Dry Cow / Fresh Cow Feeding for Better Breeding

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Introduction

Proper nutritional management of the dry and early lactation cow can profoundly affect subsequent reproductive performance. Nutritionally related periparturient complications constitute major risk factors for subsequent infertility.[1] There is substantial evidence that energy balance alters fertility in apparently normal, cycling dairy cows.[2] The effect of energy balance on fertility may either be acute or latent.

High producing dairy cows undergo a period of negative energy balance during early lactation because they are unable to consume enough feed to meet nutrient requirements for milk production. Tissue energy stores are mobilized and loss of body condition occurs during the weeks preceding, and sometimes during the period in which the cow should be rebred.[3]

High producing dairy cows tend to have an increased interval from calving to conception.[4,5] However, not all high producing dairy cows experience reduced reproductive efficiency.[6] On a within-herd basis, the association between production level and fertility is low.[1] An explanation for this observation, based on differences in early postpartum energy balance, has been proposed.[7]

Reproductive success depends on growth and development of high quality follicles. Follicular quality, and hence fertility during the 60-120 day postpartum breeding period is significantly influenced by the metabolic condition of the cow in the first 3-5 weeks postpartum.[7] This paper will examine evidence that points to both acute and latent effects of postpartum energy balance on fertility. Specific recommendations to minimize periparturient metabolic disease and improve postpartum energy balance are discussed.

Bovine Follicular Development

The time required for an early preantral (primary) follicle to grow to preovulatory size is not well established for the cow. Lussier and coworkers calculated that 42 days are required for an early antral follicle to grow to preovulatory size.[8] Studies in other species indicate that the preantral growth phase may be considerably longer than the time required for antral growth. For example, in gilts, it takes approximately 100 days from activation of a resting primordial follicle to attainment of ovulatory size.[9] By extrapolation, it is estimated that a minimum of 60-80 days is required for bovine follicles to develop from the early preantral stage to ovulatory size.[7]

Energy Balance Influences Follicular Development

The hypothesis presented here and supported by others[10-13] is: adverse conditions such as negative energy balance, heat stress or postpartum disorders influence follicular quality and hence fertility. The effects may not become evident until months later. This suggests that the conditions under which follicular development occurs 60-80 days prior to insemination have as great or greater impact on fertility than the period immediately preceding insemination.[7] This could explain several clinical observations regarding exposure to adverse conditions and subsequent impact on fertility. For example, dairy cows living in a hot, humid environment experience decreased fertility for up to 60 days after the onset of cooler weather.[11,14] Cows which have early postpartum clinical disorders frequently have reduced fertility 60-80 days later even though the disorder was successfully treated.[15] Cows with the greatest loss of body condition during the first 2-5 weeks postpartum have the poorest conception rates at first service.[6] Experimental evidence is not available that directly supports this hypothesis but the response of bulls to adverse conditions presents a parallel situation. Exposure to heat stress, toxins or undernutrition results in altered gene expression in developing germ cells and thus poor quality semen several weeks later.[16] Semen parameters do not return to normal until 2-3 months after the adverse condition is corrected.[17] An analogous situation may exist in the female in which adverse conditions not only cause an acute reduction in fertility but a latent effect as well.

Energy balance may influence follicular development by altering gonadotropin release patterns and/or peptide growth factor concentrations. Oocytes of recruited preantral follicles are highly active in terms of DNA synthesis and respond to gonadotropins and peptide growth factors (epidermal growth factor, insulin-like growth factor-I, and fibroblast growth factor). Butler and Smith suggested that negative energy balance

Presented at the Minnesota Dairy Conference for Veterinarians, The College of Veterinary Medicine, University of Minnesota; June 3-4, 1992; Dr. James Hanson, Coordinator

results in delayed return of ovarian activity after parturition by reducing pulsatile release of luteinizing hormone (LH).[6] Proper LH pulse pattern appears crucial for the onset and timing of postpartum ovarian function. Spicer *et al.* demonstrated that dairy cows in positive energy balance during the first 12 weeks postpartum had greater serum concentrations of insulin-like growth factor-I than cows in negative energy balance.[13] Growth factors stimulate DNA replication and steroidogenesis in hamster preantral and antral follicles.[18] It seems reasonable to infer that energy balance, by altering gonadotropin release and growth factor concentrations, can exert considerable influence on follicular development and ultimately follicular quality.

Follicular quality may impact fertility either through viability of ovulated oocytes or through the amount of progesterone produced by the corpus luteum (CL) subsequent to ovulation.[7] The exact mechanism by which negative energy balance adversely affects oocyte quality is unclear but a detrimental effect on the CL is well established.[12,19] Villa-Godoy *et al.* demonstrated that energy balance within 9 d postpartum was correlated with concentration of serum progesterone in second and third postpartum luteal phases. In fact, the association was stronger for the third cycle than for the second cycle.[12] These findings indicate that progesterone production by the CL is influenced by the metabolic condition of the cow 40-70 days prior to ovulation. Similarly, Spicer *et al.* found that average progesterone during diestrus of the first and second postpartum estrous cycles was lower for cows in negative energy balance than for cows in positive energy balance.[13] In the same study, there was no difference between cows in positive vs. cows in negative energy balances with regard to interval to first postpartum ovulation and intervals to first and second estrus. However, there was a difference in the percentage of cows expressing estrus at first ovulation. In positive energy balance cows, 60% of the first postpartum ovulations were associated with estrus compared with only 16.7% for the negative energy balance cows. The importance of sufficient progesterone production by the CL of cycles prior to breeding was demonstrated by Fonseca *et al.* In Holsteins, serum progesterone during the diestrus preceding AI and 7 to 25 days after AI was consistently higher for cows that conceived compared with cows that did not conceive.[1]

In order for cows to have maximum lifetime productivity, dairymen try to maintain a 12-13 month calving interval. This means cows must begin cycling soon after calving and be fertile by 50-90 days postpartum. Even if negative energy balance is corrected prior to first service, the latent effects reduce fertility during the period when dairymen desire to rebreed cows. Staples *et al.* conducted a study designed to evaluate the relationship between ovarian activity and energy balance during the first 9 weeks postpartum.[20] They found anestrus cows ate less feed, produced less milk, and lost more body weight than cycling cows. Both anestrus cows and cows in which a CL was not detected until 40-60 days postpartum obtained more energy from body reserves during the first two weeks of lactation than cows cycling prior to day 40. These findings indicate that negative energy balance must be minimized to improve reproductive efficiency.

Cows that are able to consume enough dry matter to minimize or prevent negative energy balance in the early postpartum period have healthy follicles, early return to cyclicity and high fertility.[20,21] Thatcher *et al.*[10] demonstrated in postpartum Holsteins that as energy balance increased, follicular growth was stimulated and follicles were recruited from smaller classes to move into larger classes. In the same study, those cows which experienced multiple ovulations had a higher average energy balance than cows having no or single ovulations.

Body Condition Change Alters Reproductive Efficiency

Recent studies have critically evaluated the effect of body condition on fertility. Data presented by Britt,[7] as well as Butler and Smith,[6] provide clear evidence that loss of body condition score (BCS) greater than 1.0 point (0-5 scale) during the first 5 weeks postpartum is associated with reduced fertility at first service. Recently, Weaver reported postpartum drops in BCS >0.75 and/or below an absolute score of 2.5 have detrimental effects on reproduction.[22] To indirectly test the hypothesis that negative energy balance in the early postpartum period reduces subsequent fertility. Britt[7] conducted a retrospective analysis of data collected by Fonseca *et al.*[1] In the original study, physical and endocrine parameters were monitored for the first 150 days postpartum in high producing Holstein cows in two North Carolina State University herds. Complete data were available for 76 cows. The BCS were tabulated weekly for the first 10 weeks postpartum. The greatest rate of change in BCS occurred between weeks 1 and 5. For analysis, cows were assigned to either "high" or "low" groups based on change in BCS between weeks 1 and 5. High cows freshened with a mean BCS of 2.8 and had the least decline in BCS throughout the first 5 weeks postpartum. Low cows lost more condition during the first 5 weeks postpartum even though they had a higher BCS (mean = 3.14) at freshening. For both groups, ovarian function was evaluated by determining days to first ovulation, days between ovulations, and progesterone secretion (average, peak, luteal phase mean) during each estrous cycle. Conception rates were calculated on the basis of service number as well as postpartum ovulation number. Results of this study confirm that maintaining body condition during the first 5 weeks postpartum improves subsequent fertility. These data are summarized in Table 1.

Table 1. Results of retrospective analysis of data from high producing Holstein cows sorted on the basis of change in BCS between weeks 1 and 5 postpartum. (From Britt, J.H.: Impacts of early postpartum metabolism on follicular development and metabolism. In: Proceedings of the Twenty-Fourth Annual Convention American Association of Bovine Practitioners. (Ed.: Williams, E.I.) AABP, Orlando; 1991: 39-43.

Trait	High Cows	Low Cows
No. cows[a]	46	30
BCS change[b]		
Weeks 1 to 5	+.06	-.58*
Weeks 5 to 10	-.02	+.17*
Days postpartum to ovulation		
First	17.2	23.3*
Second	35.8	44.3*
Third	58.7	64.4*
Fourth	78.4	86.1*
Fifth	102.0	110.1*
Milk yield (lbs)		
Daily mean 3-70 d	58	60
305 d mean	17,941	18,198
Days Postpartum to 1st AI	84.9	82.9
Conception Rate (%)		
First service	62*	25*
All services	61*	42*
3rd ovulation	63	27
4th ovulation	67	50
5th ovulation	53	44

[a]Primiparous, n = 45; multiparous, n = 31.
[b]BCS are on a 1 (very thin) to 5 (grossly obese) scale.
*p< .05

Prevention of Fertility Reduction Associated With Periparturient Disorders and Loss of Body Condition

Practical steps to improve postpartum fertility should be aimed at: 1) formulating dry cow diets to reduce disorders associated with parturition such as hypocalcemia, retained fetal membranes, displaced abomasum and indigestion and 2) feed cows to freshen in proper body condition and prevent severe loss of body condition during the first 5 weeks postpartum.

Periparturient disorders, even with timely treatment, are associated with lowered reproductive performance.[1] In addition to the well established cause and effect relationship between hypocalcemia and parturient paresis, there appears to be an association of several periparturient metabolic disorders (rumen stasis, displaced abomasum, retained fetal membranes, prolapsed uterus, early metritis and ketosis) with hypocalcemia.[23] In order to reduce the incidence of periparturient disorders consideration should be given to the dietary cation-anion difference (DCAD). In 1990 a field experiment was conducted at a commercial dairy to evaluate the effects of feeding an anionic diet during the last 60 days of pregnancy.[24] Holstein cows (controls=250, treated=260) were fed either a control diet formulated to NRC recommendations (1989) or an experimental anionic diet (-25 meq/100g DM). The diets were composed of the same basal ingredients, but the experimental diet contained more Ca, higher Cl and higher S. Cows consuming the experimental ration had significantly less (4% vs. 9%) clinical milk fever and subclinical hypocalcemia (19% vs. 50%). Milk yield (305 d ME) was 3.61% greater for the group fed the anionic diet. Reproductive performance was also improved. Pregnancy rates at 150, 200 and 250 d after calving were 11-17 percentage units higher for cows that had been fed the anionic diet. Number of services / pregnancy was less (3.0 vs. 3.4) for the cows fed the anionic diet.

The ideal BCS at calving and acceptable postpartum loss is still subject to considerable debate and likely varies from herd to herd. Based on available research, a conservative recommendation is BCS of 3.25-3.50 at calving with a maximum drop of 0.50.[22] Weaver suggested minimum BCS at calving is approximately 3.0.[22] A gradual transition to the lactation ration can be made in the last 2-3 weeks of the dry period to ensure cows come "on feed" quickly after calving. Steps should be taken to avoid overconditioning since fat cows are more likely to utilize body reserves to support lactation than thinner cows. A decline in fertility is associated with BCS above 4.0.[22] A system should be implemented to evaluate and record BCS at various stages of lactation. Appropriate times include: end of lactation, freshening, during 21-30 d, 50-70 d and mid-lactation.[2] Computerized analysis, including plotting of BCS data, provides useful information and can signal the need for intervention.

To maximize reproductive performance, fresh cows must consume sufficient amounts of an energy dense ration (consider calcium salts of long chain fatty acids-Megalac®, Church and Dwight Co., Inc., Princeton, NJ) to avoid excessive weight loss.[2] Feeding strategies must maximize dry matter intake to insure adequate fiber and energy. Fresh cows should be offered the highest quality feeds available and rations should be balanced to meet NRC recommendations. Feeding a TMR at least 3-4 times a day will stimulate higher feed intake than 1-

2 times a day feeding. Feeding a buffer, adding 3-5% dietary fat, maintaining moisture below 30% and providing easy bunk access will help reduce loss of BCS postpartum.[2]

Summary

This paper summarizes research indicating that adverse metabolic conditions, particularly severe periparturient loss of body condition, exert a latent as well as acute effect on fertility by negatively influencing follicular development and subsequent luteal function.[7] Data based on a retrospective analysis of records indicate that fertility during the desired breeding period is reduced in cows that lose body condition in the early postpartum period. It is reasonable to conclude that nutritional management of the dry and fresh cow that minimizes loss of body condition will significantly improve fertility. Direct testing of this hypothesis awaits further investigation.

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