RETURN TO START

Energy and Protein Status Affect Fertility

After calving, most high producing cows experience a period of *negative energy balance* (EB), when they are unable to consume enough energy to satisfy their increasing requirements for milk production. Body fat is mobilized to fill the deficit, condition score decreases and weight is lost. Practical experience and the results of several studies suggest that there is a link between EB and the interval to first ovulation. We recently completed an experiment aimed at improving our understanding of this linkage.

Output, intake and energy balance

Figure 1 illustrates relationships between milk production and energy balance for the 17 cows in our study. Notice that energy balance (EB) declined for the first week after calving as milk production and Net Energy (NE) requirement for lactation increased more rapidly than NE consumed. On average, the lowest point (*nadir*) in the EB curve occurred at 8.7 days and first ovulation was at 24.1 days post-partum (PP). Although milk volume continued to increased after the EB nadir, milk fat percentage started to decrease, resulting in a roughly constant NE for lactation. After about 10 days PP the main factor influencing EB was NE consumed. Table 1 compares average values of the factors influencing EB at its nadir with those at first ovulation.

Results of research at Cornell University suggested that first ovulation would occur at 10-14 days after the EB nadir. In our study, the average interval from EB nadir to first ovulation was 15.4 days, ranging from 8 to 24 days for individual cows. In contrast to the Cornell results, we found no significant relationship between the interval to first ovulation and mean EB from calving to ovulation.

	EB NADIR	FIRST OVULATION
NE† consumed	12.9	26.5
NE lactation	30.4	29.3
NE maintenance	10.9	10.6
NE balance	-28.4	-13.4
Milk Fat, %	5.5	4.1
Milk Yield, kg/day	34.1	39.2

†NE is Net Energy in megacalories per day

Table 1 : Mean Net Energy and milk production values for cows at nadir of energy balance curve and at ovulation.

By examining the relationships between EB and days to first ovulation in individual cows, we developed the following equation to predict the number of days from EB nadir to first ovulation:

$$\text{DNFO} = 15.62 + 1.18 \times EB_{mean} - 1.03 \times EB_{nadir} - 9.03 \times EB_{rate}$$

where:

- DNFO = days from EB nadir to first ovulation;
- EB_{mean} = mean EB from calving to first ovulation;
- EB_{nadir} = the EB value at the nadir of the EB curve;
- EB_{rate} = the rate of recovery of EB from the nadir, expressed as EB change per day.

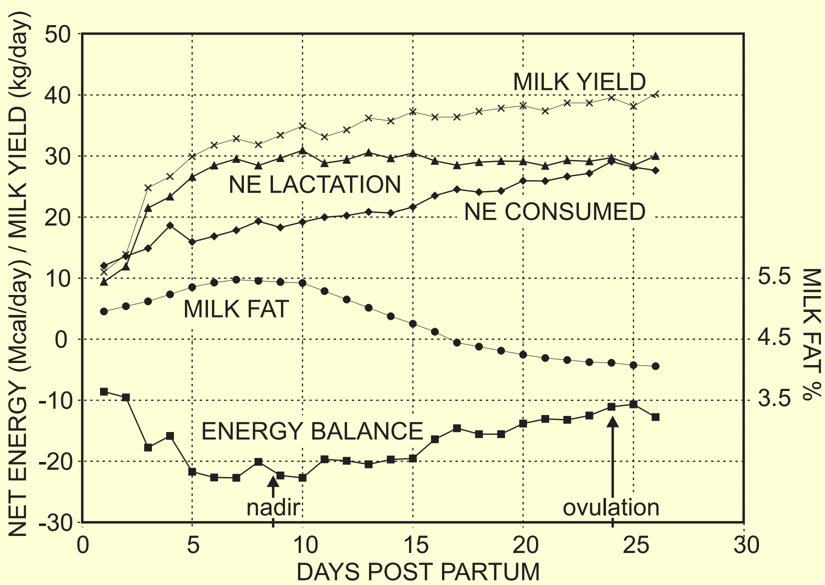

Figure 1 : Average Net Energy (NE) consumption, lactation requirements and balance, milk yield and fat test in 17 cows from calving to first ovulation. Energy balance is the difference between NE consumption and NE requirements for lactation and maintenance.

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	examples 1	2	3	4	5
EBmean	-10	-10	-10	-15	-20
EBnadir	-20	-20	-20	-25	-30
EBrate	0.5	1.0	1.5	1.0	1.0
DNFO	19.9	15.4	10.9	14.6	13.9

Table 2 : Examples showing effects of EB measures on days from EB nadir to first ovulation (DNFO).

This equation accounted for almost 90% of the variation in DNFO among our cows. Table 2 shows several examples of the calculation. Notice that the rate of recovery of EB after the nadir (EB_{rate}) has a much greater effect on DNFO than either EB_{mean} or EB_{nadir}. Since NE consumed is the main factor driving EB recovery, these observations confirm the importance of management strategies aimed at improving intakes of high energy diets by PP cows.

Mobilization of body protein

The cow calving in good body condition carries enough body fat to make a sizeable contribution to EB in early lactation. She could lose most of that fat without impairing her vital functions. In contrast, the amount of protein that can be mobilized is limited to approximately 25% of total body protein.

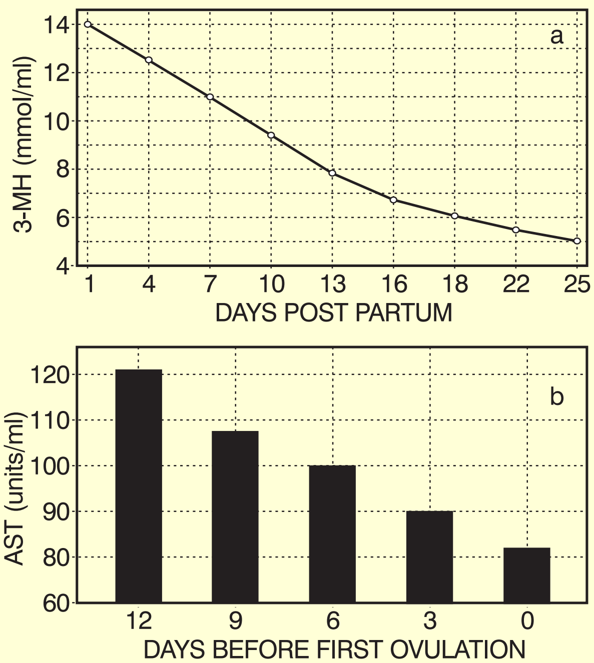

Figure 2 : Mean blood plasma concentrations of: (a) 3-methyl histidine (3-MH); and (b) aspartate aminotransferase (AST) in post partum cows.

Amino acids derived from mobilized protein may be used both for the synthesis of milk protein and for the production of glucose which is required for milk lactose synthesis (see article **1L1**). It would be very difficult to measure the absolute amount of protein mobilized in early lactation. However, we were able to assess relative changes in protein mobilization by measuring blood levels of 3-methyl histidine (3-MH), a by-product of muscle protein breakdown. Our results (shown in figure 2a) indicate that mobilization of muscle protein was high immediately after calving, declining to normal levels by the time first ovulation occurred. However, 3-MH levels varied widely among cows and were not correlated with days to first ovulation.

We also measured blood levels of aspartate amino-transferase (AST), an enzyme which can be used to indicate the contribution of amino acids to glucose synthesis. The AST data in figure 2b suggest a reduction in glucose synthesis from amino acids as first ovulation approached. This was probably due to increased availability of glucose fom the diet and greater synthesis of glucose from propionic acid, resulting directly from higher feed intake. Figure 1 in article **1L1** illustrates the flow of glucose from diet to milk lactose.

Summary

Declining energy balance (EB) is the most powerful factor inhibiting ovulation after calving. Our results indicate that the resumption of reproductive activity is more sensitive to the rate of improvement of EB, rather than the absolute EB at any particular point in time. Energy intake is the primary driving force responsible for improving EB. It is, therefore, imperative to promote the increased consumption of high energy diets as soon as possible after calving.

Another important cue for first ovulation may by a declining rate of body protein mobilization. Our measurements of blood metabolites and enzymes demonstrated significant reduction in muscle protein breakdown and lower utilization of resultant amino acids for glucose synthesis before first ovulation. Again, increasing consumption of well-balanced diets in early lactation will spare body protein mobilization and remove its inhibition of reproductive activity.

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