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Review article

Significance of litter size, duration of dry period and stage of pregnacy on milk yield and composition in dairy animals

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ABSTRACT

The factors influencing the amount and composition of produced milk can be divided into two groups, namely internal and external factors. This is very important to remember when evaluating the milk quality and in the improvement of milk yield and composition in a dairy enterprise. Of the external factors it is possible to mention a few, litter size, duration of dry period and stage of pregnancy. The present discussion explores the significance of litter size, duration of dry period and pregnancy on milk yield and composition in dairy production. In goats and sheep dams bearing twins or triplets had higher milk yield than single bearing dams, and this significant increase in milk production in these dams that carried twins and triplets was followed by an increase in lactation length. Due to the amount of milk animal produce, the drying-off process is often more complicated for dairy animals (cattle, goats and some sheep). However, this period is essential to enables dams to regain the body condition needed to support the subsequent pregnancy and lactation. The majority of dairy animals dry off spontaneously because of the aforementioned natural decrease in daily milk production. The length of dry period influences milk production in the subsquent lactation, with shortening of the dry period showing a markedly negative effect on milk performance of dams. Lactating animals should have an opportunity to rest and regenerate mammary tissue between lactations. **F**or optimal dairy animal performance in the next lactation, lactating animals should have an opportunity to rest and regenerate mammary tissue between lactations. The amount of produced milk and its composition are influenced by the stage of pregnancy, in the first half of pregnancy it is not possible to observe any pronounced changes while in the second stage of pregnancy can observe a gradual decrease in milk production as well as an imcrease in levels of individual milk components. During pregnancy and the first few days postpartum, milk supply is hormonally driven – this is called the *endocrine control system*. This implies that in the course of lactation, changes in milk production are caused by changes in activities of the endocrine system that are caused by hormones sectreted by pitiutary gland (hypophysis cerebi) and placenta. During the latter part of pregnancy, the mammary gland is making colostrum, but high levels of progesterone inhibit milk secretion resulting reduced milk yield. Progesterone influences the growth in size of alveoli and lobes; high levels of progesterone inhibit lactation before birth. Progesterone levels drop after birth; this triggers the onset of copious milk production. Estrogen stimulates the milk duct system to grow and differentiate. Like progesterone, high levels of estrogen also inhibit lactation, while the hormone prolactin must be present for milk synthesis to occur.

1. Introduction

Several factors affects milk yield and composition in dairy animals, for example breed (Soryal et al., 2005; Damian et al., 2008), udder morphology (Marnet and McKusick, 2001), genetics (Moatsou et al., 2004), parity (Peris et al., 1997; Salama et al., 2004; Carnicella et al., 2008; Ahuya et al., 2009; Crepaldi et al., 1999) feed and pasture (Dønnem et al, 2011), light (Flores et al., 2010), number of kids (Carnicella et al., 2008; Ahuya et al., 2009; Crepaldi et al., 1999), kidding time (Crepaldi et al.,1999) kid holding systems (Marnet et al., 2002) and milking interval (Salama et al., 2003; Salama et al., 2004). The present discussion explores the influence of litter size, length of dry period and pregnacy on milk yield and composition in dairy animals.

There was a significant increase in milk production in ewes that carried twins and triplets was followed by an increase of approximately 1% in lactation length and lambing intervals, and was due mainly to an increase in early lactation parameters such as maximum secretion potential of the lactation, peak yield, and the increase in milk yield midway between the start and peak of lactation (Pollott and Gootwine, 2004).

A nonlactating period prior to parturition in dairy cows, commonly referred to as the dry period, is important for optimal milk production during the subsequent

lactation (Sanders, 1928). A dry period between lactations is believed to be required to maximize milk yield in the subsequent lactation (Annen et al., 2004) through influencing mammary functionality. Dix and Becker, (1936) suggested that body condition should be a factor in determining dry period length.

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Late lactation events such as increasing day pregnant and decreasing milk yield have been associated with estrogen secreted by the developing fetal-placental unit could mediate changes in milk composition that promote milk fat hydrolysis (Bachman et al., 1988). During the latter part of pregnancy, the mammary gland is making colostrum, but high levels of progesterone inhibit milk secretion resulting reduced milk yield. It is therefore not surprising that studies of the influence of nutrition on foetal development and lactation performance have focussed on the level of feeding during late pregnancy and lactation (Robinson 1983; Treacher 1983). There is an assumption that the placenta is involved in mammogenesis (Mellor 1987). The present discussion explores the significance of litter size, duration of dry period and pregnancy on milk yield and composition in dairy production.

2. Litter size and milk production in dairy animals

Milk production was higher, but not significantly, in ewes suckling twins than in those suckling single lambs, especially in well-nourished lactating females (Khaldi, 1983). Raats et al., (1983) observed that the total milk production of the ewes increased with litter size. This confirmed the results from previous studies in sheep (Alexander and Davies, 1959; Gardner and Hogue, 1964). Peart et al. (1972) reported the same trend with triplet-suckled sheep ewes. Milk production was affected by litter size, with twin- and triplet-bearing ewes producing approximately 20 litres more milk per lactation than single-bearing ewes (Pollot and Gootwine, 2004). Butler et al., (1981) observed that progesterone, like placental lactogen, was related to litter size and, presumably placental mass and these hormone had a bearing on milk production. The relationship between litter size and placental lactogen concentrations, together with the absence of difference in estradiol secretion, suggests that differences in production of the lactogenic hormone may contribute to the superior lactational performance that has been reported for ewes which bear multiple offspring. The concentration of placental lactogen in circulation was directly related to litter size in different sheep breeds, with the greatest concentrations being observed in Finnish Landrace ewes bearing three lambs. Interestingly, litter size influenced a number of lactation traits (Pollott and Gootwine, 2004) and the effect was related to the prepartum effect of the number of fetuses carried by the dam. Ewes bearing twins or triplets had a greater milk yield, by approximately 6%, than single bearing ewes. A sharp increase in milk production occurred approximately 1 to 2 wk after conception, followed by a return to preconception levels by 4 wk and then a drop in milk yield as pregnancy progressed. In sheep, Alexander & Davies (1959) concluded that milk yield is either influenced by the number of lambs suckled or by the extent of the sucking stimulus. Snowder and Glimp (1991) working with three breeds of sheep (Rambouillet, Columbia, and Polypay) the total estimated yield of ewes with twins was 13 to 17% higher than that of ewes with singles, whereas in the Suffolk breed, suckling twins increased total milk yield 61% over that of ewes with singles. Twin lambs induced a larger differential in dam milk production in late lactation (70 to 98 d) than in earlier lactation (28 to 70 d). Number of lambs did not influence milk protein, Ca, or P content (P greater than .05). Fat levels in colostrum and 4-d milk were elevated 14 and 20%, respectively, in ewes suckling twins compared with ewes suckling singles.

It is well established that milk yield in goats is influenced by litter size (Raats et al., 1983) and milk yield is proportional to the mammary alveolar surface area (Richardson, 1973). Ueckermann, (1969) in goats, observed that the total milk production of the does increased with litter size. Litter size did not affect milk yield, although milk yield was always higher for goats that had given birth to twins than for goats that had given birth to a single kid in 210 d of lactation (Peris et al., 1997). Nevertheless, the goats that had given birth to a single kid exhibited higher persistency during lactation and neither total milk yield nor the lactation pattern was significantly affected by year of birth. Goats with twins tend to yield significantly higher amounts of milk than do goats with a single kid (Zygoyiannis and Katsaounis, 1986), however, in a study where the dam kept one kid as a maximum the differences in the suckling stimulus did not exist (Peris et al., 1997). Multiple kidding can increase the interval of posterior kidding by extending it due to stress of the goat, as to keep the pregnancy of one or more does. This implies that there is a greater mobilization of nutrients for gestation and lactation, making it necessary to have a greater period of recovery of the doe until the next conception. Therefore, if the goat has not properly recovered, this can harm subsequent lactation (Galina et al. 1995). Krajinović et al., (2011) stated that birth type is correlated with the amount of produced milk meaning goats with more kids per litter produce more milk than goats with single-born kids. This phenomenon is accounted for by mechanical stimuli on the udders of goats with more kids and by the impact of genetics. Multiple kidding, goats receive the same stimulus (milking) and the effect of the type of kidding occurred more because of the differences during pregnancy than in lactation. The argument is that perhaps, because of this, it was not possible to verify the significant effect of the type of kidding on some milk constituents (Pimenta Filho et al. (2004). However, the impact of the litter size on milk yield was independent from the order of lactation, body weight of goats and the kidding season (Mioč and Pavić, 2002). Goats with more kids had longer lactation, and produce more milk and milk fat (Subires et al., 1988). Type of kidding did not influence fat yield and percentages of protein and lactose (Brito et al., 2011), in contrary, the influence of type of kidding, simple or multiple, on milk yield has previously been verified by some authors, explained by the presence of the hormone placental lactogen, progesterone and prolactin during gestation, which are mammary gland stimulants. According to Hayden et al., (1979), the extent of mammary development depends in part on the number of foeto-placental units and on placental mass. However, their influence differ in quantity according to the type of gestation, simple or multiple and also they might affect milk production during lactation and simultaneous pregnancies (Sands and Mcdowell, 1978; Analla et al., 1995; Browning et al., 1995). There is confounding effect of age of ewe and litter size on milk yield, where older ewes showed a less marked response to litter size than younger ewes. The shape of the lactation curves indicated that the initial increase in milk yield because of multiple suckling was of shorter duration in the older ewes. The assumption is made that the diminishing response to litter size because of advancing age was possibly a result of limited nutrient supply. The initially higher milk production and the more rapid decline in milk yield of the triplet-suckled six-year-old ewes during the first three weeks of lactation could reflect the depletion of body reserves. It is likely that after depletion of this nutrient source, the natural grazing could not sustain the initial high level of lactation (Raats et al., 1983). This may imply that the total amount of milk, protein and fat available per kid, decreased with an increase in litter size. There are more nutrients available per kid from the older ewes than from younger ewes with the same number of kids.

3. Dry off period and extended lactation in dairy animals

Several hypotheses have been proposed to explain the requirement for the dry period, which include (1) replenishment of body reserves, (2) regeneration of mammary tissue, and (3) optimization of benefits from endocrine events near the time of parturition (Annen et al., 2004). A nonlactating period before parturition is believed to be necessary to permit replacement of damaged or senescent epithelial cells (Capuco et al., 1997) resulting in maximization of milk production during the ensuing lactation. Very long lactations are not desirable either, because a non-lactating (dry) period prior to parturition is required to restore mammary gland secretory tissue for milk production in the subsequent lactation (Fowler et al., 1991).

Rémond et al. (1997) reviewed several studies and reported a consistent increase in milk protein content after a shortened or omitted dry period and attributed it to lower milk yields and therefore a lower dilution effect. Extended lactation in dairy cows is an alternative to the typical 300-d lactation, however, it reduces the number of dry days within the animal's lifetime and the metabolic stress related to negative energy balance during early lactation (Knight, 1997), and may be profitable for dairy farmers (Arbel et al., 2001). Dry period is one of the important management strategies, where previous studies reported that to maximize milk yield in the next lactation in dairy cows, a 50 to 60 d dry period is necessary (Sorensen and Enevoldsen, 1991; Smith and Becker, 1995). In general a period of 50 days of dry period is recommended in cows (Fowler et al., 1991). Capuco et al. (1997) showed that mammary growth in cows was initiated within the first 25 d of a 60-d dry period. Moreover, cows with a 30-d dry period produced amounts of milk similar to cows with a 60-d dry period (Bachman, 2002). However, a dry period of <40 d results in reduced milk production during the following lactation (Coppock, et al., 1974). There have been four hypotheses proposed for reduced milk yield in cows subjected to short or omitted dry periods, which include, 1) nutritional limitations during late-gestation, 2) hormonal differences, 3) reduced mammary epithelial cell number, and 4) reduced synthetic and mitotic functionality of mammary epithelial cell (Annen et al., 2004). The mammary gland of the dairy cow requires a nonlactating (dry) period prior to an impending parturition to optimize milk production in the subsequent lactation (Dias and Allaire, 1982). The dry period includes the time between halting of milk removal (milk stasis) and the subsequent calving. Generally, 45 to 50 days is recommended. If less than 40 days, then milk yield in the subsquent lactation will be decreased (Swanson 1965; Coppock et al. 1974). Recently researches argue that reduction of dry period can improve cow performance regarding milk production and composition, metabolic status and fertility (Bachman, 2002; Gulay et al., 2003; Gümen et al., 2005; Pezeshki et al., 2007; De Feu et al., 2009; Watters et al., 2009). This is on the background that an optimal duration of the dry period is generally 40 to 60 d., this has been observed to balance loss of milk production during the current lactation with increased production during the following lactation. Previous studies support the conclusion that dry periods less than 60 d can reduce milk production in the subsequent lactation(Funk et al., 1987; Sorenson and Enevoldsen, 1991; Remond et al., 1992; Makuza and McDaniel, 1996), however, recently, several experiments have estimated dry period lengths reporting a decrease in the dry period length from 50–57 d to 30–34 d reduced the milk yield up to 10%. Dickerson and Chapman (1939) indicated greater milk yield reductions in undernourished herds that used a shortened dry period. In determination of the effects of dry period length on milk yield, milk composition, some blood metabolites, complete blood count, body weight and score and follicular status in primiparous and multiparous Holstein cows Safa et al., (2013) showed that reducing the dry period length to 20-d had a negative effect on milk production, milk composition and reproductive performance in Holstein dairy cows. Continuously milked cows or glands have depressed milk yields but no differences in mammary DNA content or cell number. Nutritional status and endocrine hormones are not factors in reduced milk yield in continuously milked glands. The total number of mammary cells did not differ between dry and lactating mammary glands during the preparturient period, processes of proliferation and cell turnover seemingly increased the percentage of epithelial cells in mammary glands of dry cows prior to parturition. A dry period is a requirement for mammary gland repose to maximize milk yield in the subsequent lactation (Cameron et al., 1998; Rastani et al., 2005). Fitzgerald et al. (2004) observed that the proliferation of mammary epithelial cells in the glands of primiparous dairy cows dried off for 60 d was greater than in the glands without dry-off at 7 d before calving. These authors reported no differences after parturition in cell proliferation between glands with or without dry periods, suggesting that reduced cell proliferation before parturition caused milk yield losses in the subsequent lactation in glands without a dry period.

Continuous lactation without dry period resulted in depressed milk yields are due to reduced functionality of mammary parenchyma in cattle (Annen et al., 200). The necessity of a dry period appears to be for reasons other than nutritional reasons (Smith et al., 1966). However, physiological events necessitating a dry period were still remain unknown that time (Swanson, 1965). However, Remond et al., (1992) in dairy cows observed that omitting the dry period reduced milk yield by 15 to 25% during the subsequent lactation indicating that a dry period between lactations is indispensable for dairy cows. Nowadays, one of the most important economic problems in dairy herds is poor reproductive efficiency. So, improvement in reproductive efficiency may lead to enhanced performance in dairy characteristics. Therefore, reducing dry period length may affect fertility efficiency (Gulay et al., 2003; Gumen et al., 2005; De Feu et al., 2009; Watters et al., 2009).

Omission of the dry period between lactations reduced the quality of colostrum and had negative effects on milk yield in dairy goats. Goats dried off spontaneously for 27 d were as productive as goats dried off for 56 d, indicating that less than 2 mo of dry-off may be sufficient in practice (Caja et al., 2006). In goats the omission of the dry period between lactations did not reduce subsequent milk production. The only study carried out in multiparous goats used the half-udder design and showed that continuously milked half-udders were as productive as half-udders not milked (given a dry period), which implies that the dry period seems to be unnecessary in dairy goats (Fowler et al., 1991). In sheep ewes require a dry (non-lactating) period before they lamb again. For goats studies have shown that goats require at least 28 days or the next lactation milk production is lower. High producing dairy ewes need a dry (non-lactating) period to recoup body condition in preparation for the next parturition and lactation, while cows require a minimum of 40 days. Without this quiet period, mammary cell proliferation is reduced at the next lambing and as much as 1/3 less milk is produced the following lactation. A ewe should have a dry period not shorter than 28 days and more appropriately a minimum of 60 days. Experienced livestock dairy producers often successfully use methods different in drying practices. Regardless, best practices are best practices for a reason and the consequences of improper dry off procedures can be serious and even fatal. In sheep very long lactations are rare and in general the dry period is sufficiently long to restore mammary gland secretory tissue (Fowler et al., 1991). Late gestation which is next to lactation, has the greatest nutrient demands for fetal growth and the development of the potential for high milk production. Over 80 percent of fetal growth occurs in the last six weeks of pregnancy. Inadequate nutrition (especially energy) during this time will have detrimental effects on milk production of the ewe.

4. Pregnancy and milk production in dairy animals

Pregnancy has been shown to cause a significant decline in milk yield of dairy cows due to hormonal changes (Bachman et al., 1988; Akers, 2002) and the nutritive requirements of the fetus, especially during the third part of gestation (Bell et al., 1995). Working with dairy cows Caja et al. (2004) observed that the volume of cisternal milk decreased, whereas its proportion increased, as lactation advanced. The effect of pregnancy on cisternal milk volume was attributed to a decrease in the nutrients available for milk synthesis resulting in a decrease in milk yield. The difference between goats and cows could be due to the larger cisternal compartment in goats compared with cows (Salama et al. 2004). In another study alveolar milk contained more fat than cisternal milk, except for traditional 12 months kidding interval goats at wk 39 (wk 10 of pregnancy) when milk yield was very low (Salama et al., 2005) which confirmed the results obverved in dairy cows by Ayadi et al., (2004) and ewes by McKusick et al., (2002). The reason was that milk fat globules are large and do not pass freely from alveoli to cistern, and therefore more fat is retained in the alveolar compartment (McKusick et al., 2002). This emphasizes the importance of milk ejection and complete milking for recovery of milk that is rich in fat. Lactogenesis and pregnancy are coordinated by hormones (Thatcher et al., 1980), the observed effects of pregnancy and milk yield could be related to the hormonal changes that occur during pregnancy imposed upon lactation. Estrogen is of interest because its serum concentration increases as the fetus matures during an advancing lactation (Eley and Head, 1979; Robertson and King, 1979). This increase in estrogen , which is of fetal- placental origin, affects mammary gland development and in initiation of parturition (Thatcher et al., 1980). Late lactation events such as increasing day pregnant and decreasing milk yield have been associated with estrogen secreted by the developing fetal-placental unit which could mediate changes in milk composition that promote milk fat hydrolysis (Bachman et al., 1988). Lactogenic and mammogenic stimuli of advanced pregnancy oppose apoptotic (cell death) stimuli induced by cessation of milking (Capuco et al., 2004). Therefore, in dairy cows extensive cell loss does not occur during involution, and mammary epithelial cells growth begins to increase before the involution process is complete (Annen et al., 2003). The production decline during the last 3 wk of gestation was dramatic in multiparous cows, but the increase in daily milk yield was rapid during the first 2 wk after parturition (Mark et al., 2004). Very low milk yields in the last 2 wk of gestation and leaky tight junctions allowing extracellular fluid into alveolar lumens may result in a transudate of plasma becoming the primary secretion rather than milk (Wheelock et al., 1965; Linzell and Peaker, 1974). Continuously milked cows may have reduced colostrum quality due to the lack of a secretion accumulation period. Further research needs to be conducted to better understand milk composition and physical properties of late-gestation and mammary secretions.

Knight and Wilde, (1988) studying lactational effects of pregnancy in dairy goats mated at peak of lactation observed milk yield decreased at the same rate in pregnant goats during the first 8 wk of pregnancy as in nonpregnant goats. Nevertheless, milk yield decreased more quickly in the pregnant goats thereafter, reaching 57% of the milk yield of nonpregnant goats in the last week before parturition. However, the study did not assess the effects of pregnancy on milk composition and milk partitioning in the udder. Pregnancy caused a dramatic milk yield drop in dairy goats, which was observable from the second month after mating, and which facilitates drying off before the next kidding (Salama et al., 2005). Linzell (1973) observed that well-fed nonpregnant goats, milked twice daily, can lactate continuously for 2 to 4 yr, however, there was no information on the quality of milk produced from goats under extended lactation. The doe is often pregnant in very late lactation and concurrent pregnancy with lactation will affect milk yield. In very late pregnancy, there is cell loss (via programmed cell death, called apoptosis), as well as a decline in the milk secreted per cell. This role of hormones in galactopoiesis, a similar scenario can be assumed for the dairy cow.

Proper nutrition during pregnancy favors the development of the secretory tissue of the mammary gland, probably as a result of the action of the placental lactogen hormone secreted by the placenta during the pregnancy. The effect is an increase in the number of mammary secretory cells and thus a higher potential milk yield. Growth and differentiation of the glandular epithelium during pregnancy are important determinants of the total area of secretory epithelium and consequently of milk yield. Knowledge of the physiological and environmental factors that influence the number and the activity of mammary secretory cells is necessary to determine a proper strategy for maintaining lactation. There was a marked effect of pregnancy on milk production in sheep (Doves et al., 1994). This was on the background that 85% of the growth of the foetus and almost all of the growth of the mammary tissues occured during the last 50 days of pregnancy. It is therefore not surprising that studies of the influence of nutrition on foetal development and lactation performance have focussed on the level of feeding during late pregnancy and lactation (Robinson 1983; Treacher 1983). There is an assumption that the placenta is involved in mammogenesis (Mellor 1987). Mavrogenis et al. (1980) observed reduced milk production in ewes which were underfed before day 100 of pregnancy, despite ad libitum feeding over the last 6 weeks of pregnancy. Nutrition in the first 100 days of pregnancy can influence milk production in 2 ways. The first appears to operate via the process of mammogenesis, while almost all of the growth of the mammary tissue occurs late in pregnancy, the process is strongly influenced by secretions from the placenta, the concentrations of which are in turn affected by placental size (Mellor 1987). By directly affecting placental development, ewe nutrition before day 100 can thus influence udder size and the capacity for milk production in the subsequent lactation (Davis et al. 1980). Proper management and nutrition of the ewe flock during gestation period is critical for optimizing milk production of the ewes. Apart from balanced nutrition, beign important for fetal development, lamb vigor and survival at birth, may influence milk production of the ewe. During pregnancy and the first few days postpartum, milk supply is hormonally driven – this is called the *endocrine control system*. This implies that in the course of lactation, changes in milk production are caused by changes in activities of the endocrine system that are caused by hormones sectreted by pitiutary gland (hypophysis cerebi) and placenta. During the latter part of pregnancy, the mammary gland is making colostrum, but high levels of progesterone inhibit milk secretion resulting reduced milk yield. Progesterone influences the growth in size of alveoli and lobes; high levels of progesterone inhibit lactation before birth. Progesterone levels drop after birth; this triggers the onset of copious milk production. Estrogen stimulates the milk duct system to grow and differentiate. Like progesterone, high levels of estrogen also inhibit lactation, while the hormone prolactin must be present for milk synthesis to occur.

5. Implications

It is well established that milk yield in small ruminants is influenced by litter size. Dams with multiple young ones. Twin lambs induced a larger differential in dam milk production in late lactation than in earlier lactation and number of lambs did not influence milk protein and mineral content. Fat levels in colostrum in ewes suckling twins were elevated compared with ewes suckling singles.

From the discussion on dry period it has shown that dry off period between lactations is indispensable for dairy animals to maximise milk production. Proper dry cow management is important in preparing cows for the next lactation Pregnancy. This is the time when the dairy animal's udder needs time's body needs time to restore body energy and nutrient reserves. A cow's body condition at drying-off should be close to that desired at calving. Adequate body energy and nutrient reserves are required to attain and hold top production during early lactation. It seems the reduction in subsequent milk yield in dairy animals subjected to modified dry periods was caused by decreased replenishment of body reserves during trimester of gestation, thus resulting in inadequate body reserves to partition to milk production in the subsequent lactation. An understanding of the changes that the mammary gland undergoes during a traditional dry period is important when evaluating the effects of continuous milking on the mammary gland. Dairy animals in poor body condition will drop off in milk production and are difficult to get bred. Increased production levels and improved persistency of lactation in modern dairy breeds (cattle, goat, sheep) provide new reasons to reevaluate the optimal dry period length in dairy animals. This is considering that additional days of lactation maximize income generated per dairy animal per lactation and decrease the number of replacement animals needed to keep a dairy enterprise operating at desired dam number capacity. The new focus on dry period research need to take into account the several changes have occurred since the adoption of previous dry period in different animal species. Such changes include improved milk production per lactation in different animals species, greater emphasis on profit, use of artificial insemination and embryo transfer, total mixed rations, increased milking frequency, altered photoperiod, and use of bovine somatotropin in dairy production.

In the present discussion there is considerable evidence that understanding the mechanism acting within the body in relation to the control of milk secretion may improve milk production in dairy animals. Therefore, knowledge of extramammary factors influencing milk production is essential to study in both pregnancy and period of lactation which can provide quantitative information in management of dairy animals. Mammary growth during pregnancy is a prerequisite for satisfactory lactation in all dairy animals. During pregnancy, the mammary gland is competing with many other organs for nutrition to sustain growth. Mammary secretory activity in dairy animals is initiated from pregnancy although it is at a low level.

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