ADDIS ABABA UNIVERSITY

FACULTY OF VETERNARY MEDICENE

THE EFFECT OF NUTRITIONAL STATUS ON REPRODUCTIVE PERFORMANCE OF URBAN DAIRY FARM SYSTEMS IN DEBRE ZEIT.

By

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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 of MSc. in Animal physiology.

June, 2008

This thesis has been submitted for examination with my approval as university advisor.

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ACKNOWLEDGMENTS

First, I would like to sincerely thank my advisor Dr. Alemayehu Lemma, for his commitment and guidance made this thesis possible. I would also like to thank Ato Tafesse who helped me by showing the places were the farms are found and in collecting data's from the farms. I am also grateful to animal physiology department laboratory technician Ato Yoseph who helped me in the laboratory while I was conducting my experiment. Finally, I would like to thank my wife and my children, who were always by my side from beginning to end, for their endless support, encouragement and faith in my ability to succeed in all that I do.

Table of contents **Page**

LIST OF TABLES **Pages**

Pages

LIST OF FIGURES

ABBREVATIONS

BCS	Body condition score
MUN	Milk urea nitrogen
BUN	Blood urea nitrogen
LH	Lutenizing hormone
GnRH	Gonadothropin releasing hormone
CI	Calving interval
DO	Days open
NSC	Number of services per conception
CP	Crude protein
RDP	Rumen degradable protein
SDF	Small size dairy farm
MDF	Medium size dairy farm
LDF	Large size dairy farm
NEBAL	Negative energy balance
NEFA	Non esterified fatty acid

ABSTRACT

The relationship between nutrition and reproduction is a topic of increasing importance. Many research reports have clearly demonstrated that energy, protein and minerals intake is the most important nutritional factors affecting reproduction in dairy cows. This is particularly evident in the tropics where feed is often inadequate. A study was conducted to determine the effect of nutritional status on reproductive performance in urban dairy farms around Debre Zeit from November 2007 to May 2008. A total of 212 lactating cows in 16 farms of different sizes have been monitored over the study period. The study was conducted based on farm sizes, body condition score, milk yield and milk urea nitrogen levels as indicators of nutritional status and calving interval, service perconception and days open as a measure of reproductive performance. The most common feed resource comprised crop-residues and agro-industrial byproducts such as wheat bran, straw, noug and linseed cake, and local brewery byproduct and rarely hay. The mean body condition score was 2.6 and out of the total sample, 49.5% had a poor body condition. Most (72.4%) of the animals with poor body condition were known to be coming from large farms. The overall mean (±SD) calving interval, days open and service perconception were in the order of 468.31±109.63 days; 162.50 ±111.06 days; and 2.33 ±1.75, respectively while the conception rate was 62.5%. Calving interval and days open were only slightly affected by body condition and milk urea nitrogen concentration while service perconception was significantly affected ($P<0.05$) by both body condition and milk urea nitrogen concentration. High milk producing cows were found to have a relatively longer calving interval and days open and higher number of services perconception compared to the low milk producing ones ($P<0.05$). High milk urea nitrogen concentration was highly correlated with low milk production and vice versa. The currently prevailing feeding system and nutritional status did affect the performance of the cows. Apart from this poor heat detection as well as poor AI service were also major contributors to poor reproductive performance of the cows. It is therefore perceived that improvement of diets, proper feeding strategy, and determination of milk urea nitrogen at herd level could help monitoring the nutritional status of the cows and will help to timely correction before it affects reproductive performance. Key words. Urban dairy cows, Reproductive performance, Body condition, MU

1. INTRODUCTION

Understanding the physiology of reproduction is known to improve the productivity of cattle. Most importantly establishing potential points where intervention in the reproductive cycle of the cow can result in more efficient performance and hence higher productivity. Many studies show the influences of nutrition on cattle fertility. Differences in nutrition probably account for most variation in reproductive performance between different group of animals and among animals within the same group. Even though all effects of the components of nutrition are not fully understood, the need for balance between energy and protein has been confirmed and certain minerals and vitamins are essential for reproductive function (Butler *et al*, 1989; Ferguson *et al*, 1989; Hurley, 1989).

The effects of underfeeding are greatest on pre-pubertal animals and lactating cows. Weight loss at postpartum, either due to underfeeding or high lactation demands, extends the postpartum anestrous period (Entwistle, 1983). Underfeeding also reduces milk yield, which reduces the growth of the calf. This reduces calf weaning weight and delays age at puberty, which reduces the potential life time productivity of a replacement calf. In modernized dairy production systems, animals are fed according to their production potential and that all ingredients of the animal's diet are fed in controlled amounts. Most cattle in the tropics are poorly fed, particularly on smallholder resource poor farm levels is very different. Majority of dairy cows on these farms entirely depend on voluntary intake of essential nutrients (energy, protein and minerals) from feeds offered. Most of these feeds are deficient of the required nutrients (Minson, 1982). This becomes worse during the dry season as animals heavily depend on crop residues. Therefore, most dairy cows on smallholder farms are chronically in poor body condition during this season d are not in a good physiological state to exhibit reproductive cycle.

The nutritional status of animals is difficult to measure, and this complicates interpretation of the interaction of nutrition with reproduction (Haresign, 1984). An animal's nutritional status is usually assessed on changes on live weight and body condition. However, there are long term effects through some of the elements of reproduction, such as ovulation, fertilization and placentation, may take only a short course.

An animal's energy status regulates metabolic hormones and reproduction and energy metabolites are possible signals between nutrition intake and reproductive performance.

Even though it is known that nutrition is one of the most important factors that affect the reproductive performance of dairy cattle, little is known about the direct effect under the newly emerging urban dairy production system particularly prevalent in Ethiopia. Therefore, the objectives of this study are

- To determine the nutritional status and feeding systems under urban dairy
- To determine the reproductive performance
- To establish the relationship between nutritional status and reproductive performance

2. LITRATURE REVIEW

2.1. Physiology of reproduction in dairy cattle

The reproductive cycle of the cow is mainly coordinated by hormones produced by the hypothalamus, stimulates the anterior pituitary to secrete two gonadotrophins releasing hormone-follicle stimulating hormone (FSH) and luteinizing hormone (LH). Both of these hormones control ovarian function: FSH initiates maturation of follicles, and LH induces ovulation and lutenization of granulose and thecal cells. The major hormones produced by the ovaries are estrogens, which are produced by the follicles, and progesterone, secreted by the corpus luteum. Estrogens play important role in estrus manifestation, and progesterone in maintenance of pregnancy. Both regulate the reproductive cycle through a series feedback mechanisms acting on the hypothalamus and pituitary glands. In addition to these hormones, prostaglandins, which are produced by several tissues, including the uterus, also control the cow reproductive cycle in various ways. Other hormones, produced by the thyroid, parathyroid and adrenal glands, the placenta and the pancreas are also important in regulating reproduction.

The interval between calving and conception depends on the reestablishment of normal ovarian cycles after calving, the occurrence of estrus behavior at the appropriate time in the cycle, and the pregnancy rate following service (Peters, 1984). The interval between parturition and ovulation is characterized by sexual quiescence (postpartum anestrous). The duration of this interval varies with breed, milk yield level, animal age, suckling or lactating status, nutritional level before and after calving, season, climate, health status and calving difficulty. Of these factors, nutrition and suckling appear to be very important.

2.1.1. Estrous cycle in dairy cows

The estrous cycle comprises all events related to reproduction occurring between two periods of sexual activities. Cycle length has generally been determined by monitoring cow sexual behavior but similar information can be obtained by palpating ovarian structures or by measuring progesterone levels (Martinez, et al, 1984; Llewelyn et al, 1987). Estrous cycles average 25.1± 6.0 days in Zebu (Alberto, 1983) and 22.2± 6.0 days in small East African Zebu (Mattoni et al, 1988).Cycle length varies among breeds and animals within a breed, and with season, nutrition, disease, age management and cow production status.

2.1.2. Detection, duration and intensity of estrous

Many of the heats start when animals are confined for the night and would be undetected by day time observation only. Duration of estrus in dairy cattle ranges from 1 to 21 hr (Esselmont, et al, 1980). In Ethiopia, Alberto (1983) reported an average estrous duration of 4.5± 2.2 hours in Zebu while Mattoni et al, (1988) found a mean of 7.7± 4.5 hours and ranged from 1 to 24 hours in small East African Zebu cattle. Sineshaw (1991) found a mean estrous duration of 18..5 hours and a range of 4.0 to 43 hours in Zebu x Friesian heifers at Debre Zeit. In these crossbred heifers, 27% and 50% of the estrous periods lasted for 5 to 10 and 15 to 25 hours, respectively. The literature on estrous duration in Zebu cattle as summarized by Mukasa- Mugerwa (1989) indicates that it ranges from 1.3 to 17.4 hours. Estrous manifestations are different in different breed cows. Estrous in Zebu cattle tends to be subdued and is usually associated with weak external manifestations (Mukasa- Mugerwa, 1989). This behavior coupled with the short estrous duration make estrous detection difficult in Zebu cattle. There is very limited information on estrous manifestation and behavior in Ethiopian cattle.

Mottoni and colleagues (1988) reported from their work on Small East African Zebu's that during the day, mounting activity is greater when cows are not grazing and 59% occurred during the day with peaks between 6 to 9 hours and between 16 to 19 hours. The average mounts by bull per estrous was 9.2 with a range from 1 to 58. Vaginal discharge was observed in only 64% of the cows in estrous. Other sexual activities involved butting, licking, mounting and standing to be mounted. However, standing heat was associated with only 40% of actual estrous periods and as such can not by itself be used as a reliable indicator of estrous. Ovulation occurred 25.5± 5.3 hours after the onset of estrous. At Debre Zeit, Sinishaw (1991) working on Zebu x Friesian heifers found highest incidence of estrous onset per hour (40%) to occur between 6 and 10 am.
Estrous detection is more difficult in Zebu than in Taurus cattle due to a number of physiological and managerial problems. In Zebu cattle, estrous duration is shorter, the intensity is weaker, and behavioral manifestation of estrous is variable between individuals. Mattoni et al (1988), from their work on Small East African Zebu, reported that vaginal mucus discharge is not considered reliable and almost 50% of the mounting activity occurred within one third of the day with 59% occurring during daylight hours. Furthermore, up to 5% of the heats were associated with only one mount by the bull, suggesting that the chances of missing estrous period in Zebu cows is thus very high. Similarly, Geleto (1991) monitored onset of postpartum estrous in Borana cows

reported that data on postpartum estrous intervals based on progesterone and visual observation and/or markings by teaser bulls did not coincide in any of the cows. In fact, on average 2.6 estrous periods per cow were missed or silent. Sineshaw (1991) also monitored estrous behavior in Zebu x Friesian heifers and reported that vaginal mucus discharge was observed in 87% of the estrous periods and teaser bulls carried out mounting activity in only 54% of the estrous periods.

Accurate detection of estrous is essential for effective reproductive management, particularly where artificial insemination or hand mating is practiced. Poor heat detection can cause increased levels of apparent or managemental infertility. Successful heat detection is possible only when cows can be correctly identified, proper records are maintained, stockmans are properly trained and sufficient time is spent watching for estrous. Esselemont et al,(1985) recommended that in order to improve heat detection among Bos taurus cattle, it is useful to watch for heat three or four times a day, leaving not more than 8 hours between visits. Such a system improves heat detection rates to 80%. Villa- Godoy A. et al (1990) estimated that estrus is detected with only 50 to 60% of ovulations when dairy cows are observed 2 to 3 times daily. When surveillance of cows is continuous, estrus is detected with at least 95% of second and third postpartum ovulation

2.2. Reproductive Performance

The reproductive performance is one of the main factors affecting efficiency of dairy herds (Disken et al, 2003). A negative energy balance (NEBAL), alters reproductive performance affecting age at puberty (Kinder et al, 1995) and the duration of the postpartum anestrous period (Dunne et al, 1999; Sinclair et al, 2002).There are several ways by which the reproductive performance of dairy cattle can be measured. These are like calving interval, days open, conception rate, and service perconception. Even though each of these parameters affects the performance of the cow, calving interval is considered as important index of reproductive performance (Roberts, 1986; Arbel et al, 2001).

2.2.1. Calving interval

Calving interval (CI) has been extensively analyzed and reported. It is probably the best index of a cattle herd's reproductive efficiency. A 12 month CI is generally considered as the most economically desirable program for dairy cows. To achieve this, cows must re-initiate the ovarian activity shortly after calving, be detected in heat, bred and conceive within 85 days postpartum (PP). Resumption of ovarian activity in the postpartum period does not necessarily lead to conception and methods of stimulating estrus must be considered in relation to their effect on conception and, indirectly, calving intervals (Holness *et al*, 1980).

Under many dairy systems in tropical countries a one year CI is often difficult or impossible to achieve. In Ethiopian highland Zebu cattle, raised under traditional management, the lactation period is eight months and CI average 26 months with a range of 12- 36 months (Mukasa Mugerwa et al, 1991). This means that cows conceive about 8 months after the end of lactation, which appears to be the period required to regain body weight and condition, to continue the cycle and conceive again (Mukassa-Mugerwa *et al*, 1989).

A long CI is the major constraint to productivity of dairy cattle on smallholder farms. This is caused due to poor breeding management (i.e. lack of accurate estrus detection, repeat breeding, and more services before conception) and poor ovarian function as a result of under nutrition, particularly at critical periods of the cows' reproductive life, reflected in the slow recovery from loss in body weight and condition score during the early postpartum period. Calving interval can be divided into three periods: gestation, postpartum anoestrus (from calving to first estrus) and the service period (first postpartum estrus to conception).The postpartum anoestrous and service periods is sometimes also called the "days open" period and is the part of the calving interval that can be shortened by improved herd management.

2.2.2. Days Open

The number of days open (DO) may be the best indicator of current reproductive efficiency. DO can be influenced by factors such as length of voluntary waiting period, detection accuracy, semen quality and breeding technique, nutrition, cow fertility, disease or weathers. The DO period should not exceed 80-85 days if a calving interval of 12 months is to be achieved (Peters, 1984). This requires re-establishment of ovarian activity soon after calving and high conception rates. The duration of this period is influenced by nutrition (Wiltbank et al, 1982), season, milk yield, parity (Buck *et al*, 1980), suckling and uterine involution. The days open till conception has been reported to range from 130 to 300 days in Zebu and crossbred cows under research station management conditions (Tegegne et al, 1981).

2.2.3. Number of Services Per-conception

The number of services per conception **(NSC)** is directly related to the conception rate in a herd. Conception rate influences days open because if a cow dose not conceive, she will be open an additional estrus cycle (21) days. Conception rate problems may be caused by heat detection accuracy, length of voluntary waiting period, semen handling and semen quality, time of insemination techniques, reproductive tract infection, nutritional status, fertility or weather.

The number of services per conception (NSC) depends largely on the breeding system used. It is higher under uncontrolled natural breeding and low where hand-mating or artificial insemination is used. NSC values greater than 2.0 should be regarded as poor, and some of the factors contributing to high NSC values are elaborated below. Choudhuri et al (1984) estimated the repeatability of NSC to be 19% from 2152 records for Haryana cattle. The NSC was 2.81 ±0.03 and was significantly affected by herd, season, placenta expulsion time, lactation length and milk yield. Since heritability can be broadly estimated from repeatability, this study indicates that heritability of NSC is low and most of the variation in NSC is attributable to environmental factors.

Sharma and Bhatnagar (1975) found a significant effect of parity on NSC in Sahiwal, Red Sindhi and Tharparkar cattle. The NSC was highest at the fourth lactation for F_1 crosses with Brown Swiss. Kumar and Bhat (1979**)** noted that Haryana heifers needed more services per conception than cows.

Azage Tegegn *et al* (1981), using 3 local Ethiopian breeds, the Barka, Horro and Boran, found that NSC was lower for animals from wet areas than for those from drier areas (1.74 ±0.6 vs 1.98 ±0.07). Crossbred cows required 0.12 and 0.14 fewer services per conception than local zebu cows in wet and dry areas, respectively. The NSC at four cattle breading stations of the Ethiopian

Institute of Agricultural Research ranged from 1.76 to 1.95 in Zebu and crossbred cattle (Tegegne et al, 1981). At the Abernossa ranch, NSC averaged 2.1 and 2.45 for Boran cows and Boran x Friesian crossbred heifers, respectively (Makonnen, 1987) At Asella research station, NSC ranged from 1.82 to 2.5 in Arsi x exotic crossbred dairy cows (Kiwuwa, 1983). El-Amin et al (1981) concluded that NSC did not differ significantly between Red Butana and Red Butana crosses (average 2.6) but was influenced by month of calving. NSC increased over the study period, probably due to changes in management. This is partly supported by an analysis by Busch and Furstenberg (1984) of 483 600 inseminations performed by 379 technicians on 623 farms in the USA, which showed that the 90- and 120-day non-return rate differed significantly among inseminators and the inseminator effect was greater than the farm effect. However, non-return rate did not differ among bulls.

2.3. The Role of Nutrition in Reproduction

2.3.1. Nutrition and Reproduction in Dairy Cows

Energy restriction influences reproductive function through depression in GnRH release in hypothalamus centers in the brain (Butler & Smith, 1989; Schillow, 1992). GnRH stimulates release of LH from the pituitary gland. LH stimulates follicular development, ovulation & luteal function at the ovary. Following calving, mean LH and LH pulse frequency are diminished for about 10 days due to the previous influence of pregnancy (Butler & Smith, 1989; Randel, 1990; Schillow, 1992). By 10 days post calving, LH pulse frequency & mean LH increase, resulting in stimulation of follicular development (Lucy et al, 1991). With typical nadir energy balance & days to nadir, first ovulation occurs by 30 days post calving (Dachir *et al*, 1984). In a typical population of cows, 70% will have palpable corpus luteum by 40 days post calving (Roberts, 1986). With restriction in energy intake, LH pulse frequency is diminished (Butler & Smith, 1989; Randel et al, 1990; Canfield & Butler, 1991; Imakawa, 187; Schillow, 1992), follicular development is impeded (Lucy et al, 1991), luteal function is decreased (Burke et al, 1997; Villa-Godoy, 1988), first ovulation is delayed (Butler & Smith, 1989; Canfield et al, 1990; Canfield & Butler, 1991; Lucy et al, 1991) and eventually reproductive function ceases (Randel,1990). In dairy cows, prolonged & severe negative energy balance (NEBAL) may delay time to first ovulation & impair reproductive efficiency.

LH pulse frequency may be modulated by serum insulin and Insulin like growth factor 1 (IGF-I) concentrations (Beam & Butler, 1997; Thatcher et al, 1996). Typically insulin & IGF-1 concentrations will reflect nutrient adequacy. Both hormones will be low with under nutrition. Insulin & IGF-1 rise with week post calving in association with increasing dry matter intake. Time to first ovulation was associated with IGF-1 concentrations (Beam & Butler, 1997; Thatcher et al, 1996). The slower the rise in IGF-1 concentration is the longer the time to first ovulation. In addition, the lower the IGF-1 concentration is the lower the fertility (Thatcher et al, 1996). Nutritional, metabolic and hormonal signals which may influence hypothalamic function & GnRH secretion include specific amino acids absorbed from the diet, glucose, ketone bodies & insulin (Rutter & Manns, 1987; Schillow, 1992). Resumption of ovarian activity following severe restriction may take several weeks. Typically, in most dairy herds fewer than 15 % of cows should be anestrous beyond 40 - 50 days post calving. If anestrous cows are higher in proportion, then the nutritional program should be examined.

As energy balance increases ovarian follicular growth is stimulated (Thatcher et al, 1996; Staples et al, 1998). Cows with more positive energy balance have larger dominant follicles and more follicles move into class 2 and 3. Thus, the ovary appears to be stimulated by improved energy status. In addition progesterone production by the corpus luteum is increased with improved energy status and improved body condition (Burke et al, 1997; Staples et al, 1998). Fertility is not conferred with initiation of ovulation. Both estrus expression and conception improve with each estrous cycle through to the third estrus post calving (Thatcher & Wilcox**,** 1973). In addition to the number of ovulations post calving, Harison et al, (1990) reported lower estrus expression in higher producing cows. He suggested that energy balance may have effects on reproduction through ovarian function in addition to central effects on LH secretion.

Alteration in concentration of growth hormone (GH), Insulin, IGF- I, glucose, and none esterified fatty acid (NEFA) in blood are indicative of energy availability and may provide short or long term signals that mediate the effect of nutrition on LH secretion (Bossis I, *et al*, 2000). According to Butler WR (2000), increased capability for milk production has been associated with a decline in fertility of lactating cows. Nutritional requirements increase rapidly with milk production after calving and result in negative energy balance (NEBAL). NEBAL delays the time of first ovulation through inhibition of LH pulse frequency and low levels of blood glucose, insulin and insulin-like growth factor-I (IGF-I) that collectively restrain estrogen production by dominant follicles. Up-regulation of LH pulses and peripheral IGF-I in association with the NEBAL nadir facilitates ovulation. NEBAL reduces serum progesterone concentrations and fertility.

Diets high in crude protein support high milk yield, but are also associated with lower reproductive performance. High protein can result in elevated plasma urea concentrations that affect the uterine environment and fertility. Nutritional interactions resulting in poor fertility of high producing dairy cows include the antecedent effects of NEBAL and effects of high dietary protein. Long term chronic restriction of feed intake in heifers have demonstrated that NEBAL causes a linear decrease in the maximum diameter of successive dominant follicles and eventually in anestrous due to suppressed LH pulse frequency in the final estrus cycle before anovulation (David R *et al*, 1999).

Long term restriction in feed intake induces nutritional anestrous in cattle. This is due to inadequate hypothalamic GnRH secretion which reduces LH and FSH secretion from the pituitary gland (Rhodes *et al*, 1995) and suppresses follicle growth and oocyte maturation. There is little evidence of an effect of short-term nutrient restriction on plasma FSH concentration. Recent studies indicate that a short term restriction of energy intake to 0.4 times maintenance requirement results in an increase in plasma FSH concentrations compared with heifers on a dietary intake of 2.0 times maintenance FSH is essential for follicular growth and ovulation. Data on the effect of short term dietary restriction on LH pulse patterns in cattle are limited, but there is evidence in sheep that restricted feeding can reduce LH pulse frequency causing low ovulation rate (Nolan *et al*, 1998). On the other hand, adding supplementary fats in inadequate diets, results in increased concentrations of LH (Hightshoe *et al*, 1991).Effects of short term dietary restriction on LH pulse patterns are more difficult to observe in ruminants. FSH is essential for follicle growth and ovulation. Yet there is little evidence of an effect of nutrition on plasma FSH concentrations. However, Mackey *et al* (1997) have shown that short term restriction of dietary intake to approximately 40% of maintenance energy requirements increased FSH in heifers compared with those 200% of maintenance energy requirements. Acute Restriction in energy intake 3 to 6 days before ovulation decreases the growth rate and maximum size of the preovulatory dominant follicle. This subsequently results in fewer follicles emerging in the second follicle wave of the estrus cycle (Mackey, *et al*, 1997). Suckling interferes with hypothalamic release of GnRH, providing a marked suppression in pulsatile LH release, resulting in extended postpartum anestrous (Montiel and Ahuja, 2005).

Feed intake in sheep can influence the concentration of progesterone, with a strong negative correlation between dietary intake and progesterone concentrations. Progesterone is believed to play an important role in oocyte maturation and embryo development. Liver blood flow and metabolic clearance of progesterone are positively correlated and affected by increasing energy intake in dairy Cows. Low progesterone post-breading can reduce fertility. However, as steroids are selectively stored in fat, any dietary regime that results in fat mobilization will result in the release of stored progesterone. This may account for some of the increased progesterone evident in animals on low dietary intakes. Minor changes in maternal progesterone concentrations during the initial period of embryo development may alter the secretion of ant-luteolytic agent causing critical condition to embryo survival (Maurice *et al*, 2003). In sheep, over feeding which reduced circulating progesterone concentration also reduced pregnancy rates and decreased both the rate of development and viability of embryo (Parr *et.al*, 1987). In cattle timing of the progesterone rise after ovulation is of critical importance to the development of the embryo (Mann et al, 1999).

2.3.2. Effect of nutrition on heifers

Nutrition regulates reproductive efficiency of cattle. Poor nutrition delays puberty reduces conception rate, increases pregnancy loss, aberrant estrous cycles and reduce birth weight in heifers (Armstrong *et al*, 2001; Robinson, 1990; O`Calloghan, *and Boland*, 1999; Robinson *et al*, 1999). Chronic restriction of nutrient intake causes cessation of estrous cycles in heifers and reduces follicular growth and concentrations of LH and estradiol in plasma (Bossis et al., 1999). Heifers fed inadequate amount of energy reach sexual maturity late, stop cycling in those that have begin to have normal cycle and resume when they start to consume adequate amount of energy (McDoland *et al*, 1988).Over feeding energy to heifers before they reach puberty increases weight without sufficient bone growth which increases calving difficulty and accumulation of excess fat tissue in the development udder decreasing amount of milk producing tissue.

Heifers that are raised on a protein deficient diet lack the skeletal growth in relation to their size and are older when they start cycling. They will also have more difficulty during calving and may not milk as well once they enter the milking herd. Different studies indicate that drought delayed the onset of puberty in heifers and stopped ovarian activity in half of those that had already reached puberty (Post and Reich, 1980).

2.3.3. Effect of Nutrition on Postpartum Cows

The reproductive performance of the postpartum cow is related to nutritional status (Van Niekerk, 1982; Montiel *and Ahuja*, 2005). Cows fed a high-energy diet after calving conceives sooner than those with a lower energy intake (Wettemann *et al*, 2002). Level of nutrition before calving affects the length of the postpartum anestrous period; anestrous periods are shorter in cows fed more before calving. Feeding level after calving and changes in body weight and body condition are important and affect both the anestrous period and conception rates. Level of feeding after calving has little effect on the reproductive performance of cows calving in good body condition. Body condition at calving, which is largely a consequence of level of nutrition before calving, is important in determining the length of the estrous period, and that cows in higher body condition have shorter anestrous period (Osoro. and Wright, 1992).

Energy status is generally considered to be the major nutritional factor that influences reproductive process with prolonged low energy intake impairing fertility. Nutrition and suckling are the major factors influencing the resumption of postpartum ovarian cycles, as they affect hypothalamic, pituitary and ovarian activity and this inhibit follicular development (Montiel and Ahuja, 2005). Inadequate pre calving and/or post calving energy or protein nutrition lowers pregnancy rates as well as first service conception rates and extends postpartum intervals in suckled postpartum beef females. Yet excessive protein intake may depress postpartum rebreeding performance especially in older dairy cows. Underfeeding of the postpartum cow extends the period of ovarian inactivity due to a suppression of the pulsatile release of LH from the pituitary gland, which in turn is controlled by release of GnRH from the hypothalamus (Rundle, 1990). Supplementation during the postpartum period increases the cumulative percentage of cows in estrus and pregnant during a 60 days breeding season (Cicciolin *et al*, 2001). Although protein is generally regarded as less important than energy for reproduction, low protein intake can also cause infertility. However, it may be difficult to differentiate the effects of low protein intake from concurrent low energy intake, because protein deficiency usually leads to decreased appetite (Mathis, 2000).

Cattle in the tropics are most of the time dependent on natural pastures and crop by products for feed. The crude protein content of the feed is often below 7.5%, which reduces rumen efficiency and reduces the true digestibility of the feed. As a result, lactating cows are unable to meet their nutritional requirements and lose weight and condition during lactation. This prolongs the lactation anoestrous period, and cows tend to calve in alternate years (Mathis, 2000). High level of feeding before calving reduces the postpartum anoestrous period in cows (Short *et al*, 1990). In addition, more cows exhibited estrus before the breeding season and subsequent pregnancy rates are increased. Feeding a high plane of nutrition to anoestrous cows for 45 days resulted in 56% resuming cycling and 55% ovulating, whereas those cows kept on a low plane diet neither cycled nor ovulated (Dindorkar *et al*, 1982).

The growth and development of the fetus, parturition, lactation and involution of the uterus, all use energy. The energy used by these processes must be supplied to the cow if she is to rebreed soon after calving. Generally, if a farmer is not able to provide the cow’s whole energy needs, then some will be met from body reserves or fat. Thus a cow in good condition is better to meet the energy requirements of parturition, lactation and involution of the uterus, and will therefore rebreed sooner, than a cow in poor condition. Cows should be fed well for 25-55 days before parturition and, if possible, for 90 days after parturition (Olivares *et al*, 1981).

2.4. Body Condition Score

Body condition scoring (BCS) describes the systematic process of assessing the degree of fatness of an animal (Nicholson and Syers, 1987). The score reflects the plane of nutrition on which an animal has been exposed over a reasonable length of time (Suth et al, 1998). BCS are numbers used to suggest status of an animal and reflects the body energy reserves available for metabolism, growth, lactation and activities (Montiel and Ahuja, 2005). The loin, ribs, tail-head, brisket, flank, vulva or rectum and udder are the important parts of the body used in determining the score. The scoring system for dairy cows has a range of 1 to 5, with 1 representing very thin cows and 5 representing very fat cows. A cow with a body condition of 3 is said to be in average condition; however description of an “average” conditioned cow vary (Todorov and Mitev, 1993)

2.4.1. Body condition and reproductive performance

Numerous research studies have indicated that under-nutrition due to limited feed availability or poor quality feed sources during late gestation (prepartum) and/ or early lactation (postpartum) has detrimental effects on subsequent reproductive efficiency. Reproductive performance is closely linked to the amount of available energy reserves a cow has which is reflected by her amount of body fat or body condition (Sprott, 1985). Energy and protein intake is considered to be the most important nutritional factors affecting body condition of dairy cows (Lanyasuna et al, 2005).

Changes in body weight or condition score of cows indicate a likely level of subsequent reproductive performance.The fertility of cows in poor condition is low. Cows below the “critical condition score” are least likely to reproduce. Condition at mating has been indicated to be more important than weight. Van Nikerk (1982) observed a calving rate of 78% for cows in optimum condition compared with just 8% for animals in the poorest condition. Animals should be fed well to promote good reproductive performance. It is more efficient to feed animals to maintain good body condition than to allow them to lose weight in the hope that it can be regained before mating season. Wright (1985) estimated that lose of one unit in condition score would supply 3200 MJ of metabolisable energy; restoring the animal’s condition score would require about 6500 MJ of dietary metabolisable energy. This agrees with Van Niekerk (1982) who concluded that the feed cost of maintaining a cow at condition score of 3.0 was half that of required to raise cow's condition from 1.5 to 3.0. The level of fatness or BCS at key periods in lactation, could affect the resumption of estrous cycles and reproductive success. The change in BCS over the first few weeks of lactation may indicate the extent of metabolic load as the shortfall of energy to fuel production is thought to be met through mobilizing body reserves (Pryce et al, 2001).

Body condition at calving, which is largely a consequence of level of nutrition before calving, is important in determining the length of the postpartum anestrous period and that cows in higher body condition have shorter anestrous period (Houhton et al, 1990). If intake of energy and/ or protein is below that required to meet the cows needs for maintenance, pregnancy or lactation, and environmental stress, cows will try to compensate by mobilizing stored energy (body fat) and will therefore lose body condition. Following calving, the nutritional requirements again increase to support lactation and repair of the reproductive tract.

Severe energy deficiency leads to loss in body weight and therefore body condition. It has been reported (Graves and Mc Lean, 2003; Voh and Otchere, 1989) that lower conception rates and longer CI are associated with severe weight loss. Very long CI implies very low reproductive performance. Kishindi (1999) compares performance of dairy stock on large scale (resource endowed) and some well managed smallholder (resource- poor) farms in Tanzania and a significant difference were observed between large commercial and smallholder dairy farms. On smallholder dairy farms in Kenya, CI is long, with official national estimate of 450 days (Muriuki, 2003) and some studies have reported an average of 590 days on some dairying areas (Staal et al, 1999).

2.5. Milk Urea Nitrogen

In addition to being an essential nutrient of all plants and animals, protein is the most expensive nutrient fed to dairy cattle. When protein is consumed it gets broken down into smaller compounds such as peptides, amino acids and ammonia in the rumen. While the peptides and amino acids can be absorbed in the small intestine and used directly by the cow for growth and lactation, rumen microbes can use ammonia for microbial growth and protein synthesis (Van Soest, 1994). The amount of nitrogen required by the microbes is determined by the amount of available carbohydrate. If dietary protein is fed above the level needed by the microbes, the ammonia will be converted to urea in the liver and excreted in the urine. Feeding more energy will increase the microbes' need for nitrogen and promote the use of excess ammonia (Van Soest, 1994).

A proper balance of protein and energy, or more specifically rumen degradable protein and rapidly fermentable carbohydrate, allows the cow to make the best possible use of protein in the diet. Milk urea nitrogen (MUN) reflects if an optimal balance of protein (especially degradable and soluble protein fractions) and fermentable carbohydrate occurs. As a guideline, 30%–40% of the diet should be represented by non-structural carbohydrate to maintain optimum rumen health and function (Nocek, 1997). It is difficult however to make recommendations for crude protein (CP). The amount of CP to include in the diet will depend on milk yield, milk protein percentage, growth rate, body size, energy content and type, as well as amino acid composition and degradability of dietary protein. Generally, the amount of CP in the diet will need to be increased if the requirement for rumen degradable protein (RDP) is not met (NRC, 2001). Monitoring urea nitrogen concentration is an effective way to determine whether or not dietary protein and energy are in proper balance. There are two ways to test for urea concentrations: from samples of either blood or milk. A blood sample is an invasive and time consuming procedure, while milk urea nitrogen (MUN) can be tested using samples submitted for fat and protein analysis.

The type of dietary protein fed will determine how much ammonia is produced and consequently, the concentration of MUN. Feedstuffs, such as alfalfa, hay, canola and oats, which are rapidly degradable in the rumen, result in higher ammonia production. Milk urea nitrogen concentration tends to increase when this type of protein is fed. Feedstuffs that is more slowly degraded in the rumen, such as brewers and distillers grain and corn gluten meal, produce less ammonia, which result in a lower urea nitrogen concentration. The balance of rumen degradable and undegradable protein is something someone should consider when formulating the ration for crude protein content.

According to Ontario Dairy Herd Improvement, the normal range for MUN concentration is between 10–16 mg/dl. When MUN concentration is below this range, more degradable protein may be needed to meet the microbial nitrogen requirement for protein synthesis. Cows will respond with higher milk yield to this dietary change. When MUN concentration is above the normal range perhaps too much total or degradable protein or too little energy is being fed. Routine feed and ration evaluation is important at this point knowing the nutrient content of the feed will help determine whether protein or carbohydrate is causing the imbalance. Balancing the ration to meet dietary requirements will improve productivity as well as profitability. Besides the effect of protein and energy, MUN concentration may also vary by season, month, and parity group, stage of lactation and time of sampling. In Europe, the milk urea nitrogen concentration is highest from July to September and in cows between 60–150 days in milk. It is lowest in first lactation cows as well as cows in their first 60 days in milk or after 150 days in milk. The rate of decline between mid and late lactation is larger in animals in their second lactation or greater (Godden *et al*., 2001).

Increasing level of dietary CP is associated with increases in services per pregnancy and days open (Ferguson and Chalupa, 1989). Increasing rumen degraded intake protein in excess of requirement decrease fertility (Ferguson et al, 1988; Ferguson and Chalupa, 1989). Elrod and Butler (1993) showed that a decrease in uterine pH was associated with higher degraded intake protein and represents a possible cause of conception failure. Monitoring of BUN or MUN is a technique that can be used for measuring protein and energy status in cattle from biological samples obtained at strategic times relative to production cycles, feeding changes, and seasonal availability of forage. These indicators should be used as an adjacent to other measures such as body weight and BCS that reflect the integrated effects of nutrition over time. Metabolic indicators such as BUN or MUN, on the other hand, are used to assess short term or real- time changes in nutritional status. When forage quality is low, a deficiency in protein intake can limit dry matter utilization and intake. However, providing supplemental protein to cattle consuming low quality forage (low quality protein low energy content) may or may not increase forage dry matter intake depending on the energy to protein ratio of the forage. Expressed as digestible organic matter: crude protein (DOM: CP) the optimum ratio is about 7:1 (Moore et al, 1995).

2.5.1. Factors affecting BUN and MUN in cattle

Under controlled feeding situation, when energy intake is held constant, increasing dietary protein increases BUN or MUN concentrations. Isocaloric semi purified diets with three levels of CP were fed to steers at equal intakes of 5 Kg/ day (Hammond, 1983ab). Mean MUN concentrations increased from 2.6mg/dl to 11.1 mg/dl as dietary CP increased 6 to 18% of the diet. For growing steers, BUN levels between 11 and 15 mg/dl were associated with maximum rates of gain (Byers and Moxon, 1980). With finishing steers, maximum performance was associated with BUN concentrations of 7 to 8 mg/dl (Preston et al, 1978). Balanced diets for lactating dairy cows were associated with average BUN concentrations of 15mg/dl (Roseler et al, 1993) and average MUN concentrations of 15 to 16 mg/dl (Baker et al, 1995). Increased degradability of dietary protein can lead to increased ruminal ammonia concentrations resulting in increased BUN concentrations. In steers fed isocaloric diets that differed widely in nitrogen degradability, there was an average difference in BUN of over 6 mg/dl (Hammond, 1975). In lactating dairy cows, an imbalance of degradable and ruminally non-degradable intake protein increased BUN and MUN (Roseler et al, 1993). Similarly, an imbalance of ruminally degradable and ruminally non-degradable protein increased BUN and MUN in lactating dairy cows, but this increased was not as great as an increase in BUN and MUN caused by excess CP (Baker et al, 1995).

Increased dietary energy intake while holding protein intake constant, would be expected to decrease BUN. This was demonstrated in an experiment with bulls where diets were formulated and rationed to provide 75 or 150% of maintenance energy requirement but equal CP intake (Chase et al, 1993). At the high level of protein intake BUN averaged 5.6 mg/dl and at the low of energy intake BUN averaged19.7 mg/dl. The effect of increased level of intake on BUN concentration appears to be similar to the effect associated with increased energy intake. High dietary protein intake resulting in BUN or MUN of greater than 19 to 20 mg/dl has been associated with an altered uterine environment and decreased fertility (reduced conception rate, decreased pregnancy rate) in lactating dairy cows and heifers (Elrod and Butler, 1993; Elrod et al, 1993; Ferguson et al, 1993; Butler et al, 1996).

3. MATERIALS AND METHODS

3.1. Study area

The data presented in this study were collected 47 kms south-east of Addis Ababa in Debre Zeit which is located at an average altitude of about 1900 meters above sea level. The area receives annual rainfall of 1115.6mm[3] with two rainy seasons: June through September (main rainy season) and March to May (short rainy season). The average minimum and maximum temperature are 8.5^0C and 30.5^0C, respectively (KIMSA, 2003).

3.2. Study animals

The study populations are diary cows among the commercial dairy farms found in Debre Zeit. A total of 16 dairy farms found within Debre Zeit town were purposely selected based on willingness to be part of the study. The farms were sorted out based on herd size and were grouped in to small (2 – 10), medium (11 -20) and large farms (above 20 animals). All animals in the study group were examined for general health. Apparently healthy animals were included in the study to avoid the effect of ill health on nutritional status. The total numbers of cows included in this study were 280, out of which 212 were lactating Holstein Friesian cows having an average 62.5% exotic blood.

3.3. Study design

A cross-sectional survey was carried out across the farms and then pre-designed structured questionnaires was developed, pre-tested and administered through personal interview to farm owners and attendants of all farms considered for this study. The farms were categorized into defined strata based on herd size. These were small dairy farm (SDF), medium dairy farm (MDF) and large dairy farm (LDF).

Reproductive performance was determined from CI, NSC, DO and conception rate. Data on reproductive performance was collected through personal interview and from analysis of farm records. Nutritional status of the cows was determined from BCS and MUN. Body condition of each animal was scored on a 1 to 5 scales according to Edmondson *et al*. (1989) and Todorov and Nitev, (1993). The body weight was also estimated using the heart girth perimeter. Then, cows were categorized into three BCS groups *visa vise* Poor (BCS= 1.5 - 2.5), Moderate (BCS= 2.75 - 3.5) and Good (BCS= 3.75 - 5.00). Depending on the amount of milk production, the cows were categorized into groups of low milk producing (2 - 9 lit/day, or 730 – 3285 lit/ lactation) and high milk producing (10 - 30 lit/day or 3650 – 10950 lit/lactation). About 10ml of fresh milk was collected twice a day from all study animals to determine the milk urea nitrogen level (MUN). The sample was either immediately analyzed or stored in a refrigerator at -20^{0}C until analysis to prevent the effect of microbes on the concentration of urea.

Testing for MUN was performed with Fluitest Urea Col. kit (Biocon® Diagnsotik, Germany) using a standard photometric analyzer (Photometer 5010, Germany). The kit contains an enzyme urease that breaks urea to produce ammonia gas and carbon dioxide. Finally ammonium ion reacts with hypochloride and salicylate in alkaline medium to give green color (2.2 Dicarlindophenoboxyl) whose intensity is measured at 580 to 600 nm using a photometer. The cows were then categorized based on MUN concentration values into three groups *visa vise* cows with low MUN (<12mg/dl), normal MUN (12 -16 mg/dl) and high MUN (>16mg/dl). High or low MUN level were considered as indicative of nutritional imbalance in the relative to the proportion of protein and carbohydrate.

3.4. Statistical analysis

All data collected were compiled, stored on Microsoft Excel sheet. The data was analyzed using a computer statistical software package SPSS 15.0 for windows (USA, 2006). Mean, standard deviation, mode, percentile, minimum and maximum values of both nutritional status and reproductive performance were calculated using descriptive statistics. The data were then subjected to X^2 test, ANOVA and GLM to compare different variables of performance and nutritional status. P-values of <0.05 and 0.001 were used to determine the level of significance.

4. RESULTS

4.1. Status of the study dairy farms

Out of the 18 farms considered in this study, 50% were small farms, 27.78% were medium farms and 22.22% were large farms. The percentage of animals in each farm size category is given in figure 1. Regardless of the production system or farm size, animals were stall fed. Animals in all farm groups were commonly dependent on crop-resides and agro-industrial byproducts comprising wheat bran, alfalfa, hay, straw, molasses, noug and linseed cake, and local brewery byproduct. The nutritional content of the most commonly fed feedstuffs are summarized in table 1. Regardless of the production system or size of the farm, all cows were milked by hand twice a day (morning and evening). The mating system used across all farms was AI.

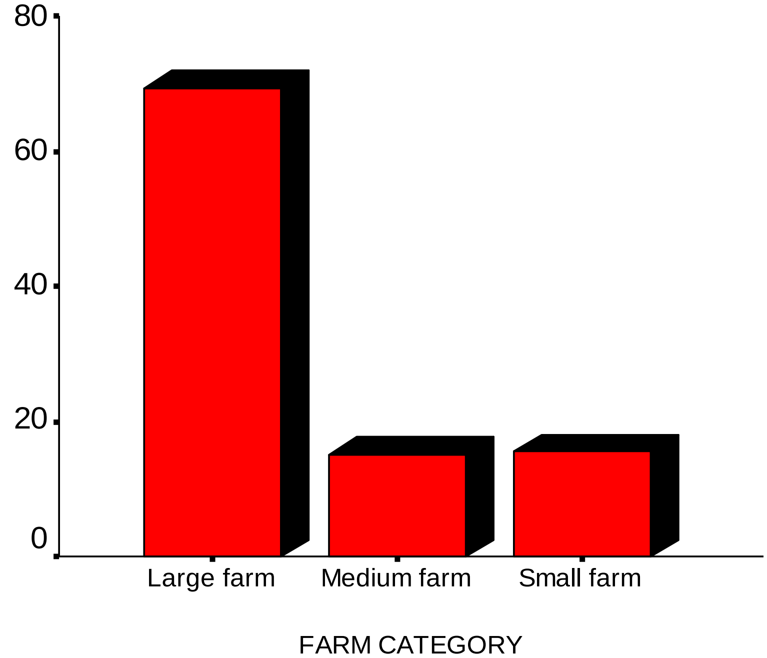

Figure 1. Percentage distribution of dairy cows in different study farm groups

Table 1. Summary of nutritional content of feeds commonly fed to the cows

Feed type	DM [%]	CP [%]	NDF [%]	ADF [%]	Ca [%]	P [%]
Teff straw	91.11	5.55	73.61	45.59	0.30	0.07
Wheat straw	91.64	4.22	74.53	49.11	0.12	0.90
Hay	92.49	6.62	67.44	41.36	0.26	0.30

Wheat bran	94.17	17.02	23.21	10.99	0.13	1.36
Linseed cake	93.18	31.96	31.59	20.57	0.43	0.89

DM=Dry matter, CP=crude protein, NDF= Neutral Detergent Fibe

ADF= acid Detergent Fiber

4.2. Nutritional status of the study cows

Out of the total sample, 49.5% had a poor body condition (Figure 2). Most of the animals with poor body condition were known to be coming from large farms (Table 2).

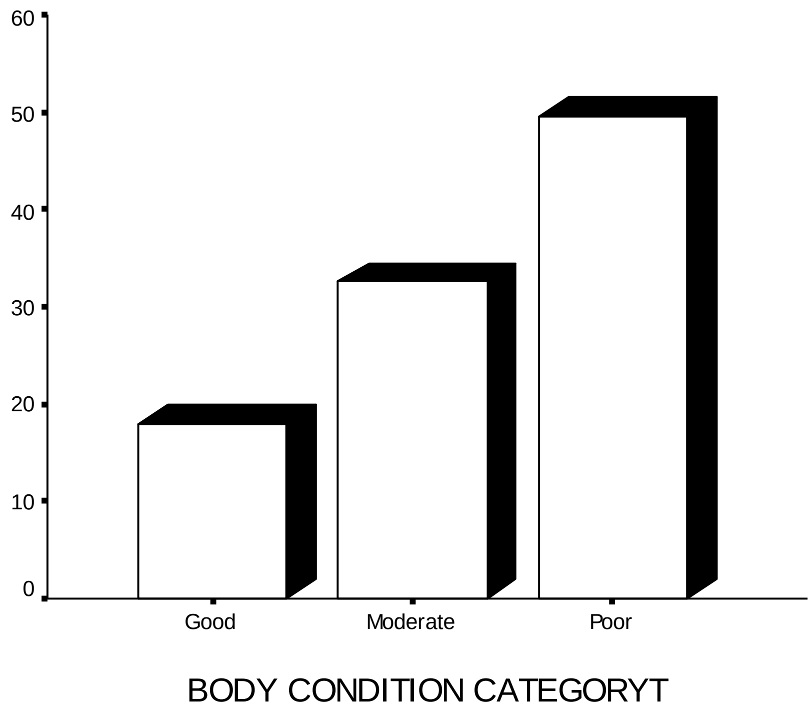

Figure 2. Percentage distribution of cows in the different body condition category

Summary of the distribution of body condition of the cows in relation to the different farm groups is presented in table 2.

Table 2. Distribution of body condition of cows within farm groups

BCS category	Farm Size			Total
	Large farm	Medium farm	Small farm	

Good	Count	28	7	3	38
	% within BCS category	73.7	18.4	7.9	100.0
	% within Farm Size	19.0	21.9	9.1	17.9
Moderate	Count	43	8	18	69
	% within BCS category	62.3	11.6	26.1	100.0
	% within Farm Size	29.3	25.0	54.5	32.5
Poor	Count	76	17	12	105
	% within BCS category	72.4	16.2	11.4	100.0
	% within Farm Size	51.7	53.1	36.4	49.5

The overall mean (SD) of MUN concentration for the study animals was found to be 18.95 ±14.4mg/dl. Further breakdown in to MUN category is presented in figure 3

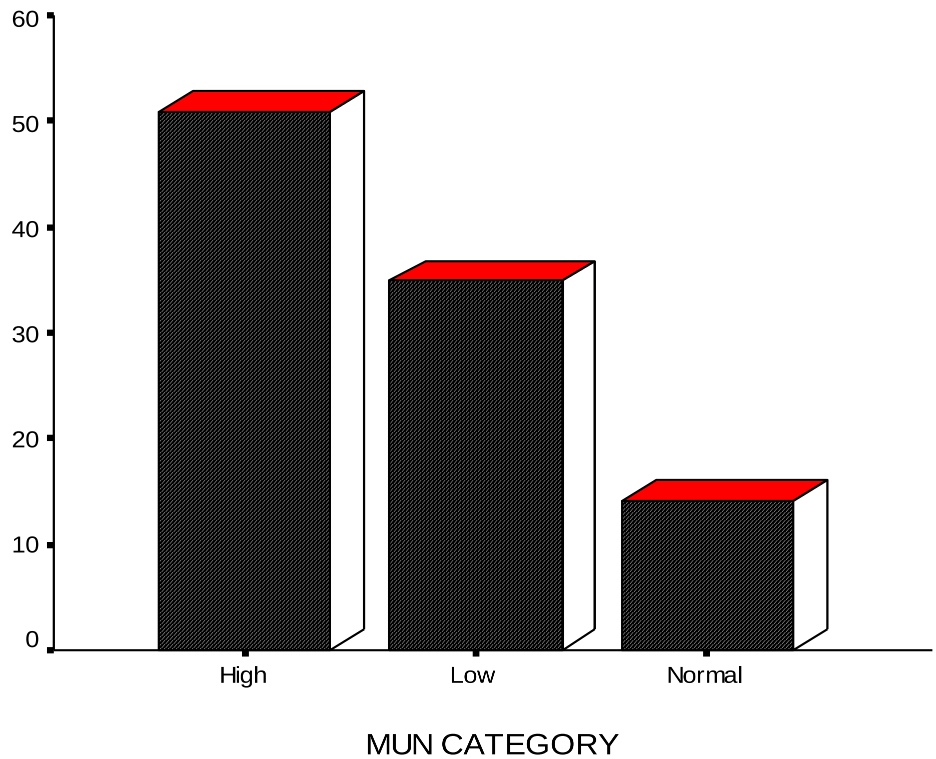

Figure 3. Percentage distribution of study animals with different MUN category

Values of MUN concentration for cows coming from the different farm sizes also varied greatly with the largest values being recorded in cows of the large farms (Table 3).

Table 3. Distribution of concentration of MUN for cows under the different farm groups

MUN categories		Farm Size			Total
		Large farm	Medium farm	Small farm	
Normal	Count	2	1	1	4
	% within MUN category	50%	25%	25%	100.0%
	% within Farm Size	1.4%	3.1%	3.0%	1.4%
High	Count	60	13	8	81
	% within MUN category	74.1%	16.0%	9.9%	100.0%
	% within Farm Size	40.8%	40.6%	24.2%	38.2%
Low	Count	85	18	24	127
	% within MUN category	66.9%	14.2%	18.9%	100.0%
	% within Farm Size	57.8%	56.3%	72.7%	59.9%
Total	Count	147	32	33	212

	% within MUN category	69.3%	15.1%	15.6%	100.0%
	% within Farm Size	100.0%	100.0%	100.0%	100.0%

In this study, the overall nutritional status of the study animals was evaluated and the mean values for BCS, MUN and milk production levels are summarized in table 4.

Table.4. Overall nutritional status and milk production level of the study animals

Parameters	N	Mean	SD	Mode	Min	Max
BCS	212	2.76	0.79	2.00	1.50	5.00
MUN (mg/dl)	212	18.95	14.40	6.00	1	91
Milk production (lit/day)	212	9.40	5.04	7	2	30
Milk production (lit/lactation)	212	3429.62	1840.45	2555	730	10950

Analysis of milk production into different levels revealed that 33.5% of the cows were high producers while 66.5% were low milk producers.

4.3. Reproductive performance

The overall reproductive performance of the study animals is given in table 5. In addition to this the conception rate was found to be 54.42%, 81.98%, and 57.44% for small, medium, and large farms, respectively.

Table 5. Overall reproductive performance of the dairy cows under study

Parameters	Mean	SD	Mode	Minimum	Maximum
CI	468.31	109.63	345	285	910
NSC	2.33	1.75	1	1	11
DO	162.50	111.06	60	40	640
Conception rate	62.5%	15.12	54.42	54.42	81.98

4.4. Effect of Farm Size and Nutritional Status on Reproductive Performance

Comparison of the mean calving interval among the different farm groups revealed that cows under large farms had a significantly longer CI (X^2=50.4 , P< 0.05), while animals coming from medium farms had the shortest CI. The mean NSC was found to be significantly higher (X^2= 40.4, P< 0.05) in cows coming from large farms and lower for medium farms. The mean DO was also found to be significantly longer (X^2= 90.6, P< 0.01) in the large farms while values were similar for small and medium farms.

Table 6. Comparison of reproductive performance of cows among the study farm sizes

	Farm Size	N	Mean	SD	F	P
CI (days)	Large farm	147	483.55	119.64	6.358	0.002
	Medium farm	32	410.59	53.43		
	Small farm	33	456.39	81.37		
NSC	Large farm	147	2.56	1.91	5.213	0.006
	Medium farm	32	1.56	1.05		
	Small farm	33	2.00	1.17		
DO	Large farm	147	188.39	117.94	14.743	0.000
	Medium farm	32	102.34	66.91		
	Small farm	33	105.45	58.95		

CI was not affected by body condition of the cows while NSC was found to be significantly higher (X^2 =24.0, P< 0.05) in those cows having good body condition than those with moderate or poor body condition (Table 7). The DO was found to be slightly longer in those cows with poor body condition and shorter in those with good body condition. But, there was no statistically significant difference (P> 0.05) between the farm groups.

Table 7. Comparison of reproductive performance of cows among the body condition categories

	Body condition category	Mean	S.D	N	F	P
CI (days)	Good	449.95	112.48	38	1.414	0.246
	Moderate	459.70	109.19	69		
	Poor	480.62	108.45	105		
NSC	Good	2.66	1.92	38	3.473	0.033
	Moderate	1.88	1.38	69		
	Poor	2.50	1.85	105		
DO	Good	137.97	91.53	38	2.962	0.054
	Moderate	148.26	113.31	69		
	Poor	180. 72	113.84	105		

CI interval was not statistically different (p>0.05) for all cows except a tendency of increase in length for animals with high concentration of MUN than for animals within the normal range of MUN concentrations (Table 8). Cows with normal MUN concentration were found to have a relatively shorter DO compared to the cows with low and high MUN concentration.

Table 8. Comparison of reproductive performance of cows among the MUN categories

	MUN category	**Mean**	**SD**	**N**	**F**	**P**
CI (days)	High	470,58	104.30	81	0.158	0.924
	Low	467.99	114.74	127		
	Normal	428.34	21.20	4		
NSC	High	2.19	1.58	81	0.356	0.785
	Low	2.43	1.85	127		
	Normal	2.00	1.73	4		
DO	High	159.22	107.54	81	0.200	0.896
	Low	165.50	115.05	127		
	Normal	120.33	32.01	4		

Cows that produce high amount of milk were found to have a relatively long CI and DO and higher NSC compared to the low milk producing ones (Table 9). There was, however, only a slightly significant difference (P<0.05) in the mean NSC between the high and low milk producing cows.

Table 9. Comparison of reproductive performance of cows among the milk production categories

	Milk production categories	Mean	SD	N	F	P
CI (days)	High	475.73	126.55	71	0.488	0.486
	Low	464.57	100.32	141		
NSC	High	2.66	1.98	71	4.026	0.046
	Low	2.16	1.6	141		
DO (days)	High	173.69	113.19	71	1.085	0.299
	Low	156.86	109.94	141		

Out of the total milking cows, 45.6% of the high milk producing cows belonged to the large farm comprising a total of 147 cows (Table 10) conversely; the small farm group had no high milk producing cows.

Table 10. Milk production levels of the study cows among the farm groups

Production categories		**Farm Size**		
		Large farm	Medium farm	Small farm
High	Count	67	4	0
	% within production category	94.4%	5.6%	.0%
	% within Farm Size	45.6%	12.5%	.0%
Low	Count	80	28	33
	% within production category	56.7%	19.9%	23.4%
	% within Farm Size	54.4%	87.5%	100.0%

Analysis of the distribution of BCS of cows for different level of production is given in table 11. Out of the 105 cows with poor body condition, 71.4% were low milk producers

Table 11. Production level of cows under the different BCS categories

Production category		**BCS categories**		
		Good	Moderate	Poor
High	Count	21	20	30
	% within production category	29.6	28.2	42.3
	% within BCS category	55.3	29.0	28.7
Low	Count	17	49	75
	% within production category	12.1	34.8	53.2
	% within BCS category	44.7	71.0	71.4

The association of MUN and BCS were also analyzed. Accordingly, the lowest MUN was recorded in animals with poor body condition (Table 12).

Table 12. Distribution of concentration of MUN among the different body condition categories

BCS category		MUN Concentration		
		High	Low	Normal
Good	Count	9	27	2
	% within BCS category	23.7	71.1	5.3
	% within MUN category	11.1	21.3	66.7
Moderate	Count	31	37	1
	% within BCS category	44.9	53.6	1.4
	% within MUN category	38.3	29.1	25.0
Poor	Count	41	63	1
	% within BCS category	39.0	60.0	1.0
	% within MUN category	50.6	49.6	33.3

The association of MUN was also analyzed for the milk production levels of the study cows. Accordingly, high milk producing cows were found to have low MUN concentration and the vice versa (Table 12).

Table 13. Relationship between milk production and concentration of MUN

Milk production		MUN Concentration		
		High	Low	Normal
High	Count	24	46	1
	% within production categories	33.8	64.8	1.4
	% within MUN categories	29.6	36.2	33.3
Low	Count	57	81	3
	% within production categories	40.4	57.4	2.1
	% within MUN categories	70.4	63.8	100.0

5. DISCUSSION

Dairy production in the tropics is often limited by deficiencies of protein, energy and minerals. These deficiencies have been reported to cause serious health and reproduction problems. This consequently leads to poor herd productivity. Of all nutrients considered to be limiting dairy production and reproduction in the tropics, energy and protein are the most critical.

Production and reproduction performance of an animal depends largely on its body condition. Energy and protein intake is considered to be the most important nutritional factors affecting body condition of dairy cows on dairying farms. It is widely known that many high producing cows are often in negative energy balance during early lactation. This is largely attributed to the facts that, high yielding cows are at high nutrient mobilization state. As such they can not consume adequate feed to meet the nutrient requirements for high levels of milk production. The energy stores in the body tissues are more often mobilized leading to weight losses. Factors associated with the negative energy balance have been suggested as causes of reproductive failures.

In this study, the mean estimated values for MUN and BCS were compared with the optimum recommended values of animals in good condition. The value was found higher for MUN and lower for BCS. High concentration of MUN concentration was known to affect fertility as its synthesis by liver cells utilizes energy. Low BCS also shows that the animals have no enough energy to reproduce and produce milk. Therefore generally we can say that the animals had poor nutritional status.

When we compare the nutritional status of the dairy cows among the farm groups, those cows in the large farm group were found to have lower nutritional status than the small and medium farms. The overall mean values of the CI and DO were found the same as the mean estimate for smallholder dairy farms else were in the tropics (Kishindi, 1999; Muriuki, 2003). Although the present estimate is within the range of previous reports, it is an extended when compared with the optimum DO (80-85 days) recommended to achieve the commonly accepted 365 days CI (Roberts, 1986; Arbel et al, 2001).

5.1. Calving interval

Results obtained in the present study are in agreement with earlier reports. Kiwuwa et al (1983) reported the mean CI for crossbred cows in the Arsi region of Ethiopia to be 453± 3 days .But it is shorter than the overall mean CI of 501±15days found for Fogera breed by Mokonen (1987). Muriuki (2003) determined the CI of smallholder dairy farms in Kenya and found it as 450 days. Staal et al (1999) also determined in some area in Kenya to be 590 days.

Comparing the mean CI of the three farm groups in this study, the CI of the largest farm group was found significantly ($P < 0.05$) extended than in the other two farm groups. This result shows that the reproductive performance of the urban dairy farms decreases as herd size increases; this is possibly brought about by poor management especially poor heat detection, shortage of available feed for large size herds.

BCS and MUN concentration had no significant effect on the CI. But there exists a tendency to increase as the BCS decreases and the MUN concentration becomes different from the recommended range. The CI of cows with normal MUN concentration was found to be the shortest when compared to that of the other farm groups. These findings is supported by the fact that high dietary protein intake resulting in MUN of greater than 19 to 20 mg/dl has been associated with an altered uterine environment and decreased fertility in lactating dairy cows (Elrod and Butler, 1993, Elrod et al, 1993, Ferguson et al, 1993, Butler et al, 1996). Therefore we can say that nutrition had an effect on CI and DO of the dairy animals.

Cows that produce large amount of milk were found to have a relatively long CI and highest NSC compared to the low milk producing cows. This outcome indicates that high milk producing cows require more energy for milk production than low milk producing cows. Shortage of energy supply as a result of utilizing for more milk production inhibits the physiological process of reproduction resulting in an extended CI and high NSC.

5.2. Days open

The current overall mean estimate of DO fall within the ranges reported for crossbred and Zebu cattle in different management systems in Ethiopia. Tesfu et al (1993) who worked on crossbred cows and Zebu in the central highlands of Ethiopia reported mean values for DO of 199.8 days for Zebu and 157.8 days for crossbred cows, respectively. The overall mean open days for crossbred cows in large peri-urban and intra urban dairy farms in Addis Ababa area was estimated 124 days (Yoseph 1999). Whereas, in West Shewa zone, the mean value reported for DO were 185.0 days (Yoseph *et al* 2003). Similarly, estimates of days open have been reported to range between 130 to 300 days in Zebu and crossbred cows under management conditions of research centers in Ethiopia (Azage *et al*, 1981). Although the estimate from this study is within the range of previous study reports, it is unfavorable and extended compared with the optimum DO recommended to achieve the commonly accepted one year CI. The DO was found slightly longer in cows with poor body condition and those cows having MUN concentration out of the normal range. These findings also indicate that nutritional status had an effect on reproductive performance of the cows because high or low MUN concentration and low body condition are indicatives of poor nutritional status of the cows.

In cows categorized under the milk urea concentration category, the DO mean values were found to vary from short in the cows with normal MUN to long in cows with low and high MUN concentration indicating that the reproductive performance is affected by MUN concentration. The average values of DO in the low and high milk producing cows were also found to affect reproductive performance of the dairy cows under study. High milk producing cows require more energy to synthesize milk than the low milk producing cows. This shows that nutrition is given to the cows indiscriminately (with out considering differences in sex, age, level of lactation etc). There are more high milk producing cows in the large farm and no one cow is registered in the small farm. This indicates that the reproductive performance of cows in the large farm was poor as compared to the small farm. The data from this study further shows that cows with poor body condition produce low amount of milk and have low concentration of MUN than the other group. High milk producing cows were found to have low MUN concentration. Generally, the variation in the reproductive performance observed among the small, medium and large farm groups' cold be due to management effects, including nutrition.

5.3. Number of services per conception

The estimated overall mean value of NSC was found similar to reports by other investigators in Ethiopia for crossbred cows, all in the range of 1.5 to 2.5 (Beyene 1992; Yoseph 1999; Yoseph *et al*, 2003). Tegegne et al (1981) estimated the NSC for Zebu and crossbred cattle was 1.76 to 1.95. The estimated NSC for Boran and Bora x Freisian crossbred cows in Abernosa ranch was 2.1 and 2.45, respectively (Mokonon, 1987). Kiwuwa (1983) estimated the NSC of the Arsi x exotic crossbred dairy cows ranging from 1.82 to 2.5. Even though the present result is within the ranges of previous reports, it was found to be higher when compared with other NSC in modern dairy farms elsewhere which may be due to poor heat detection, less availability of AI service and availability of feed.

Cows in the large farm group need more services than the other two groups. This indicates poor reproductive performance in the large farm group as compared to the medium and small farm groups. The poor reproductive performance in the group was related to problems associated with close supervision and better heat detection by owners as the herd size is not manageable. The availability of AI service at the time of heat detection was also another important factor determining the reproductive performance of the cows.

The NSC was significantly higher in those cows having good body condition than those with moderate or poor body condition. The level of body condition score of cows indicates the subsequent reproductive performance. Poor body condition score corresponds to low fertility. Most of the cows in the large and the medium group had poor body condition. Most of the cows in the small dairy farm group had moderate body condition. This data shows that the reproductive performance of cows in the large and medium farm size is lower than in the small size farm group. Among the herds in the farm group, most cows in the large farm had high and low MUN concentration in their milk showing poor reproductive performance. All the cows categorized in the small dairy farm group and most of the cows in the medium farm group were low amount of milk producing cows. Correspondingly, this shows that cows in these farm groups use most of their energy for reproductive activity resulting in a better reproductive performance than in the large farm group.

6. CONCLUSION AND RECOMONDATION

The present study in urban dairy cows revealed that the reproductive performance is poor as expressed by the high NSC, prolonged calving interval and days open. Majority of the animals had also a body condition ranging from poor to moderate, also confirmed by an irregular MUN concentration. The fact that nutritional status has a direct consequence on reproductive performance is high; animals could not be expected to have a better performance under the currently prevailing feeding system. Moreover, delayed and silent estrus due to nutritional factors or poor heat detection and AI services or other factors, which need further investigation, might have contributed to the poor reproductive performance. Conversely, analysis at farm level indicated a relatively better reproductive performance at small farms showing lack of adjustment of management level as the farm size grows. This implies the necessity of improving management conditions particularly feed resource and herd management capability of the owners prior to expanding herd size. Another contributing factor to the poor nutritional status could be scarcity of feed, exacerbated by high cost and poor quality. Based on the above conclusion the following remarks are recommended:

- Most of the owners of the dairy farms are not aware about strategic feeding system for dairy animals and have very limited knowledge concerning which feed to use, when and how to use it. This, therefore, calls for enhancement of farmers' capacity to make appropriate choices at appropriate time for appropriate cow. Building farmers' capacity through training/ field demonstration should therefore be made part and parcel of dairy development process.

- At research level, animal nutrition researchers must seek to strengthen research- farmer linkage, develop cost effective ways of maximizing information exchange on the available feeds and broaden feed resource base.

- If providing a lasting solution to the poor reproductive performance of the urban dairy herds is sought, then it is imperative to begin by tackling the problem of poor nutrition. Deliberate efforts should be made to ensure that rations balanced for energy, protein and minerals are provided to the dairy animals. This will help maintain cows in satisfactory condition conductive for optimum performance at calving and breeding.

- Monitoring of MUN is a simple technique for measuring protein and energy status that should be used as routine procedure in dairy farms to establish the nutritional status of a farm and to accordingly adjust the feeding system. Therefore, determination of MUN concentration and BCS should be used regularly, at least once per month, in all dairy farms

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