Nutritional Implications of Altering the Dry Period Length

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Introduction

Traditionally, the dry period has been approximately 8 weeks long and divided into 2 feeding periods. The first period has been termed the "far-off" dry period when cows are fed a high-fiber, low-energy diet to maintain body condition. This period may be followed by a "close-up" period, typically 3 weeks long during which cows are fed a diet that is intended to help them transition from a dry to a lactating cow. Shortening the dry period and, in the extreme case, eliminating the dry period, clearly has implications on how cows are fed prior to calving. Changing dry period length has the potential to modify feed intake patterns or energy requirements before or after calving. Reducing dry period length may decrease postpartum milk yield, so for the practice to gain acceptance, there must be other benefits that more than compensate for this disadvantage. Potential benefits include additional milk production by extending the lactation preceding calving and improved energy status postcalving. Improved energy status postcalving may lead to improved animal health and reproduction.

Influence of Shortened Dry Periods on Energy Balance

Energy intake, requirement, and balance for cows as they progress through a traditional 56-d dry period to early lactation are shown in Figure 1. During this experiment, cows were fed a "far-off" dry cow diet and a "close-up" prefresh diet with higher energy density. Cows were overfed energy during the entire dry period. Negative energy balance (**EB**) during early lactation results because the cow is unable to consume sufficient energy to meet requirements for maintenance and milk production. Severity of negative EB during early lactation has been related to disorders of metabolism, reproductive performance, and immune status. Reducing the severity of negative EB in early lactation has been an important goal of nutritionists. Most of the research in this area has focused on identification of dry cow feeding strategies to improve the metabolic status of early lactation cows. Typically, these studies have examined metabolic parameters such as blood energy metabolites, liver triglyceride, dry matter intake (**DMI**), and milk production. Rarely is EB reported and virtually all of the research has been conducted with limited numbers of cows so health and key reproductive parameters cannot be critically evaluated. A recent review of the literature (Grummer, 2010) indicates that manipulation of dry cow diet has little or no effect on milk yield and DMI. Without significant changes in these 2 parameters, there is no chance of significantly altering the energy status of postpartum cows. This in large part

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may explain why there has been such little progress in reducing the incidence of energy-related metabolic disorders or improving reproductive performance of cows despite 20+ years of intense investigation of dry cow nutrition.

Some feel that significant improvement in health and reproduction of cows will only occur when we stop emphasizing high milk production. However, the relationship between milk yield and EB is very poor (Grummer and Rastani, 2003). Clearly, more imaginative strategies in dairy cow management will be needed if substantial improvements in postpartum EB are going to be realized.

Our laboratory has examined the effect of shortening or eliminating the dry period as a means to improve postpartum energy status of dairy cows. The extreme measure of eliminating the dry period may have the greatest potential to improve EB and subsequently animal health and fertility. Theoretical milk yield and EB responses for cows experiencing a 60-d dry period and no dry period are shown in Figure 2. First, eliminating the dry period is likely to reduce peak milk production following calving, although this effect is most dramatic for cows entering their second lactation compared to more mature cows (Watters et al., 2008). Extending the previous lactation and eliminating the dry period can capture a substantial portion of the "lost" milk production (Figure 2; Watters et al., 2008). This effectively shifts milk production from a time (postpartum) when the cow cannot consume sufficient energy to support lactation to a time (prepartum) in which cows are in positive EB and are not experiencing energy deficits. Additionally, cows that are continuously milked do not experience as great a decrease in days in milk (**DIM**) immediately before and after parturition (Rastani et al., 2005). Consequently, the magnitude of negative EB postpartum is reduced (Figure 1; Rastani et al., 2005) and potential for enhancing health and reproductive performance is increased. Some of the same benefits may be obtained by shortening the dry period; however, they likely will be of a smaller magnitude than obtained when eliminating the dry period completely (Gumen et al., 2005).

In our first study (Gumen et al., 2005; Rastani et al., 2005) to examine the effects of dry period length on EB, cows were assigned to treatments at -56 d prepartum. The 3 treatments were 1) 56-d dry: cows fed a low-energy far off diet from -56 to -29 d prepartum and a moderate-energy transition diet from -28 d to parturition; 2) 28-d dry: cows fed lactation diet (minus buffer) throughout the dry period; and 3) 0-d dry: cows fed lactation diet (minus buffer) until calving. After calving, all animals were fed the same lactation diet. Actual days dry for the 56-, 28- and 0-d treatments were 54, 29 and 5. Some cows on the 0-d treatment spontaneously dried up. One of the most striking observations was that cows on the 0-d dry treatment essentially did not enter into negative EB (Figure 3) after calving. This reflected lower solids-corrected milk production and greater DMI for cows that were continuously milked. Although it was not statistically significant, cows that experienced the 28-d dry period had numerically higher EB than those on the 56-d treatment. We confirmed the beneficial effects of eliminating the dry period on EB in a second study (Rastani et al., 2007). At 28 d prior to expected calving, cows were assigned to 0x (28-d dry period), 1x or 4x/d milking until parturition. Before or after the treatment period, all cows were milked 2x/d. Energy balance of cows that were continuously milked remained remarkably consistent and did not become negative during the transition period (Figure 4). The benefit of avoiding negative EB may be enormous. This may lead to a reduction in postpartum disorders and an improvement in reproductive function of dairy cows because it would eliminate the dramatic fluctuations in metabolism that cows currently endure.

Does Improved Energy Balance From Shortened Dry Periods Benefit the Cow?

In our first study (Rastani et al., 2005), which examined 56 vs. 28 vs. 0 d dry, loss of body condition score (Figure 5) and body weight postpartum increased as days dry increased. This reflected a more favorable EB as days dry decreased. As one might expect, shortening the dry period resulted in a reduction in plasma nonesterified fatty acids (**NEFA**; 403, 394, and 235 uEq/L), and liver triglycerides (22, 20, and 11 ug/ug of DNA). However, the differences were only significant between cows with 0 and 28 day dry. Ovarian dynamics were monitored by ultrasound 3 times/week (Gumen et al., 2005). Reducing the dry period resulted in a more rapid resumption of ovarian activity (Table 1). Although this trial ended at 70 d postpartum, reproductive performance of cows was monitored beyond 70 d. Cows that were on the 0-d dry treatment had fewer days to first AI, higher first service conception rate, fewer services per conception, and fewer days open. We suspect that these benefits were due to differences in EB. However, because there were limited cows numbers in this trial and cows were not on experiment beyond 70 d, these results were interpreted with caution.

Subsequently we conducted another study (Watters et al., 2008, 2009) utilizing a large commercial dairy herd to facilitate greater replication and examine effects of shorter dry periods on metabolic disorders and reproduction. The drawback of doing this type of trial is the inability to monitor feed intake and EB. Cows (n=772) were assigned to either a 55- (traditional dry period, **T**) or 34-d dry period (shortened dry period, **S**). Dry cows on T were fed a low-energy diet until 34 d before their expected calving date and then all cows (T and S) were fed a moderate-energy transition diet until calving. Cows were monitored for days to first ovulation, days to first AI, first service conception rate, days open, and percentage of cows pregnant at 150 DIM. Breeding to observed estrus, after removal of tail chalk, began at 45 DIM and continued until 70 DIM when the Ovsynch protocol was initiated. Cows that had not ovulated by 70 DIM were considered anovular. For statistical analysis, cows were categorized as young (second lactation following calving) or old (third or greater lactation after calving).

Average days dry for T and S were 55.5 and 34.0. For treatment T, 90% of the cows had a dry period that ranged from 44 to 65 d, while for treatment S, 90% of the cows had a dry period that ranged from 20 to 45 d. For the first 100 d postpartum, cows assigned to T produced more milk (43.6 vs. 41.5 kg/d) and tended to produce more solids-corrected milk (**SCM**; 38.6 vs. 37.4 kg/d) than cows on S. It is important to note that there was a treatment x parity interaction: younger cows accounted for treatment differences in milk and SCM yield. There was no effect of dry period length on production by older cows. Milk fat percentage did not differ between treatments, but milk protein percentage was greater for cows assigned to S (2.83 vs. 2.68%)

Median days until first postpartum ovulation occurred sooner for S compared to T (35 vs. 43 d; Figure 6). This confirmed results from our earlier study with fewer cows (Gumen et al., 2005). The percentage of cows that were classified anovular by 70 DIM was more than two-fold greater for cows on T than S (18% vs. 8%). There was a 20-d reduction in days open for older cows that had a shorter dry period compared to a traditional dry period length (113 vs. 133). At 300 DIM, 85% of cows in both treatments were pregnant. There was some evidence that the improvement in days to pregnancy found in our study might be related to earlier postpartum AI and to improvements in conception rate. Cows with a shorter dry period had, at least numerically, an earlier time to first detected estrus per AI and more cows were bred prior to the timed AI than for cows with a longer dry period. For example, a total of 54% of S cows received AI prior to 69 DIM (when Ovsynch began) compared to only 45% of T cows. Conception rate tended to be greater in older cows on S than T combining data from first and second service (32% vs. 24%). Although we were unable to measure EB in this study, we speculate that a reduction in negative EB after a shorter dry period is likely to account for the earlier postpartum ovulation and reduction in anovular cows by 70 DIM. Body condition score was lower for cows on T than S, although the difference was small (3.07 vs. 3.01). The postpartum NEFA concentrations were lower for cows assigned to S compared with T (337 vs. 428 uEq/L).

Feeding Strategies for Cows with Shortened Dry Periods

Typical nutritional management of cows on a 8-wk dry period includes a far-off dry cow diet and a close-up diet. The far-off diet is low in energy density and is designed to maintain body condition of the cow during the first 5 wk of the dry period whereas the close-up diet is fed during the final 3 wk of the dry period and is designed to acclimate the cow and rumen microorganisms to the high-energy lactation diet that will be fed following calving. This traditional strategy involves two grouping changes and two diet changes within a 3-wk time frame. In some cases, this leads to increased stress from grouping and diet changes, larger than desired declines in feed intake, and metabolic complications postpartum.

Feeding one diet the entire 8-wk dry period may help reduce the likelihood of this scenario. However, feeding a transition-type diet that is moderate in energy for 8 wk may lead to overconditioned cows and an increased incidence of metabolic disorders (Rukkwamsuk et al., 1999). Feeding one high fiber diet during the entire dry period may be successful (Drackley and Janovick Guretzky, 2007). However, questions persist as to whether a dramatic jump from a high to a low fiber diet at calving is best for the cow or the rumen microbes. Although feeding a high fiber diet for the entire dry period has gained popularity, a recent poll conducted on a nationally broadcast webinar on transition cow nutrition (12/2010; Dr. Tom Overton in conjunction with Dairy Herd Management Magazine) indicated that almost two-thirds of listeners still prefer feeding a higher energy density diet during the close-up dry period.

A compromise strategy may be to shorten the dry period and feed 1 diet with high energy throughout the dry period. That was our approach in the study comparing

56-, 28- and 0- day dry periods that was previously discussed (Gumen et al., 2005; Rastani et al., 2005). Days dry were confounded by dietary treatment, so actually that experiment compared 3 different management strategies that entailed both dry period length and diet. In that study, shortening the dry period to 28 d had no negative effects on postpartum production and reproduction so the advantage was extra milk production by extending the lactation (shortening the dry period).

Nutritional Opportunities When Shortening the Dry Period

The elimination of feeding a close-up diet in favor of feeding 1 diet (usually high fiber) for an entire 8 wk dry period has created some problems for the incorporation of feed additives prepartum. In this scenario, if additives such as anionic salts, monensin, or ruminally protected choline are fed as part of a totally mixed ration, they have to be fed for the entire 8 wk period. Although it is unlikely that feeding these additives for 8 wk will harm the animal, it is not a very economical practice particularly because these additives do not have to be fed that long to be effective in controlling the incidences of postpartum disorders such as milk fever or ketosis and fatty liver. However, if the dry period is shortened to 4 wk and only 1 diet is fed during that time, the duration of additive feeding is also shortened.

Strategies for Implementing a Short Dry Period

Feeding a high fiber diet to a single dry cow group for the entire dry period is becoming more common and highly desirable for those considering implementation of a short dry period because it facilitates having variable dry period lengths depending on characteristics of the cow. This is important because not all cows respond similarly (i.e. favorably) to shortened dry periods. If there are some cows that are more likely to be negatively affected by short dry periods, a 1 dry cow group feeding system allows managers to tailor the entry time (relative to expected calving) that a cow joins the dry cow group

Unfortunately, we know very little about potential interactions between cows and dry period length. Several studies have indicated that reducing the length of the dry period to less than 60 d has a more detrimental effect between the first and second lactation than between later lactations (e.g. Annen et al., 2004, Watters et al., 2009). A very strong interaction has been documented between calving interval and the dry period length required to obtain maximum milk yield the following lactation (Dias and Allaire, 1982). Cows with longer calving intervals required fewer days dry, and the relationship was stronger as cows got older. Although some have speculated that high producing cows may have a need for a longer dry period, there is very little research available to determine if this is the case. Additional studies are needed before a conclusion can be made whether there is a level of milk production by dry period length interaction. In practice, managers are probably more likely to give a higher producing cow a shorter dry period to avoid dry-off during copious milk secretion. Likewise, managers may prefer a longer dry period for cows that are low producing and overconditioned because they are consuming a lactation diet that is too high in energy density. Other candidates for a longer dry period include cows with foot problems (i.e. keep them off concrete longer) or cows that are pregnant with twins and are likely to calve early relative to expected calving date.

Conclusions

Reducing the dry period may enhance energy status of cow after calving. Less body condition score loss and more favorable energy balance may lead to improved reproductive performance. The improvement in reproductive performance observed when shortening the dry period may be independent of loss in milk production since it is observed in older cows that are more immune to reductions in milk production. Shortening the dry period is compatible with managing for one group and one diet during the dry period. The reduced dry period length allows for continued feeding of high energy density diets during the dry period; however, optimum diets during shortened dry periods have not been investigated. Reducing the dry period also facilitates more economical feeding of additives such as anionic salts or choline when there is one dry cow group.

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Table 1. Ovarian dynamics and reproductive performance of cows fed and managed for 56, 28, and 0 d dry periods

	56 d	*28 d*	*0 d*
Follicle diameter (mm) at first ultrasound	6.3[b]	8.2[ab]	9.5[a]
Days to first 10 mm follicle	10.5[b]	8.9[a]	8.0[a]
Days to first postpartum ovulation	32[b]	24[b]	13[a]
Days to first AI	75	68	69
First service conception rate, %	20[b]	26[ab]	55[a]
Services per conception	3.0[b]	2.4[ab]	1.7[a]
Days open	145[b]	121[ab]	94[a]

[a,b] differ at $P < 0.05$.

Figure 1. Energy status of dairy cows during the dry period and early lactation.

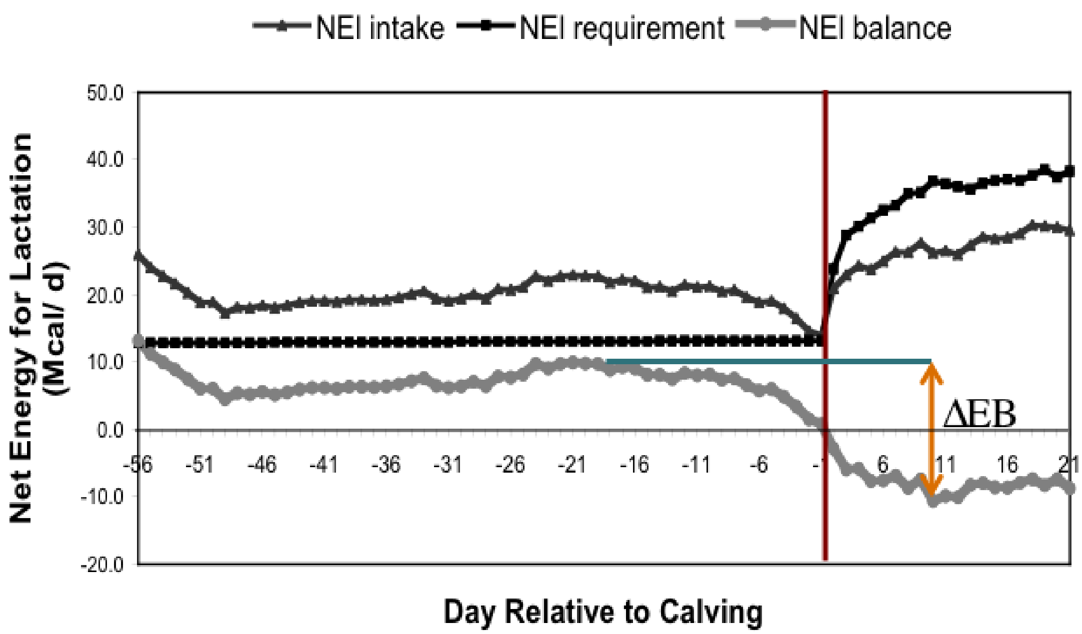


Figure 2. Theoretical comparison of milk yield and energy balance of cows experiencing a 0- or 60-d dry period.

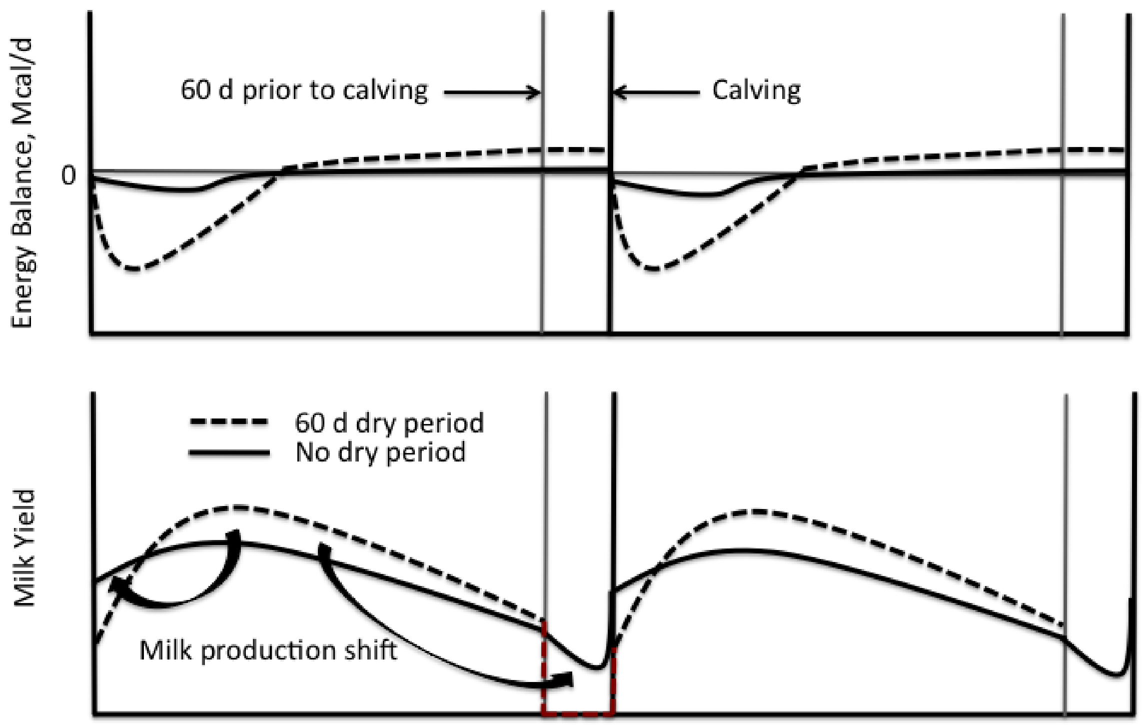


Figure 3. Energy balance of cows experiencing a 56-, 28-, or 0-d dry period. Cows on the 28 and 0 day dry period treatment were fed high-energy lactation type diets the entire trial. Cows on the 56 day dry period received a low energy far-off dry cow diet for the first 4 wk of the dry period and a moderate energy diet for the final 4 wk of the dry period.

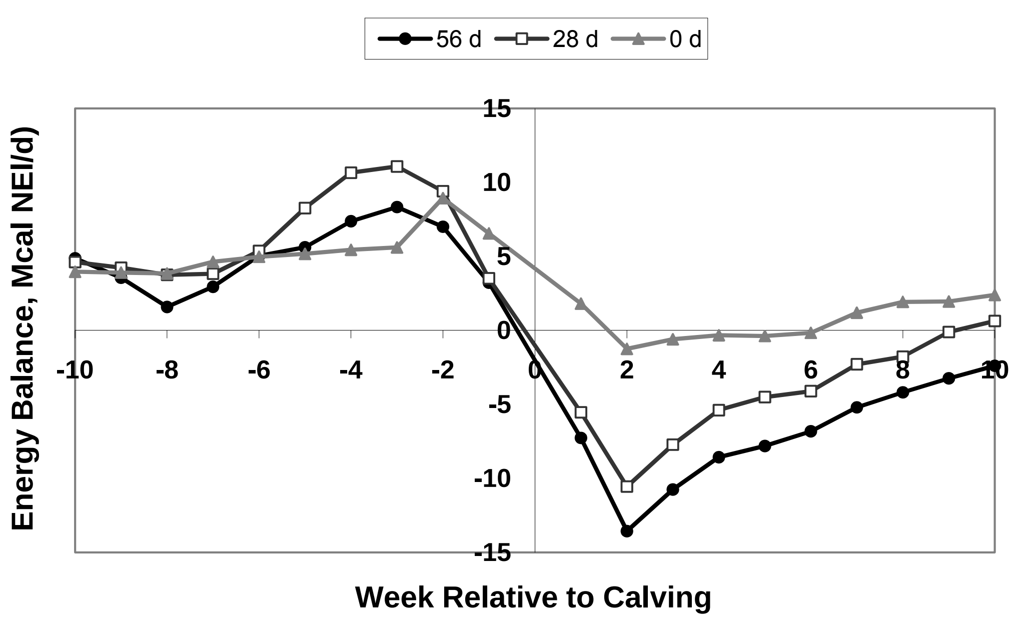


Figure 4. Energy balance if cows that were milked 0x, 1x, or 4x/day for the last 28 days of pregnancy.

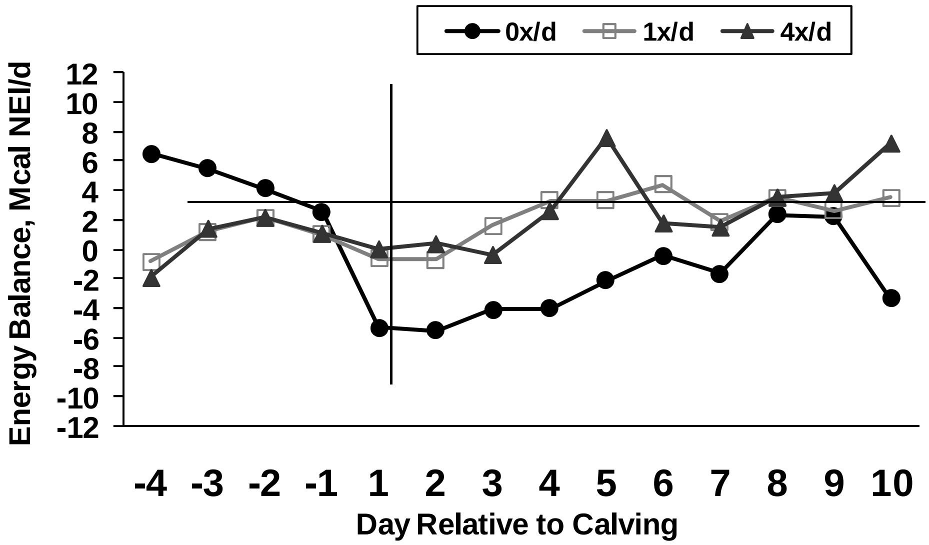


Figure 5. Body condition scores of cows fed and managed for 56 (■), 28 (□), or 0 (▲) d dry periods.

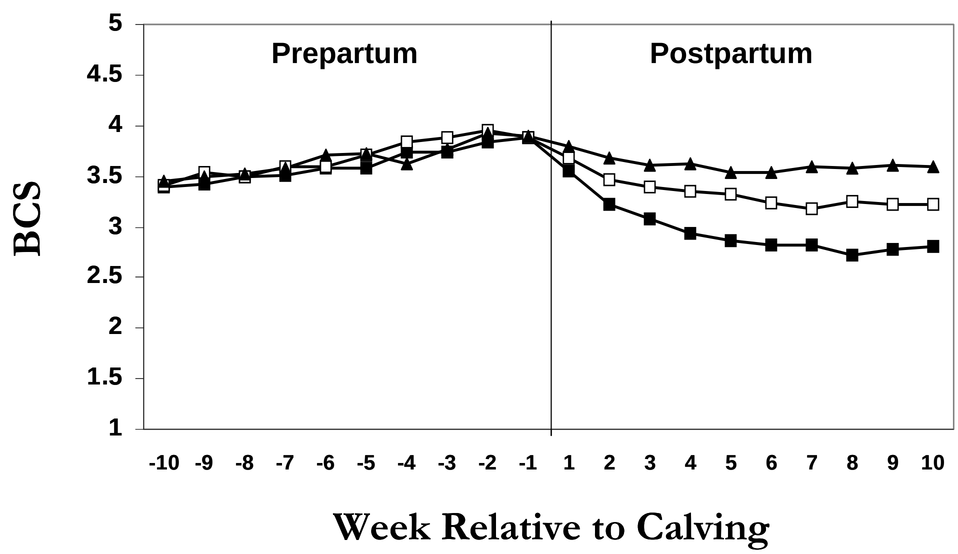
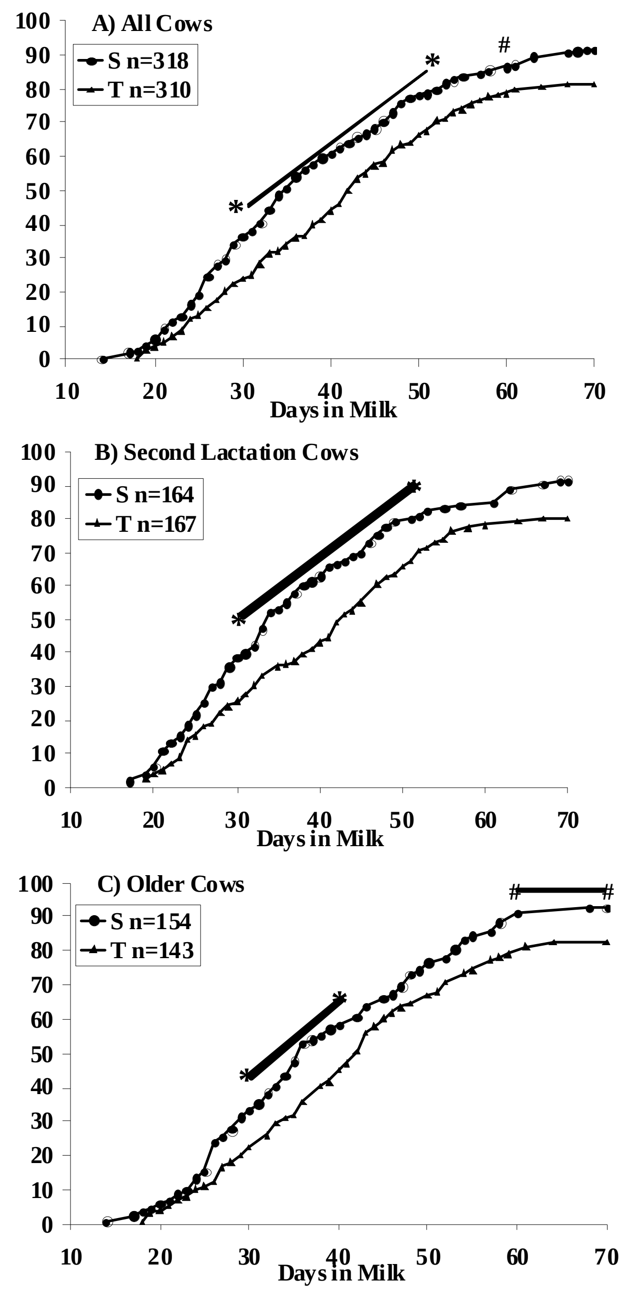


Figure 6. Survival curves for days to first ovulation for cows managed for S (●) shortened 34 d dry period or T (▲) traditional 55 d dry period shown for: A) All cows; B) Younger cows (dry period between first and second lactation and reproduction during second lactation); and C) Older cows in their third or greater lactation. Differences between treatment groups were analyzed at 10 d intervals by Chi Square analysis and significant differences are shown directly on the Kaplan-Meier curves with an asterisk (* indicates $P < 0.05$) or a pound sign (# indicates $0.05 \le P < 0.10$) with lines connecting points with similar statistical differences.



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