *et al.,* 2004). These different findings on the length of post-partum period are outlined in Table 2. Climate, season, lactation period, suckling period, weaning time, animal breed, body condition, energy intake, age, body weight, diseases, stresses and management have an influence on post-partum period (Vandeplassche, 1985; Negussie *et al.,* 1998; Shiferaw *et al*., 2003). As to the findings of these different authors, the suggestion given to either the shorter or longer post-partum interval is related to one or more of the above influencing factors. The age of the cows, breed, calving season, forage availability, nutritional deficiencies coupled with heavy internal and external parasitic burden and management problems in oestrus detection probably contributed for the long post-partum period observed in their study (Mukasa-Mugerwa *et al*., 1991; Shiferaw *et al*., 2003). The extended interval from calving to resumption of ovarian cyclical activity is attributed partly to suckling (Swensson *et al*., 1981; Obese *et al*., 1999). Long post-partum period was also reported to be because of the reluctance of farmers to allow AI for their cows, failure to detect oestrus and inefficiency of AI service (Agyemang and Nkhonjera, 1990). The length of post-partum period was affected by year of calving and dam's parity number (Mukasa-Mugerwa *et al*., 1991). The post-partum anoestrus period is extended in younger cows than older animals a result of their concurrent nutrient requirements for growth and location. Higher post-partum period in zebu than crossbred cows has also been reported (Alberro, 1983; Negussie *et al*., 1998).

### ***2.3.2. Age at first calving***

Assessments of reproductive efficiency of cows using AFC have been reported by a number of investigators (Alberro, 1983; Mukasa-Mugerwa *et al.,* 1989a; Agyemang and Nkhonjera, 1990; Haile-mariam *et al.,* 1993; Haile-mariam and Kassa-mersha, 1994; Negussie *et al.,* 1998; Ageeb and Hayes, 2000; Masama *et al.,* 2003; Rocha *et al.,* 2001; Shiferaw *et al.,* 2003). These different findings on AFC are outlined in table 1. A variety of factors may advance or delay AFC. Environmental factors especially nutrition determines prepubertal growth rates, reproductive development, onset of puberty, subsequent fertility and adaptation to the environment (Agyemang and Nkhonjera, 1990; Haile-mariam *et al.,* 1993; Negussie *et al.,* 1998; Masama *et al.,* 2003; Shiferaw *et al.,* 2003).

$F_1$ crossbred heifers have been shown to have earlier calving than indigenous heifers (Alberro, 1983; Agyemang and Nkhonjera, 1990; Haile-mariam *et al.,* 1993; Negussie *et al.,* 1998). This apparent superiority of $F_1$ crosses over indigenous heifers is suggested to be due to heterosis effect exhibited by the $F_1$ crosses and the additive genetic effect from the exotic blood for faster growth rates at an earlier age (Negussie *et al.*, 1998). However, 75% crossbred heifers (Friesian x Zebu) showed longer AFC than $F_1$ crosses (Agyemang and Nkhonjera, 1990; Haile-mariam *et al.*, 1993). This was attributed to lack of adaptation of the heifers with higher exotic blood, i.e. the reduction in genes contributed by cattle of indigenous origin in the crossbred per se is responsible. Similarly, year of birth has been described to influence AFC. Factors such as inconsistency of age at first breeding, scarcity of feed and other managerial differences over the years is stated to contribute to the variation in AFC (Agyemang and Nkhonjera, 1990; Haile-mariam *et al.*, 1993;).

### *2.3.3 Calving interval*

CI has been considered to be a very important index of cow reproductive efficiency and herd performance (Swensson *et al.,* 1981; Alberro, 1983; Mukasa-Mugerwa *et al.,* 1989a; Agyemang and Nkhonjera, 1990; Bekele *et al.,* 1991; Mukasa-Mugerawa *et al.,* 1991; Haile-mariam *et al.,* 1993; Haile-mariam and Kassa-mersha, 1994; Negussie *et al.,* 1998; Obese *et al.,* 1999; Rocha *et al.,* 2001; Mayne *et al.,* 2002; Masama *et al.,* 2003; Shiferaw *et al.,* 2003). CI is the length of period between two consecutive calving of a cow (Negussie *et al*., 1998; Shiferaw *et al.,* 2003) and is a function of the number of days open and GL (Agyemang and Nkhonjera, 1990). Since GL is more or less a constant character within a given species, days open to conception becomes sole component of CI (Agyemang and Nkhonjera, 1990). Average values of CI in cows reported by different authors are indicated in Table 1.

Different factors have been reported to influence CI. The CI has been found to decrease as the age of cow increased (Bekele *et al* 1991; Negussie *et al,* 1998; Obese *et al,* 1999). The larger CI in young growing animals is attributed to lactation stress in their earlier parities and the ability of middle aged to gain body weight quickly after calving. It has also been reported that crossbred cows had a shorter CI than their indigenous herd mates (Alberro, 1983; Agyemang and Nkhonjera, 1990; Negussie *et al.,* 1998). The impact of season on CI has also showed that cows calving at the end of the dry season and during shorter rainy season had relatively shorter duration of CI than those calving during the rainy season. This seasonal variation is attributed to improvements of nutritional conditions in the subsequent rainy season to meet their requirements for maintenance, growth, lactation and fertility (Mukasa-Mugerwa *et al.,* 1989a; Negussie *et al.,* 1998; Obese *et al.,* 1999). Extended CI is associated with long post-partum anoestrus period, poor oestrus detection and low conception rates (Mukasa-Mugerwa *et al.,* 1991). Long open periods and hence long CI generally reflect problems associated with management (Agyemang and Nkhonjera 1990) and ovarian function, retained fetal membranes and the subsequent intrauterine infection (Bekana *et al.,* 1994a; 1996a; 1996b; Bekana, 1997; Kindahl *et al*., 1999). Undernutrition has also been reported to cause longer CI as a result of impaired ovarian function resulting in repeat breeding due to poor body condition during early post-partum period (Obese *et al*., 1999; Masama *et al*., 2003).

### *2.3.4. Number of services per conception*

NSC, as an indicator of reproductive efficiency has been defined as the number of services required for a successful conception (Swensson *et al*., 1981; Alberro, 1983; Bekele *et al*., 1991; Haile-mariam *et al*., 1993; Negussie *et al*., 1998; Shiferaw *et al*., 2003). The findings of these research works are summarised in Table 2. Several factors have been reported to influence the NSC. Indigenous cows are more or less similar to their contemporary $F_1$ crosses in this trait suggesting that under optimal feeding and management conditions indigenous cows could be as fertile as the crosses (Alberro 1983; Haile-mariam *et al*., 1993; Negussie *et al*., 1998). Slight improvement of number of service per conception observed in the $F_1$ crosses could be due to favorable heterosis effect exhibited by those groups (Negussie *et al*., 1998). Breeding taking place during the dry season required more services per conception than the short and long rainy season (Swensson *et al*. 1981; Haile-mariam *et al*. 1993; Negussie *et al*., 1998).

**Table 1. Summary of different findings of age at first calving and calving interval**

| Breed | Country | AFC (months) | CI (days) | Source |
|---|---|---|---|---|
| Friesian x Zebu (F1) | Malawi | 36.70 | 488.0 | Agyemang and Nkhonjera, 1990 |
| 3/4 Friesian Zebu | Malawi | 40.10 | 482.0 | Agyemang and Nkhonjera, 1990 |
| Sanga cows | Ghana | - | 444.3 | Obese *et al*., 1999 |
| Holstein- Friesian | Sudan | 25.20 | - | Ageeb and Hayes, 2000 |
| Mixed | Zimbabwe | 58.30 | 594.0 | Masama *et al*., 2003 |
| Mixed | Zimbabwe | 36.80 | 512.0 | Masama *et al*., 2003 |
| Boran | Ethiopia | 45.20 | 465.0 | Haile-mariam *et al*., 1993 |
| F1Boran- Friesian | Ethiopia | 31.50 | 525.0 | Haile-mariam *et al*., 1993 |
| 3/4 Friesian x 1/4 Boran | Ethiopia | 32.70 | 487.0 | Haile-mariam et al., 1993 |
| 75%- 87% Friesian | Ethiopia | - | 495.5 | Bekele *et al*., 1991 |
| 75%- 87% Friesian | Ethiopia | - | 435.2 | Bekele *et al*., 1991 |
| 75%- 87% Friesian | Ethiopia | - | 544.9 | Bekele *et al*., 1991 |
| Pure Friesian | Ethiopia | - | 445.4 | Bekele *et al*., 1991 |
| Zebu x Friesian | Ethiopia | - | 475.1 | Bekele *et al*., 1991 |
| Arsi | Ethiopia | 32.80 | 410.7 | Negussie *et al*., 1998 |
| F1 Friesian x Arsi- Zebu | Ethiopia | 28.50 | 351.2 | Negussie *et al*., 1998 |
| Friesian x Arsi- Zebu | Ethiopia | 29.20 | 358.1 | Negussie *et al*., 1998 |
| Friesian x Zebu | Ethiopia | 30.20 | 386.7 | Negussie *et al*., 1998 |
| Friesian x Zebu | Ethiopia | 40.60 | 551.8 | Shiferaw *et al*., 2003 |
| Friesian x Zebu | Ethiopia | 41.91 | 734.0 | Shiferaw *et al*., 2003 |
| Friesian x Zebu | Ethiopia | 39.65 | 517.6 | Shiferaw *et al*., 2003 |
| Friesian x Zebu | Ethiopia | 36.78 | 462.0 | Shiferaw *et al*., 2003 |
| Friesian x Zebu | Ethiopia | 41.25 | 490.7 | Shiferaw *et al*., 2003 |
| Friesian x Zebu | Ethiopia | 42.40 | 442.0 | Hail-Mariam and Kassa-mersha, 1994 |
| *Bos taurus* | Northern Ireland | - | 407.2 | Mayne *et al*., 2003 |
| *Bos taurus* | Portugal | 32.00 | - | Rocha *et al*., 2001 |

AFC= Age at first calving, CI= Calving interval

**Table 2.Summary of different findings of post-partum period and NSC**

| Breed | Country | PPP (day) | NSC | Author |
|---|---|---|---|---|
| Zebu x Friesian | Ethiopia | 196.80 | 1.83 | Bekele *et al*., 1991 |
| Arsi Zebu | Ethiopia | 304.10 | - | Mukasa -Mugerwa *et al*., 1991 |
| Arsi | Ethiopia | 134.10 | 2.00 | Negussie *et al*., 1998 |
| $F_1$ Jersey x Arsi | Ethiopia | 76.30 | 1.80 | Negussie *et al*., 1998 |
| $F_1$ Friesian x Arsi | Ethiopia | 82.90 | 2.00 | Negussie *et al*., 1998 |
| Friesian x Zebu | Ethiopia | 120.80 | 2.00 | Negussie *et al*., 1998 |
| Friesian x Zebu | Ethiopia | 185.02 | 1.75 | Shiferaw *et al*., 2003 |
| Friesian x Zebu | Ethiopia | 318.66 | 1.66 | Shiferaw *et al*., 2003 |
| Friesian x Zebu | Ethiopia | 166.95 | 1.72 | Shiferaw *et al*., 2003 |
| Friesian x Zebu | Ethiopia | 154.22 | 1.79 | Shiferaw *et al*., 2003 |
| Friesian x Zebu | Ethiopia | 163.21 | 1.78 | Shiferaw *et al*., 2003 |
| Brahman | Mexico | 143.90 | - | Soto *et al*., 2001 |
| Friesian x Zebu | Tanzania | 130.00 | - | Lyimo *et al*., 2004 |
| Bostaurus | Portugal | 176.90 | - | Rocha *et al*., 2001 |
| Bostaurus | Portugal | 148.10 | - | Rocha *et al*., 2001 |
| Friesian x Zebu (F1) | Malawi | 216.00 | - | Agyemang and Nkhonjera, 1990 |
| 3/4 Friesian Zebu | Malawi | 211.00 | - | Agyemang and Nkhonjera, 1990 |
| Sanga cows | Ghana | 101.30 | - | Obese *et al*., 1999 |
| Mixed | Zimbabwe | 104.00 | - | Masama *et al*., 2003 |
| Mixed | Zimbabwe | 86.00 | - | Masama *et al*., 2003 |
| Boran | Ethiopia | - | 1.81 | Haile-mariam *et al*., 1993 |
| 50% Boran x Friesian | Ethiopia | - | 1.61 | Haile-mariam *et al*., 1993 |
| 75%- 87% Friesian | Ethiopia | 215.50 | 1.60 | Bekele *et al*., 1991 |
| 75%- 87% Friesian | Ethiopia | 156.50 | 1.62 | Bekele *et al*., 1991 |
| Friesian & Crossbred | Ethiopia | 165.40 | 1.95 | Bekele *et al*., 1991 |
| 75%- 87% Friesian | Ethiopia | 271.40 | 2.33 | Bekele *et al*., 1991 |

PPP= Post-partum period (Days open till conception), NSC=Number of services per conception.

Lack of deep frozen semen occasionally annual climatic change and hence fluctuations in the quantity and quality of feed available and different management practices followed over the seasons and years could be possible reasons for such annual and seasonal variability in the number of services required per conception (Negussie *et al*., 1998). Management factors such as accuracy of oestrus detection, availability of bulls, the timing of insemination, use of proper insemination technique, quality of semen, proper semen handling and skill of pregnancy diagnosis influences the NSC (Shiferaw *et al*., 2003). The higher NSC might result also from repeat breeding due to infectious and /or non-infectious diseases (Bekele *et al*., 1991). A short oestrus period in tropical cattle such as Arsi zebu and accompanying difficulties in ascertaining the right time for a successful insemination have been reported as reasons for relatively high number of service per conception (Swensson *et al*., 1981).

# 3. MATERILS AND METHODS

## 3.1. Study area

### *3.1.1. Climatic and topographic description of the study area*

This study was conducted in Adami Tulu Jido Combolcha Wereda located in the Southeast Shewa Zone of the Oromia Regional State. The Zone is the largest part of the Mid-Rift Valley that lies 130-180km South of Addis Ababa.

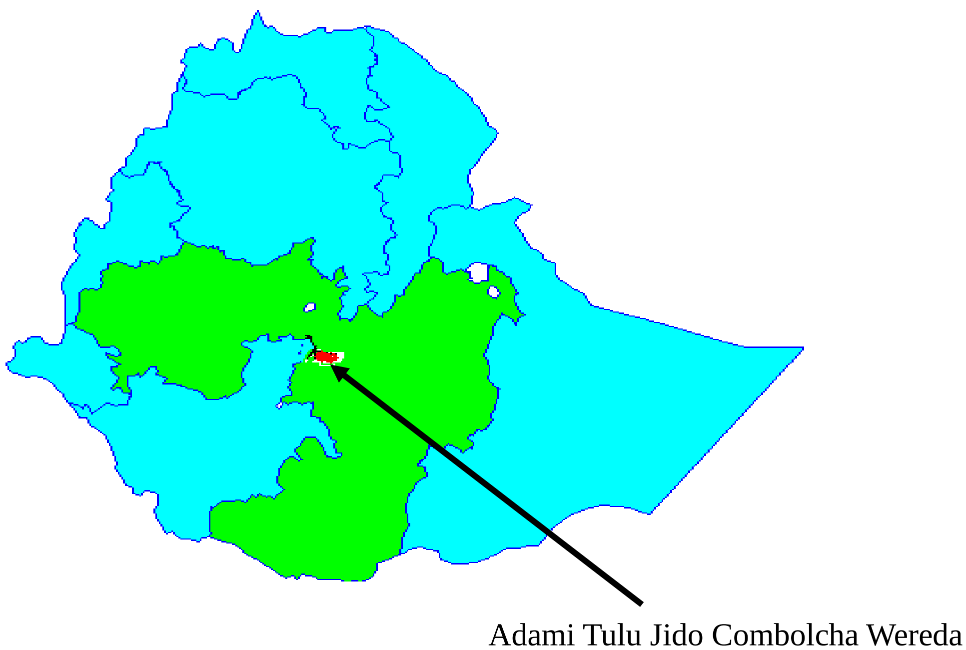


Figure 1: Map showing the study area

The altitude ranges from 500-1800 meters above sea level. The area has an erratic, unreliable and low rainfall, averaging between 500 and 900 mm per annum. The rainfall is bimodal with short rainy season from March to May and long rainy season from June to September followed by the dry season from October to February. The areas have an average maximum and minimum temperature of 27.2 $^{0}$c and 12.7 $^{0}$c, respectively, and a relative humidity of 60% (Ebro *et al.*, 1998).

The total human population of Adami Tulu Jido Combolcha Wereda is about 111,926 out of which 72% live in the rural area and 28% dwell in the urban areas. The total land area of the Wereda is estimated to be about 75,223 hectare, of which 36,661 is under crop production and the remaining 17, 113 hectare is used for grazing (Ebro *et al.*, 1998).

### ***3.1.2. Livestock population, distribution and management system***

Mixed crop-livestock farming is the predominant production system in the area. There are about 254,694, 11,384, 133,902, 12,505, and 49,966 cattle, sheep, goat, equines, camels and poultry, respectively in the wereda. Arsi breed are the predominant cattle species of livestock in the area. Only few crossbred cattle, about 3% of the total cattle population are owned by farmers and the remaining are indigenous. The average number of cattle owned per household in Adami-Tulu is 22.2. Cattle are used as a source of draft power, manure for crop production and to provide milk and meat. The main livestock feeds in the area are grazing on natural pasture. Supplementation with hay, crop residues like maize stover and teff straw were used. The development of small-scale irrigated agriculture using Zeway Lake have significant impact in increasing livestock feed resource during the dry season through agricultural by products especially horticulture by products. The major livestock diseases in the area are anthrax, black leg, brucellosis, drmatophilosis, mastitis and parasitic problems (Ebro *et al.*, 1998).

Smallhoder dairy cows were largely introduced in the area by the Adami Tulu Agricultural Research Station and Abernossa Ranch that supply crossbred dairy heifers. The population of crossbred cattle owned by smallholder dairy producers in the area was 7,600 heads. Rural smallholder dairy farms owned local cattle. The rural farmers keep animals' free stall and seldom practiced supplementation of feed with concentrates. The urban smallholder dairy farms kept only crossbred dairy cattle and regularly provide supplementation feeds like concentrates and keep cows tie stall (Ebro *et al.,* 1998).

Breeding of crossbred cows in most rural farms was practiced using AI, the source of semen is obtained from Friesian or Jersey sire. In some cases, natural mating is used with Friesian sires. Oestrus was detected by visual observation of farmers and reported to AI technician. On each occasion, cows showing oestrus smallholder dairy producers' need to travel 5 to 10 km distance to get the inseminator for AI service. Pregnancy diagnosis was conducted by veterinarian by using the rectal palpation method after two and half months post breeding.

The study population includes all smallholder dairy farms and their dairy cows found in the rural and urban sectors of the Adami Tulu Jido Combolcha Wereda of Southeast Shoa Zone.

## 3.2. Study design

### *3.2.1. Study type*

Retrospective and follow-up studies were conducted to collect data on the reproductive performance and AI efficiency of crossbred dairy cows of urban and rural smallholder dairy farms.

### *3.2.2. Sampling procedures*

The retrospective and follow-up types of study were conducted by using simple random sampling and purposive sampling procedures, respectively. The sample for the retrospective study were 141 rural and 146 urban smallholder dairy farms keeping 2-5 crossbred dairy cows per farm. A total 244 and 259 dairy cows were used from the rural and urban area, respectively.

For the follow-up study, the purposive sampling was used to determine the performance of smallholder diary cows managed under AI services during the period of October 2004 to February 2005. A total of 128 postpartum crossbred cows (68 cows from urban area and 60 cows from the rural area) from 68 urban and 60 rural smallholder dairy farms were included in the sample.

### *3.2.3. Data collections*

**Questionnaire survey**

A total of 141 rural and 146 urban smallholder dairy farms owning 244 and 259 dairy cows, respectively were used for the questionnaire survey. A structured questionnaire format was prepared and multiple visit interviews were administered to farmers included in both the questionnaire survey and follow-up study to generate data on general farm conditions, cow attributes (age, parity, and breed) and individual cow reproductive performance parameters (AFC, CI and GL), oestrus signs and times of oestrus detection, times of AI services and seasons of previous calving (Annex 1). The questionnaire format was pre-tested by few farmers' individuals and evaluated for the appropriateness of the questions. Data regarding previous values of days open and number of services per conception were collected from record of AI service receipt (Annex 2).

**Follow up study**

From a total of 503 cows included in the questionnaire survey 128 selected postpartum crossbred cows were used for the follow up study to collect data on reproductive performance parameters (DO and NSC)**.** Based on farmers request for insemination cows in heat in the morning were inseminated in the following afternoon, whereas cows that showed heat signs in the afternoon were inseminated in the following morning. Time and dates of oestrus detection and insemination were recorded for each studied cow. Monitoring of cows after first insemination were conducted every 21 days interval for any oestrus sign after the first insemination up to 90 days with the assistance of inseminator and participation of the farmers. Cows observed on oestrus after first insemination were reinseminated and followed similarly (Annex 3). In all inseminated cows, were diagnosis for pregnancy was performed 60 days after breeding by the rectal palpation method.

Main indices parameters were used to asses the reproductive performance in both questionnaire and follow-up studies:

- Calving Interval (CI): the period between two consecutive calving (Shiferaw *et al.,* 2003).
- Number of Services per Conception (NSC): the number of AI services required for conception (Shiferaw *et al.,* 2003).
- Days Open: the number of days from parturition to the subsequent conception (Shiferaw *et al.,* 2003).
- Age at First Calving (AFC): number of days or months from birth to first calving (Shiferaw *et al.,* 2003).
- Gestation Length (GL): number of days or months from conception to the subsequent calving (Roberts, 1986).

### *3.2.4. Data analysis*

Data on DO and NSC originating from both the retrospective (based on record in AI service receipt) and follow-up studies were pooled in one data sheet for analysis. Means and standard errors were calculated using the descriptive statistics procedure. The effects of the production systems on reproductive performance parameters were analysed using Independent t-test analysis method. In each production system, the effects of factors affecting reproductive performance parameters were analyzed using the General Linear Model procedure. In all cases, the SPSS computer software (SPSS 11.05, 2002) was used.

# 4. RESULTS

## 4.1. Overall reproductive performance in the study areas

The overall mean values and standard errors of AFC, CI, DO, NSC and GL are presented in Table 3. The overall mean value of AFC was 32.11 months which is equivalent to 2.67 years. Cows in the study areas were giving calves on average every 13.7 months and conceive on average within 4.49 months postpartum. The average number of services required for each conception was 1.67. Cows in the study areas had an average gestation length of 9.3 months.

**Table 3. Overall mean and standard errors of reproductive performance parameters in the study areas**

| Reproductive parameter | N | Overall mean (SE) |
|---|---|---|
| AFC (months) | 503 | 32.11 (0.158) |
| CI (days) | 503 | 411.61 (0.903) |
| DO (days) | 503 | 134.77 (0.856) |
| NSC(no) | 503 | 1.67 (0.025) |
| GL (days) | 503 | 277.62 (0.059) |

N= number of observation

The results of an independent t-test to analyze the effects of study area (rural and urban) on reproductive performance parameters are presented in Table 4. The results revealed that CI and DO were significantly ($p<0.001$) different between the two study areas. The mean value for CI was significantly ($p<0.001$) lower in the urban area (406.05 days, n=259) than in the rural area (417.52 days, n=244). In addition, the mean value for DO was significantly ($p<0.001$) lower in the urban area (129.54 days, n=259) than the rural area (140.32 days, n=244). Although better performances were recorded in the urban areas for the other parameters too, the differences were not significant (p>0.05)

**Table 4. Results of independent t-test analysis to see effect of study area on reproductive performance parameters**

| Parameters | Production system | N | Mean (SE) | t-value | DF | P-value |
|---|---|---|---|---|---|---|
| AFC (months) | Urban | 259 | 31.85 (0.22) | 1.70 | 501 | 0.090 |
| | Rural | 244 | 32.38 (0.23) | | | |
| CI (days) | Urban | 259 | 406.05 (0.95) | 6.06 | 501 | 0.000 |
| | Rural | 244 | 417.52 (1.47) | | | |
| DO (days) | Urban | 259 | 129.54 (0.91) | 6.55 | 501 | 0.000 |
| | Rural | 244 | 140.32 (1.4) | | | |
| GL (days) | Urban | 259 | 277.59 (0.09) | 0.38 | 501 | 0.706 |
| | Rural | 244 | 277.64 (0.08) | | | |
| NSC | Urban | 259 | 1.62 (0.04) | 1.82 | 501 | 0.069 |
| | Rural | 244 | 1.71 (0.04) | | | |

N= number of observations, AFC= age at first calving, CI= calving interval, DO= days open, GL= gestation length, NSC= number of services per conception, SE=standard error, DF=degree of freedom,

### 4.2. Reproductive performance in the urban area

The results of univariate analysis of variance for factors affecting AFC showed that breed had no significant effect on AFC in the urban area (p>0.05). The details of the results are presented in Annex 4.

The results of multivariate analysis of variance to determine the effect of factors on the parameters of reproductive performance of dairy cows in the urban areas are presented in Table 5. The results revealed that parity number affected DO (p<0.05) and NSC (p<0.01) significantly and season of previous calving influenced CI ($p<0.001$), DO ($p<0.05$) and NSC ($p<0.05$) significantly. Breed of cows had no significant ($p>0.05$) effect on any of the parameters.

**Table 5 Results of analysis of variance for factors affecting reproductive performance of crossbred dairy cows in the urban area**

| Factors | CI | | DO | | NSC | | GL | |
|---|---|---|---|---|---|---|---|---|
| | DF | MS | DF | MS | DF | MS | DF | MS |
| Breed of cow | 2 | 271.91 | 2 | 416.09 | 2 | 0.31 | 2 | 0.860 |
| Parity number | 3 | 39.40 | 3 | 600.78* | 3 | 1.41** | 3 | 0.340 |
| Season of previous calving | 2 | 1837.03*** | 2 | 684.80* | 2 | 0.95* | 2 | 0.040 |
| $R^2$ | 0.99 | | 0.99 | | 0.90 | | 1.00 | |

CI= calving interval, DO= days open, GL= gestation length, NSC= number of services per conception, MS= means square, DF= degrees of freedom, *= $p<0.05$; **= $p<0.01$; ***= $p<0.001$

The least squares means indicated there was a trend of decrement in DO (from 144.27 to 129.28 days) and NSC (from 1.96 to 1.42) with increasing parity number. Variable trends were observed in the case of the effect of season of previous calving on reproductive parameters. Lower value of DO was recorded in the dry season while the smallest NSC was recorded in the short rainy season and the shortest CI was recorded during the dry season (Table 6). None of the factors breed, parity number and season had significant ($p>0.05$) influence on the length of gestation period of the cows.

**Table 6 Least square means and standard errors of reproductive performance parameters in the urban area**

| Factors | N | Least square means | | | |
|---|---|---|---|---|---|
| | | CI (days) | DO (days) | NSC (no) | GL (days) |
| Over all mean | 259 | 408.07(2.24) | 134.02(2.11) | 1.67(0.08) | 277.57(0.26) |
| Breed | | - | - | - | - |
| Friesian x Zebu | 214 | 405.39(1.73) | 130.71(1.62) | 1.62(0.06) | 277.62(0.16) |
| Jersey x Zebu | 26 | 409.21(3.43) | 135.56(3.24) | 1.78(0.12) | 277.37(0.32) |
| Friesian x Jersey x Zebu | 19 | 409.62(3.68) | 135.77(3.65) | 1.60(0.14) | 277.73(0.36) |
| Parity number | | - | * | ** | - |
| 1 | 8 | 409.32(5.49) | 144.27(5.18)a | 1.96(0.20)a | 277.61(0.051) |
| 2 | 143 | 408.36(1.79) | 132.71(1.68)b | 1.75(0.07)a | 277.52(0.17) |
| 3 | 88 | 408.57(2.22) | 129.81(2.1)b | 1.54(0.08)bc | 277.66(0.21) |
| 4 and above | 20 | 406.02(3.85) | 129.28(3.63)b | 1.42(0.14)bc | 277.51(0.35) |
| Season of previous calving | | *** | * | * | - |
| Long rainy (Jun-Sep) | 136 | 406.87(2.21)a | 134.38(2.08)a | 1.65(0.08)a | 277.55(0.20) |
| Short rainy (Mar-May) | 64 | 408.07(2.70)b | 137.21(2.54)ab | 1.55(0.10)ab | 277.57(0.25) |
| Dry (Oct-Feb) | 59 | 403.33(3.01)ac | 130.46(2.84)ac | 1.80(0.11)ac | 277.60(0.28) |

N= number of observations, CI= calving interval, DO= days open, GL= gestation length, NSC= number of services per conception, *= p<0.05; **= p<0.01; ***= p<0.001, means with the same subscript do not differ significantly (p>0.05)

### 4.3. Reproductive performance in the rural area

The results of univariate analysis of variance for factors affecting AFC showed that breed had significant effect on AFC in the rural area (p<0.01) that Friesian x Jersey x Zebu heifers had higher AFC than other breeds. The details of the results are presented in Annex 4.

The result of multivariate analysis of variance for factors affecting reproductive parameters in the rural areas is presented in Table 7. The same factors influencing reproductive parameters in the urban areas were seen to have effect in the rural areas. Parity number had significant effect on DO ($p<0.05$) and NSC ($p<0.001$). Season of previous calving had significant effect on CI ($p<0.001$), DO ($p<0.001$) and NSC. Breed had no significant effect on any of the reproductive parameters ($p>0.05$)

The least square means (Table 8) indicated that DO decreases as parity number increases from 1 to 3 (from 145.63 to 133.56 days). However, the trend of increment for DO days did not hold true for those cows with parity number 4 and above (141.26 days). The same trend was observed for the NSC (from 1.95 to 1.35). Regarding season of previous calving, the best performance in CI was recorded in the long rainy season (411.79 days) while the least performance was recorded in the dry season (428.28 days). The least value for DO was observed in the short rainy season (131.15 days) while the highest value was found in the dry season (151.41 days). The same trend as DO was observed for the effect of season of previous calving on NSC. None of the factors breed, parity number and season had significant ($p>0.05$) influence on the length of gestation period of the cows.

**Table 7. Results of analysis of variance for factors affecting reproductive performance of crossbred dairy cows in the rural area**

| Factors | CI | | DO | | NSC | | GL | |
|---|---|---|---|---|---|---|---|---|
| | DF | MS | DF | MS | DF | MS | DF | MS |
| Breed of cow | 2 | 0.59 | 2 | 26.15 | 2 | 0.10 | 2 | 0.26 |
| Parity number | 3 | 622.07 | 3 | 1059.95* | 3 | 4.04*** | 3 | 1.25 |
| Season of previous calving | 2 | 6918.03*** | 2 | 7216.02*** | 2 | 0.83* | 2 | 0.65 |
| $R^2$ | 1.00 | | 0.98 | | 0.921 | | 0.997 | |

CI= calving interval, DO= days open, GL= gestation length, NSC= number of services per conception, MS= means square, DF= degrees of freedom, *= p<0.05; **= p<0.01; ***= p<0.001

**Table 8 Least square means and standard errors of reproductive performance parameters in the rural areas**

| Factors | N | Least square means | | | |
|---|---|---|---|---|---|
| | | CI (days) | DO (days) | NSC (no) | GL (days) |
| Over all Mean | 244 | 417.78(2.66) | 140.22(2.43) | 1.66(0.63) | 277.81(0.16) |
| Breed | | - | - | - | - |
| Friesian x Zebu | 176 | 417.86(2.02) | 140.16(1.89) | 1.68(0.05) | 277.73 (0.12) |
| Jersey x Zebu | 53 | 417.69(3.58) | 139.27(3.33) | 1.67(0.09) | 277.83 (0.21) |
| Friesian x Jersey x Zebu | 15 | 417.79(5.86) | 141.22(5.46) | 1.69(0.14) | 277.86(0.35) |
| Parity number | | - | * | *** | - |
| 1 | 23 | 425.11(4.85) | 145.63(4.52)a | 1.95(0.12)a | 277.97(0.29) |
| 2 | 137 | 416.78(2.52) | 140.42(2.35)a | 1.84(0.06)a | 277.60(0.15) |
| 3 | 66 | 415.13(3.48) | 133.56(3.24)bc | 1.35(0.08)b | 277.80(0.21) |
| 4 and above | 18 | 414.08(5.67) | 141.26(5.28)ac | 1.49(0.13)b | 277.85(0.34) |
| Season of previous calving | | *** | *** | * | - |
| Long rainy(Jun-Sep) | 99 | 411.79(3.26)a | 138.09(3.04)a | 1.64(0.08)a | 277.75(0.19) |
| Short rainy (Mar-May) | 53 | 413.24(3.67)a | 131.15(3.42)a | 1.56(0.09)ab | 27793 (0.22) |
| Dry (Oct-Feb) | 92 | 428.28(3.28)b | 151.41(3.06)b | 1.78(0.08)ac | 277.74(0.19) |

N= number of observations, CI= calving interval, DO= days open, GL= gestation length, NSC= number of services per conception, *= p<0.05; **= p<0.01; ***= p<0.001, means with the same subscript do not differ significantly (p>0.05)

## 5. DISCUSSIONS

The 31.85 and 32.38 months mean AFC we found for crossbred heifers in the urban and rural smallholder dairy farms, respectively, is similar to the 31.5 months reported for $F_1$ crosses of Boran and Friesian cattle and 32.7 months reported for 3/4 Friesian and 1/4 Boran crosses (Haile-mariam *et al.,* 1993) and slightly higher than the 28.5 and the 29.2 months reported for Jersey x Arsi and Friesian x Arsi crosses, respectively, at Assela (Negussie *et al*., 1998). On the other hand, the findings of AFC in the present study was lower than 36.7 and 40.1 months estimated for crossbred dairy heifers in smallhoder dairy farms in Malawi (Agyemang and Nkhonjera 1990), 58.3 and 36.8 months reported for crossbred dairy heifers at two locations in smallholder dairy farms in Zimbabwe (Masama *et al*., 2003) and 40.6 months for crossbred dairy heifers in different dairy production systems in central highlands of Ethiopia (Shiferaw *et al.*, 2003). A number of previous works indicated that management factor especially nutrition determines prepubertal growth rates and reproductive development (Negussie *et al.*, 1998; Masama *et al.,* 2003; Shiferaw *et al.,* 2003). The better managed and well-fed heifers grew faster, served earlier and resulted in more economic benefit in terms of sales of pregnant heifers and/or more milk and calves during the lifetime of the animal. The present study indicates that under smallholder dairy farm level, given reasonably good management AFC can be reduced.

The 408.07 days and 417.78 days CI found for crossbred dairy cows of urban and rural smallholder dairy farms, respectively, observed in the present study is lower than 488 and 482 days reported for crossbred dairy cows of smallholder dairy farms at two locations in Malawi (Agyemang and Nkhonjera, 1990), 475.1 days in the central highland of Ethiopia (Bekele *et al*., 1991), 487 and 525 days at Abernossa Ranch (Hail-Mariam *et al*., 1993) and 551.82 days in the central highlands of Ethiopia (Shiferaw *et al*., 2003) .On the other hand, CI estimated in the present study is higher than 351.2 to 397.5 days of CI reported by Negussie *et al*. (1998).

The 129.54 days open found in the urban smallholder dairy farms in this study is in line with 130 days found for crossbred dairy cows of smallholder dairy farms in sub humid costal Tanzania (Lyimo *et al*., 2004). However, the values for both urban (129.54 days) and rural areas (140.32 days) in the present study were higher than 104 and 86 days recorded for crossbred dairy cows of smallholder dairy farms in two areas of Zimbabwe (Masama *et al*., 2003) and 120.8 days reported for Friesian Zebu crossbred cows at Assela livestock farm (Negussie *et al*., 1998). On the other hand, the duration of DO observed in this study was very much lower than the 196.8 days reported for Friesian Zebu crosses at Abernossa Ranch (Bekele *et al*., 1991), 185.02 days for crossbred dairy cows in central highlands of Ethiopia (Shiferaw *et al*., 2003) 211 and 216 days reported for $F_1$ Friesian Zebu and 3/4 Friesian and 1/4 Zebu crossbred dairy cows of smallholder dairy farms in Malawi (Agyemang and Nkhonjera, 1990) and the 152.2 days recorded for Sanga cows of smallholder dairy farms in Accra plains of Ghana (Obese *et al*., 1999) which, might due to that reluctance of farmers to allow AI of their cows in early post-partum and/or failure to detect oestrus by farmers. Many authors suggested that differences in management most probably account for differences on DO (Masama *et al*., 2003; Shiferaw *et al*., 2003; Lyimo *et al*., 2004)

The 1.67 and 1.66 mean NSC for crossbred cows in the urban and rural smallholder dairy farms, respectively, found in the present study agrees well with the 1.62 reported in central highlands of Ethiopia (Bekele *et al.,* 1991 and Shiferaw *et al.,* 2003), respectively. Our finding is also in line with 1.61 services per conception reported by Haile-mariam *et al.,* (1993) in Abernossa Ranch. It is, however, slightly lower than 2 services per conception reported for cows at Asella (Negussie *et al.,* 1998). These is probably due to the better experiences that farmers gained through extension services and demonstration trial on the management of crossbred dairy cows and the benefit of AI from the near by Agricultural Research Station, Abernossa Ranch and better AI delivery by the Wereda Bureau of Agriculture.

The over all 277.57 and 277.81 days mean GL for crossbred cows in the urban and rural smallholder dairy farms, respectively, obtained in the present study is in agreement with 276.6 days reported by Negussie *et al*. (1998).

The significant effect of breed composition on AFC in the rural area is in line with the reports of (Agyemang and Nkhonjera, 1990). They found that heifers with 75% exotic had higher AFC than heifers with 50% exotic inheritance. The authors suggested that crossbred cows invariably have some inheritance from indigenous stock could be explained as lack of adaptation on the part of cattle with higher exotic blood. Higher AFC would appear from inadequacy in meeting the nutrient requirement of crossbred heifers as their body size increases could be a major factor causing poor adaptation.

The significant difference of CI between two production systems obtained in the present study is in accordance with the previous reports (Shiferaw *et al*., 2003; Obese *et al*., 1999) but disagree with the report of Agyemang and Nkhonjera (1990) who have reported no significant difference on the length of CI between smallholder crossbred dairy cows at different locations in Malawi, these may probably due to management effect. The absence of significant difference between breeds with respect to CI in this study is in contrast to earlier reports (Negussie *et al*., 1998). They found that Friesian Zebu crosses had significantly higher CI than Jersey-Arsi crosses at Assela livestock farm. The finding in this study that cows calved during the short and long rainy season had a significantly lower CI than those calved during the dry season in the rural farm agrees with the reports of Haile-mariam *et al*. (1993) and Mukasa-Mugerawa *et al*. (1991). These is probably due to that cows calving during the short rainy and early period of the long rainy season take the advantage of improved pasture and recoup in body weight and increase their probability of conception during the early post-partum period which results in reduction of CI (Mukasa- Mugerawa *et al*., 1991 and Haile-mariam *et al*., 1993). The observed result in this study indicated that parity had no significant effect on the length of CI which is in agreement with the report of Agyemang and Nkhonjera (1990) and Haile-mariam *et al*. (1991) for F1 crosses. However, the result of the present study is in contrast to the findings of Negussei *et al*. (1998) and Bekele *et al*. (1991) in that they reported longer CI values for cows in the first and second parity. The authors suggested that it might be due to that, lactational stress in young growing animals in early parities, the ability of middle aged cows to gain body weight and condition after calving and cows in the third and fourth parities becoming more efficient in performance.

In the present study DO is significantly different between cows managed under urban and rural smallholder dairy producers which have also been reported earlier (Shiferaw *et al*., 2003). The authors found that crossbreed dairy cows managed under mixed crop livestock production system had longer interval from calving to conception than those managed under urban dairy farm production system. The same result has also been reported also by Bekele *et al*. (1991) in the central highlands of Ethiopia These may be attributed to that rural farms are located far away from the town. Cow that are in oestrus in the rural farms were traveling long distance to get the inseminator fronting that insemination has been performed at working time resulting in low conception rate reflected by long DO. Parity number significantly influenced DO in this study, which is in agreement with earlier reports (Bekele *et al*., 1991; Mukasa-Mugerawa *et al*., 1991; Negussie *et al*., 1998) in that cows in the first and second parity have been described to have longer DO than cows in the later parities. On the other hand, Agyemang and Nkhonjera (1990) and Obese *et al*. (1990) reported that parity number of cow has no significant influence on the length of DO of dairy cows of smallholder dairy farms, which is contrary to the present finding. The result observed in this study that seasons of calving had a significant influence on the duration of calving to conception interval is in contrast to the previous reports (Mukasa- Mugerawa *et al*., 1991; Negussie *et al*., 1998 and Obese *et al*., 1999) in that season of calving had no significant effect on the duration of DO in their respective studies. This could be probably due to the availability of improved pasture and feed across all seasons. However, this is not the case in the areas where this study was carried out. It is a well established fact that feed availability in the lowland parts of the country is very much influenced by season.

The absence of significant difference between cows' of the urban and rural farms in the number of services required per conception was in agreement with the report of Shiferaw *et al.* (2003). The authors reported that no significant differences were observed between the urban and rural farms regarding NSC. The significant effect of parity number and season on the NSC found in the present study is in accordance with the findings of Negussie *et al*. (1998) and Bekele *et al*. (1991) who reported a decreasing NSC in the subsequent parities and a higher value of NSC for cows served during the dry season. The absence of significant effect of breed and parity on the length of gestation obtained in the present study is in agreement with the reports of (Negussie *et al*., 1998). These is may be due to that, GL is more or less a constant character within a given species (Agyemang and Nkhonjera ,1990).

# 6. CONCLUSIONS AND RECOMMENDATIONS

From the present study it can be concluded that the reproductive performance of crossbred dairy cows owned by smallholder dairy producers in South East Shoa Zone of Oromia is good. In general, smallholder dairy cows in the urban areas were found to perform better compared to those of the rural areas.

The reproductive performances of crossbred dairy cows of smallholder dairy farmers in both the urban and rural areas were significantly affected by parity number and season of calving.

Based on these conclusions, the following points are recommended:

- ✓ The on going activities to improve and expand crossbred dairy cattle production at smallholder level should be encouraged. In line with this, a sustainable extension service that encompasses improves animal nutrition, hygiene, feed resources management, veterinary health care practice, technical service and other infrastructures need due attention;

- ✓ Further detailed studies on smallholder crossbred dairy cows dealing with reproductive performance and on how to improve the management especially improving oestrus detection for better benefits is recommended;

- ✓ Proper stocking rate of animals by the rural farmers should be introduced to improve manage nutritional deficiencies especially during the dry season.

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## 8. ANNEXES

### Annex 1. Retrospective performance collection format

Date: ____________________

**General farm data**

A. Location

Farm code ______________ Woreda ______________ Kebele/Village ______________

B. Farmer's status and household resources

Name ____________________________________
Level of education _________________________
Family status (married/single/separated /lost) _________________________
Duration of dairy operation ______________________________
Area of land owned (Hectare): grazing ______, cropping _______,
forage cut area________, other_________
total land _______________
Other Means of income for the family other than farming ________________
Labor share in animal handing and care: husband/ wife/sons/daughters/ laborer/other )

C. Type and number of livestock kept:

cattle ______________, sheep ___________, goat ___________,
horses _____________, ass _____________, others _________

Cattle herd size and structure:

| Type | Status | Local | Crossbred (FZ/JZ/FJZ) | | |
|---|---|---|---|---|---|
| | | | <50% | 50-70% | > 75% |
| Cows | Milking | | | | |
| | Dry | | | | |
| | Pregnant | | | | |
| Heifers | Growing | | | | |
| | Breeding | | | | |
| | Pregnant | | | | |
| Calves | Male | | | | |
| | Female | | | | |
| Bulls | Growing | | | | |
| | Breeding | | | | |
| Oxen | | | | | |

D. Breeding practice

Type of mating used (AI/Natural/both)

| Cow ID | Mating method used | Identification of bull |
|---|---|---|
| | | |

Practice of oestrus detection (Y/N)

Indicate methods and the prominent and common symptoms manifested by the cows or heifers in oestrus

______________________________________________________________

Previous reproductive performance

Average number of services per conception in the previous pregnancies in the herd

| Cow ID | Number of services per conception |
|---|---|
| | |

Days or weeks elapsed during the previous parturition and the subsequent pregnancy:

| Cow ID | Breed | Previous calving date | Last service date | Confirmation of recent pregnancy |
|---|---|---|---|---|
| | | | | |

Average lactation length in months during the previous lactation in the herd

| Cow ID | Breed | Average lactation length in months |
|---|---|---|
| | | |

Average gestation length during previous pregnancies

| Cow ID | Average gestation length |
|---|---|
| | |

Average age at first calving

| Cow ID | Average age at first calving |
|---|---|
| | |

**Annex 2. Data collection format based on farm owners AI receipt record**

Owners Name ------------------------------------------

Address ------------------------------------------------

Blood level ----------------------- Parity ----------------Age ----------

Source of Cow ---------------------------------------------------------

Pregnancy Status at present --------------------------------------------

Pervious calving date (PCD) ----------------------------------------

Date of $1^{st}$ AI after (PCD) -------------------------------------------

Date of $2^{nd}$ AI after PCD ---------------------------------------------

Date of $3^{rd}$ AI after PCD ----------------------------------------------

Breed of Bull ------------------- Semen NO. ------------------------

Artificial Inseminator ------------------------------------------

No. of service the cow got after PCD ----------------------------

Last Calving Date (LCD) ------------------------------------------

Date of $1^{st}$ AI after LCD -------------------------------------------

Date of $2^{nd}$ AI after LCD ---------------------------------------------

Date of $3^{rd}$ AI after LCD ----------------------------------------------

Breed of Bull ------------------- Semen NO. ------------------------

Artificial Inseminator ------------------------------------------

No. of service the cow got after PCD ----------------------------

Days open after PCD------------------------------------------------

Days open after last calving --------------------------

Oestrus sings commonly manifested by the cow-----------------------------

Remark by the collector --------------------------------------------------------

**Annex 3. AI performance data collection format based on follow-up study**

Owners Name ----------------------------------

Address ------------------------------------------

Cow ID-------------------------------------------

Date of oestrus ----------------------------------

Oestrus sign observed --------------------------

Date of 1st AI -----------------------------------

Breed of Bull ------------------------------------

ID. No. of Bull (semen) ------------------------

Previous parturition date: ----------------------

Monitoring efficiency of AI

Follow up record after 21, 42, 63 and 84 day of first AI

Is there any sign of heat during one of these days or other days?

Yes: ______________ No: ________________

If yes fill, the same format is filled for the subsequent services

Rectal palpation record after 90 days of AI to confirm pregnancy

**Annex 4. The results of univariate analysis of variance for age at first calving mean and standard errors**

| | Mean and SE of AFC | |
|---|---|---|
| | Urban | Rural |
| Overall mean | 31.89 (0.36) | 33.13 (0.36) |
| Breed of cows | | |
| Friesian x Zebu | 31.83 (0.24) | 32.24 (027) |
| Jersey x Zebu | 31.89 (0.69) | 32.08 (0.48) |
| Friesian x Jersey x Zebu | 31.95 (0.80) | 35.07 (0.19) |
| F-value | 0.011 | 6828.712 |
| P value | 0.989 | 0.010 |

## 9. CURRICULUM VITAE

### I. Personal data

Name: Yifat Denbarga G/kidan

Place of birth: Debresina, North Shoa

Age: 38

Marital status: Married

### II. Educational background

1966-1971EC: Elementary school, Debresina

1972-1977EC: Secondary school, Debresina

1978-1983EC: Higher education, Addis Ababa University, Faculty of Veterinary Medicine

### III. Work experience

1984-1985EC: As field veterinarian in Messo and Doba Wereda, Western Hararge.

1986-1988EC: As field veterinarian in Gumer and Sodo Wereda, Gurage Zone

1989-1991EC: As Veterinary meat inspector in Melge Wondo export abattoir, Southern Nations Nationalities People Region Bureau of Agriculture

1992-1995EC: As meat inspection and quarantine head of Melge Wondo export abattoir, Southern Nations Nationalities People Region Bureau of Agriculture

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## 10. SIGNED DECLARATION SHEET

I, the under signed, declare that these is my original work and has not been presented for a degree in any university.

Name: Yifat Denbarga G/kidan

Date of submission

This thesis has been submitted for examination with our approval as University advisors.

Dr. Merga Bekana: ________________________________

Dr Kelay Belehu: __________________________________