Managing Postpartum Reproductive Issues

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Take Home Message

- Negative energy balance during early lactation is the major nutritional link to low fertility in lactating dairy cows.
- Negative energy balance delays recovery of postpartum reproductive function and exerts carryover effects that reduce fertility during the breeding period.
- Animal health components (liver, uterus, mammary gland) affect reproductive performance.
- Feeding, nutrition, and health of lactating cows for improved reproductive performance begins in the transition period and continues through early lactation.

Introduction

Over the last several decades, large increases in milk production capability among dairy cows have been associated with declining fertility (Figure 1; Butler, 2000). Conception rate in large commercial dairy herds stands at only 35-40% for mature cows as compared with 51% in first lactation cows or normally 65+% in virgin heifers. These differences within a herd indicate that fertility declines with each calving until cows reach maturity.

- Since milk production increases each lactation, what part of the decrease in fertility is due to metabolic effects linked to high milk yield?
- Since most health problems and costs are associated with calving and early lactation, what part of the decrease in fertility is due to other animal health factors?

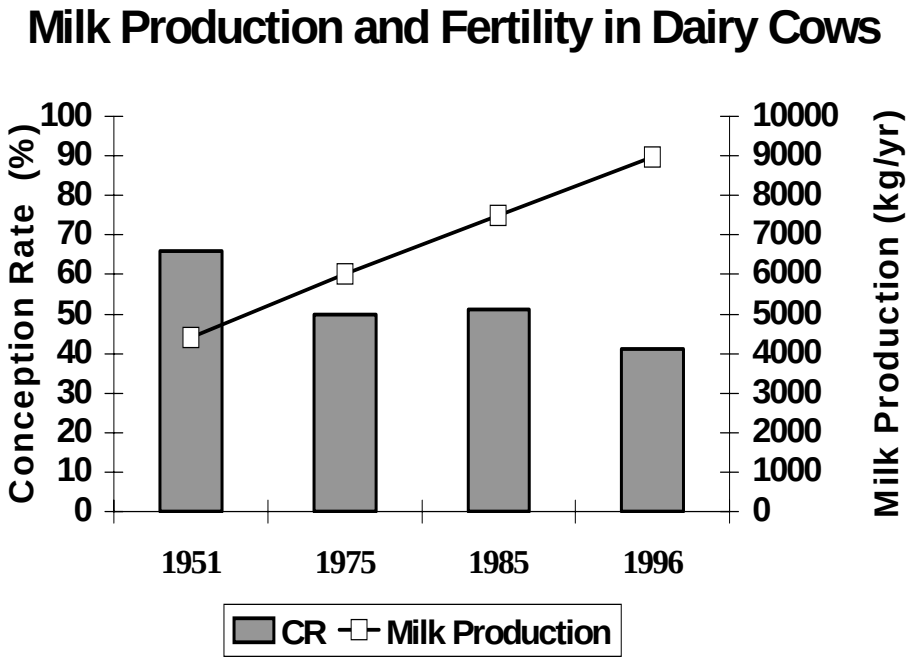

Figure 1. The inverse relationship between conception rate (CR) and annual milk production of Holstein dairy cows in New York.

The onset of lactation is associated with a prolonged period of negative energy balance (NEBAL) during which energy intake lags behind the energy requirements of rapidly increasing milk production. Depending upon the length of the elective waiting period, many cows may still be in NEBAL at first breeding. With regard to fertility to AI, there is a very positive association between conception rate and early commencement of postpartum ovulatory cycles (Butler, 2001). Conception rate increases with successive cycles and this probably is related to improvement in progesterone profiles during early postpartum cycles (Lucy and Crooker, 2001). Together these important relationships have focused concern on the NEBAL condition controlling the timing of first postpartum ovulation.

■ Resumption of Ovulation in Postpartum Cows

In considering what factors may affect the ability of cows to become pregnant again in early lactation, it is important to understand that all the organs associated with reproduction must recover from pregnancy and parturition:

Ovary

- Re-establishment of full follicular development with ovulation.
- Healthy oocyte and strongly functional corpus luteum- progesterone.

Hypothalamus/pituitary gland (Gonadotropins – LH & FSH).

Uterus – Complete involution and lack of inflammation.

Liver – Supports heavy metabolic load (Gluconeogenesis, fatty acid oxidation, insulin-like growth factor-I production).

The recovery of each of these tissue functions is negatively influenced by NEBAL (Butler, 2001). NEBAL acting perhaps through the combined metabolic signaling of low blood glucose and insulin concentrations along with elevated nonesterified fatty acids (NEFA) delays increases in gonadotropin (LH and FSH) pulses necessary for stimulation of ovarian follicles (Figure 2). Low blood insulin concentrations are also responsible for low IGF-I production from the liver, which together reduces responsiveness of the ovary to gonadotropins. Low or delayed production of ovarian steroids, estradiol from follicles and progesterone after ovulation, slows the rate of involution and recovery of normal uterine function. By way of these various interactions, NEBAL shifts the course of postpartum ovarian activity and strongly influences the resumption of ovulatory cycles. At least one large follicle develops on the ovaries in all cows by 6-8 days postpartum. What is different among cows is that this first large follicle has three outcomes which determine the variation among cows in days to first ovulation as shown in Table 1. More detailed description of the regulation of postpartum ovulation is reviewed elsewhere (Beam and Butler, 1999).

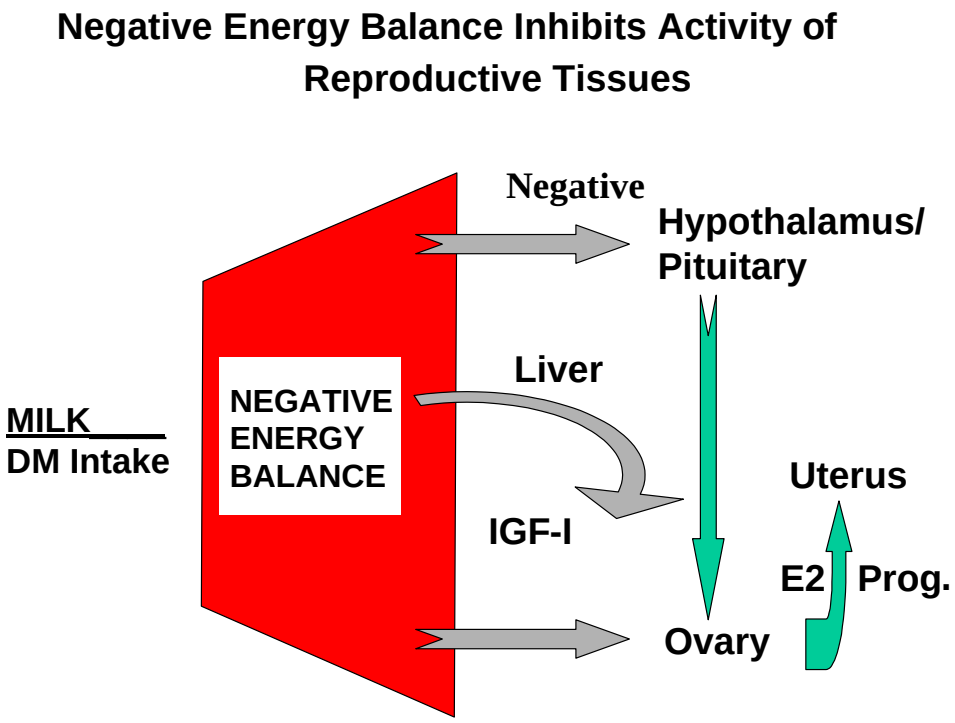

Figure 2. Negative energy balance inhibits recovery of the reproductive system after parturition.

Table 1. Onset of postpartum ovarian follicular activity and first ovulation.

Outcome	Incidence	Days to Ovulation
Ovulation	45%	20
Regression/Atresia	35%	51
Cystic	20%	48

Beginning about one week before calving, feed intake declines resulting in NEBAL that will worsen over the next 2-3 weeks with the onset of lactation and reach its lowest point (nadir) about two weeks postpartum. NEBAL results in mobilization of body fat and release of NEFA into the blood. The variation in the degree of NEBAL among individual cows is explained largely by differences

in energy intake rather than milk yield (Villa-Godoy et al., 1988). Increasing body condition score (BCS) is a major cow factor causing decreased dietary intake during the close-up dry period approaching calving. Metabolic adaptations to the emerging NEBAL surrounding the onset of lactation are both dynamic and complex with the condition changing daily throughout the transition period. Maintaining energy intake to minimize NEBAL is a major aspect of nutritional modulation of the recovery of the reproductive system.

■ Carryover Effects of Early NEBAL on Fertility

Monitoring NEBAL in dairy herds is done by observing changes in BCS. Greater NEBAL/BCS loss during the first 30 days postpartum delays first ovulation (Figure 3). Significant numbers of cows (28-50%) remain anovulatory beyond 50 days of lactation and into the breeding period (Staples et al., 1990; Stevenson, 2001). Obviously, cows that fail to resume ovulatory cycles are infertile, but even cows with delayed first ovulation will lack the benefit of multiple ovarian cycles and will express lower fertility to insemination. There is strong agreement among many studies that conception rate decreases with increased BCS loss. For example, conception rate decreases about 10%/0.5 unit BCS loss (see review by Butler, 2001). Cows remaining anovulatory after 50 days of lactation will have a higher risk of not becoming pregnant during lactation and, therefore, of being culled (Figure 4).

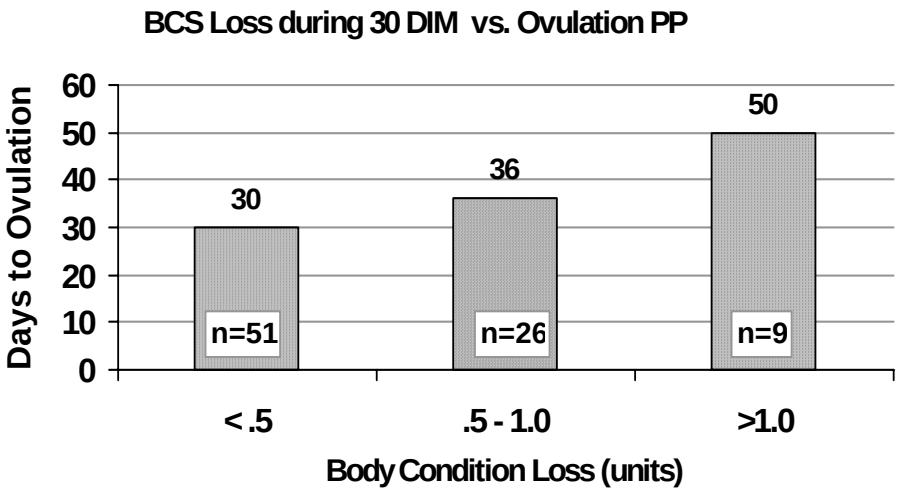

Figure 3. Body condition score loss delays first ovulation in lactating dairy cows.

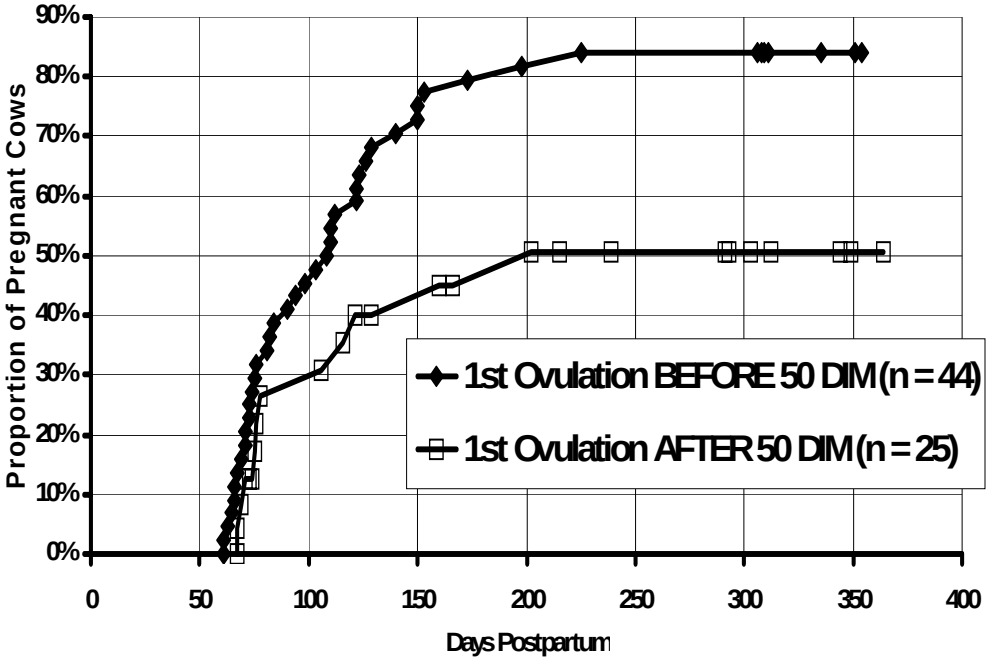

Figure 4. Delayed first ovulation until after 50 days in milk decreases pregnancy rate during lactation.

Progesterone is essential for pregnancy after breeding and must be present in blood in adequate amounts to support embryo development and survival (Butler, 2001). The levels of progesterone increase over the first three ovulatory cycles in postpartum cows with less improvement in cows with greater NEBAL (Villa-Godoy et al., 1988). Lower progesterone levels normally observed in high producing cows probably also reflects increased metabolism by the liver (Lucy and Crooker, 2001). The initial critical period for optimum progesterone influence appears to be days 5-7 after insemination (Butler et al., 1996), but research attempts at progesterone supplementation after insemination have had mixed success.

Another possible carryover effect of early NEBAL may be that oocytes are imprinted by deleterious conditions within the follicle during their development over a period of 60-80 days. Severe NEBAL impaired oocyte developmental competence at 80-120 days of lactation suggesting toxic effects of high periparturient NEFA concentrations (Kruip et al., 2001). While these results support concerns about early NEBAL affecting oocytes, results of another study

showed that early embryo development is compromised even later during mid-lactation by the ongoing metabolic effects associated with low BCS (≤2.5; Snijders et al., 2000). Therefore, the results of these and other studies on oocyte quality (Gwazdauskas et al., 2000) indicate some detrimental impact of NEBAL on oocyte competence for embryo development, but it is unclear whether such effects are only limited to follicular development during early lactation or are manifested more continuously during high milk yield.

In summary, NEBAL early during lactation exerts delayed carryover consequences on fertility during the breeding period. These effects include reduced or sub-optimum levels of progesterone in blood that influence fertility through alteration of uterine function and inadequate rate of early embryo development. In addition, NEBAL may detrimentally impact the oocyte that is released after ovulation. Reducing NEBAL is beneficial, but very difficult to achieve in cows being managed for high milk yield. Supplemental dietary fats have been proposed as a means to increase dietary energy density during a period of low intake, but have generally been unsuccessful (Staples et al., 1998). Maintaining dietary intake during the transition period is most important.

■ Animal Health Factors Related to Fertility

Liver

During NEBAL, mobilization of body fat as NEFA results in accumulation of triglycerides in the the liver that can impair some important functions such as glucose synthesis (Overton, 2001). Ketone levels in blood are also increased. Both hepatic triglyceride accumulation and increased blood ketones are associated with delayed first postpartum ovulation, but the link is unclear. Regardless, managing the transition cow to reduce fat mobilization and to increase metabolism of NEFA for improved metabolic health also benefits the recovery of ovarian activity after calving. A WIN-WIN situation!

Uterine Health

Retained placenta or calving conditions resulting in uterine infection or endometritis that persists can compromise fertility later during breeding (Jorritsma et al., 2000).

Mastitis and Fertility

Both sub-clinical and clinical mastitis during early lactation will decrease fertility (Schrick et al., 2001). The most detrimental situation was for cows with long-term sub-clinical infection that subsequently became clinical and resulted in an average of 196 days open.

■ Goals for managing postpartum reproductive issues

Maintain energy intake through the prepartum period to calving and increase intake rapidly thereafter.

- reduces NEBAL and the detrimental effects on coordinated ovarian and liver function
- reduces BCS loss, effects of NEFA on oocytes and liver, and delay to first ovulation

Maintain good uterine health during and after parturition.

- clean calving environment to minimize uterine infection that can reduce fertility later

Maintain all “other/udder” health characteristics and avoid infections.

- inflammatory cytokines on CL lifespan, fever, embryo loss

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