Optimizing Cow Size, Milk, Calf Growth Rate and Reproduction in the Cow Herd

Keith S. Lusby, *PhD*
Extension Beef Cattle Specialist
Twig T. Marston
Graduate Research Assistant
Oklahoma State University
Stillwater, Oklahoma 74078

Introduction

Type - mature size, milk producing ability, fatness - is extremely important to the cow/calf producer because it directly affects profitability. Type affects profitability because it influences (1) reproductive performance, (2) weaning weight of calves, (3) feed requirements of the cows, (4) market strategies, (5) selling price of calves and cull cows. Concern about type is not new. The following quotes taken from a booklet entitled *Progressive Beef Cattle Raising*, published by Armour and Co. in 1920 showed not only concern but a degree of understanding about type and efficiency of cows.

"The cattle that are best for beef are not best for milk or draft -- Breeders in continental Europe have tried to combine in their cattle all of the traits that make animals useful for milk, beef and draft, -- but since many of the characters are antagonistic to each other, certain compromises in type have had to be made which have rendered the animals less efficient for each of the special purposes."

That same publication also listed the numbers of registered purebred cattle in each state, including registrations for Oklahoma which are shown below.

Registered Cattle in Oklahoma - 1920

Total	38,713
Aberdeen-Angus	1,876
Galloway	319
Hereford	12,123
Polled Durham	1,217
Shorthorn	22,019
Others	1,149

The makeup of the Oklahoma cow herd obviously has changed since 1920. The changes occurred as cattlemen sought cow types that more efficiently utilized their resources for production of modern feeder cattle.

What Affects Nutrient Requirements of Cows?

The major requirement of cows in terms of amount is for energy. Energy comes from carbohydrate sources such as grains and forages, fats and even from proteins. The energy requirement can be stated in many ways with Total Digestible Nutrients (TDN), Digestible Energy (DE) and Net Energy (NE) being the most common. TDN is the most common method of expressing energy for cow nutrition.

Energy is used for three purposes by cows. The first use is for MAINTENANCE, the energy to eat, digest feed, maintain body temperature and move about. The second use is for MILK PRODUCTION and the third is for WEIGHT GAIN.

Simply put, the amount of energy required by a cow depends on how big she is and how much milk she gives. Both of these factors also influence the size of calf she can wean. The key concerns are (1) what should the calf look like? and (2) how do our resources match requirements, especially at critical times when reproduction is affected?

Cow Size

As cows get bigger, they need more energy to maintain the added weight. This is illustrated in Figure 1 which shows the daily TDN needed for cows of varying weight that all produce an average of 12 lbs of milk per day over a 205-day lactation beginning in March and ending in October. It is assumed that these cows are in the same body condition so that heavier cows are not just fatter cows. The daily requirement does not double if cow weight doubles but the requirement does increase. For example, a 1400 lb cow weighs 27% more than an 1100 lb cow but requires only 15% more energy for maintenance.

A major ramification of cow size is that fewer cows can be run on the same acreage as cow size increases. The heavier cow must produce more calf weight to offset her greater costs. As cow size has become larger in

Figure 1. Energy Requirements 12 lb Milk, 1100-1400 lb Cows.

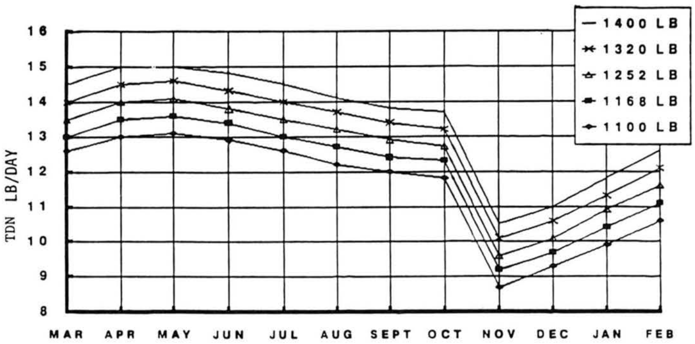
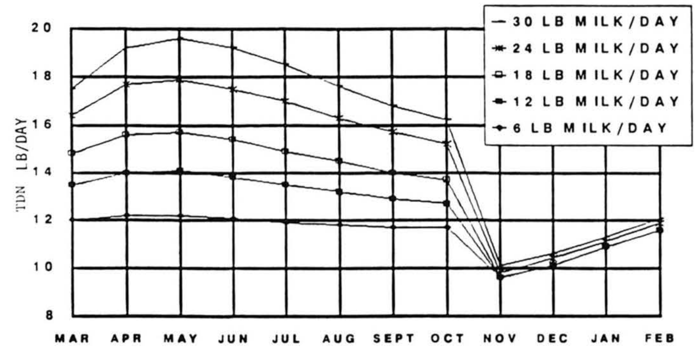


Figure 2. Energy Requirements 6-30 lb Milk, 1250 lb cows.



many herds and calf sizes have been increased to maintain efficiency, the resulting calves have become too large and late maturing to produce acceptable sized carcasses. At the other end of the scale, small cows may be more energetically efficient, but the apparent efficiency of small cows may be misleading if they produce small type, early-maturing calves with poor potential for growth and severe market discounts.

It is obvious that post-weaning performance, including the final finished weight is a principal factor dictating the choice of cow size in the breeding herd. The problem of small, early maturing calves from small cows can be alleviated by the use of very large (compared to the cows) bulls, but calving difficulty imposes limitations on that system. This was a particularly serious problem during the 1970's when cattlemen used the (then) large European breeds to correct for small cow size in many herds.

Milk Production

Milk is an energy and protein rich food. On a dry matter basis (milk contains about 12% dry matter) milk contains about 25% protein and 130% TDN. By comparison, corn contains about 9% protein and 90% TDN. It should be little surprise then that milk production requires large inputs of energy and protein. Figure 2 shows the daily TDN needed for 1250 lb cows with peak milk production of from 6 to 30 lb per day. Cows used to develop this graph calve in March and have their calves weaned in October. The energy required for milk will vary with breed. For example, Brahman crosses can produce milk containing about 4% fat compared to about 2% for beef breeds. Fat content obviously has a great impact on energy required for milk production.

Notice also that cows producing the most milk continue to have higher energy requirements even after lactation has ceased in October. As cows are selected for increased milk production, there is also an increase in the size of the "metabolic machinery" needed to process the increased energy for milk. Research shows that dairy breeds have much larger internal organs (liver, intestines, etc.) than beef breeds. The increased maintenance energy requirement for higher milking cows is not great relative to requirements for milk production, but considering that the higher maintenance costs are incurred not only by the cow on pasture but also by her calf after weaning, the difference can be economically important.

Higher maintenance requirements for beef breeds with increased milk production has been well documented. It is probable that if a beef breed is selected to produce as much milk as a dairy breed, the beef breed will look like a dairy breed, physically and metabolically.

Lactation curves

Producers often ask how much milk should a cow give in order to produce a given weaning weight. The answer is complicated because the influence of milk production on calf weaning weight depends on:

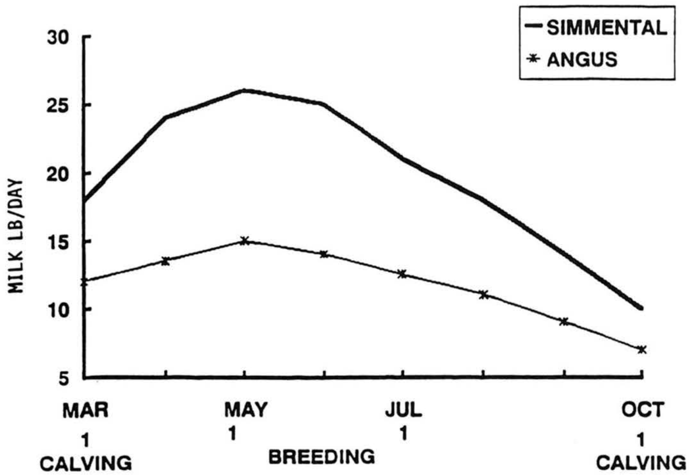
1. The total milk produced during lactation.
2. When the milk was produced.
3. Other available nutrients (forage, creep feed) and when they were available.
4. Genetic growth potential of the calf.

Spring-calving lactation

Figure 3 shows typical lactation curves for spring-calving cows differing in milk production potential. Studies were conducted in Kansas, with an average calving date of March 15 and lactation extending to October. Milk production increased for both breeds after calving and peaked at about 16 lb/day for Angus and 21 lb/day for Simmental when calves were 2 to 3 months old. The early increase indicates greater capacity for milk consumption as calves get older and bigger.

Peak milk production depends on the genetic milking ability of the cow, the capacity of the calf and the feed resources available to the cow. Milk production of spring-calving cows usually declines after early summer as forage quality declines and cows are unable to meet requirements for high levels of milk.

Figure 3. Typical lactation curves for spring--calving Angus and Simmental cows.



Fall and winter-calving cows

Cows that calve in the fall and early winter will usually have lactation curves that are shaped differently from those of spring-calving cows (Figure 4). Cows used in this study varied widely in milk production potential (Hereford, Hereford x Holstein and Holstein) and calved in November and December on native range at the Fort Reno Station. The study was conducted in the early 1970's and all calves were from Charolais bulls.

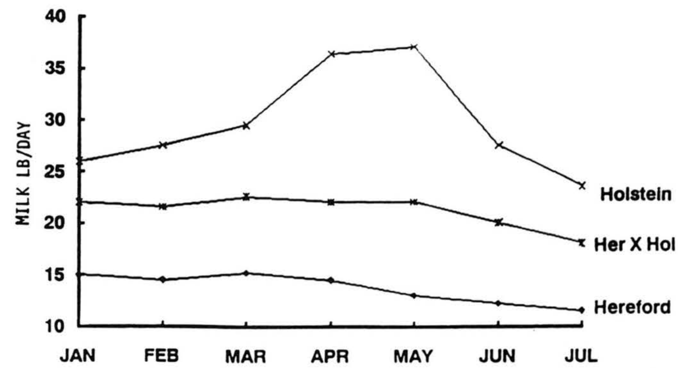
Notice that Hereford and Hereford x Holstein cows produced levels of milk that were comparable to the Angus and Simmental cows described in Figure 3, but that the lactation curves were much flatter. Forage quality during the first four months of lactation was very poor and limited milk production, especially among the Hereford x Holstein crossbreeds and Holsteins. The onset of high-quality spring forage occurred during the 4th and 5th months of lactation and increased the energy available to the cows. Thus, the typical late lactation declines in milk production seen with spring-calving cows did not occur because the level of nutrition of the cows increased in late lactation rather than decreased.

The Holstein group illustrates the practical maximum milk consumption for nursing calves. Among Holsteins, milk production increased until the 5th month of lactation and peaked at almost 40 lbs per day (about 5 gallons). Weaning weights for calves of these cows are shown in Table 1. In fact, if one wanted to design a system in Oklahoma solely to produce maximum weaned calf weight, the system would look like the Holstein cows in Figure 2. During the first three months when calves are heavily dependent on milk, the cows would produce all the calves could consume. As the calves get bigger and require some additional nutrients, spring grasses become available and the calf has the combination of heavy milk production and lush forage.

Table 1. Performance of Charolais cross calves from 3-4 yr-old cows.

	Hereford	Her X Hol	Holstein
Birth Wt.	85	86	98
Wean Wt.	594	638	726

Figure 4. Milk Production for Charolais Cross Calves from Hereford, Hereford x Holstein & Holstein Cows on Native Range



Efficiency of milk production to calf growth

When matching bulls and cows, it is apparent that the growth potential of the calf must be adequate to efficiently utilize the milk production of the cow. This was illustrated in an OSU study in which calves with widely different mature size were raised to weaning by cows varying widely in milk production. In a unique design, Holstein cows were bred to Charolais bulls to produce large-frame calves. Hereford cows were bred to Angus bulls to also produce crossbred, but small-frame calves. Calving was induced and half the calves of each breed were cross-fostered at birth to cows of the other breed. Thus half the Holstein cows raised very large calves, half raised smaller calves and vice versa for Hereford cows. Results are shown in Table 2.

Holstein cows produced about 23 lb of milk/day compared to 11.5 lb for Herefords. The additional milk resulted in 103 lbs of additional weaning weight among small-frame calves and 127 lbs among large frame calves. Small frame calves were fatter at weaning than large frame calves and were especially fatter at the high level of milk. The high level of milk reduced forage intake to small frame calves by about 30% but did not affect forage intake of large frame calves. This shows that the large frame calves were capable of consuming even the level of milk produced by a Holstein without reducing forage intake. Large frame calves were more

Table 2. Performance of Angus x Hereford and Charolais x Holstein calves raised by Hereford or Holstein dams.

Breed of calf	Angus x Hereford (small-frame)		Charolais x Holstein (large-frame)	
Breed of dam Level of milk	Her Low	Hol High	Her Low	Hol High
Preweaning data				
Daily milk, lb	12	24	11	22
Birth wt	67	67	98	104
Weaning wt	511	614	561	689
Condition score	5.6	6.9	4.5	4.9
Lb milk/lb gain	6.5	10.6	5.3	9.1
Added milk per lb of added gain		26.3		21.7
Relative forage intake (August)	100	71	111	107

Wyatt *et al.*, 1977 J. Anim. Sci. 45:1138.

efficient at converting milk to gain which would be expected because they were not as fat as small frame calves at weaning and had less substitution of milk for forage.

It is clear that if milk production of the cow herd is high, calf growth potential must be adequate to efficiently use the additional milk without reducing calf forage intake and/or producing calves that are too fat at weaning. Because high levels of milk also increase the inherent maintenance requirements of cows and their calves, and greatly increase energy requirements for production of the milk, it is imperative that milk production not be overdone.

Perhaps the influence of milk production on calf weight can be better understood by describing diet changes of calves as they grow from birth to weaning. Table 3 shows weight changes of English-bred steers at the OSU range near Stillwater. Based on actual milk production measured in May and July, and previous milk production data obtained at OSU, a milk production curve was estimated. By subtracting the net energy provided by milk from net energy requirements for the observed growth rate, the amount of energy consumed by the calf from forage was calculated. Forage intake could be calculated using estimates of forage energy content during the summer.

Table 3. Example of calf diet during the summer.

	Birth Wt	April 15	July 15	August 15	September 27
Calf wt.	90	200	350	450	500
Daily Gain		2.0	2.4	1.82	.94
Daily Milk		16	14	10	8
Forage (DM[a])		2.0	6.5	12.0	12.0

[a]Dry matter, lb/day.

The average milk production level was about 14 lb/day, translating to 2870 lb for a 205-day lactation. The calves gained 410 lbs (500-90) giving a milk:gain conversion ratio of 7:1.

How would we increase the weaning weight of these calves? One could use a bull that would produce larger frame (heavier mature wt) calves. However, since the birth weight of these calves was 90 lbs, we might not want a bigger bull.

Next, one could increase the milk production of the cow herd. Using medium to large frame calves, we could estimate that about 15 lbs of milk will be needed to each pound of added weaning weight. In order to increase weaning weight by 50 lbs from milk alone, we would need 750 lbs more total milk (50 lb x 15 lbs) or 3.66 lb more milk per day (750 lbs divided by 205 days). Average daily milk production would therefore be 17.66 with a peak of about 20 lbs.

A third option for increasing weaning weight is to increase the non-milk nutrient intake of the calves. Looking at Table 3, it is apparent that the major factor limiting weaning weight in this example is the sharp drop in calf daily gain in September. As the quality of native range declines, milk production by the cows declines also. The poor forage quality also limits the ability of the calves to increase forage intake. Hence, calf gains decrease. In this situation, a well-designed creep feed can produce efficient increases in calf gain. We would recommend a creep feed relatively high in protein (20 - 38%) and limit-fed at a rate of 1 or 2 pounds per day. The objective is to maintain or increase forage intake in addition to the added nutrients from the creep feed. OSU circular E-848 describes creep feeding in more detail.

A fourth option is to provide a higher quality forage for cows and calves during the late summer. This would maintain milk production at a higher level and also result in greater intake of higher quality forage by the calves. The reason that the milk production curves shown in Figure 4 are so well designed for heavy weaning weights should now be obvious. Whether that system is the best designed for profitability is a more complicated question.

The decision of which option to use or whether to increase weaning weight at all will depend on a number of variables. These can include:

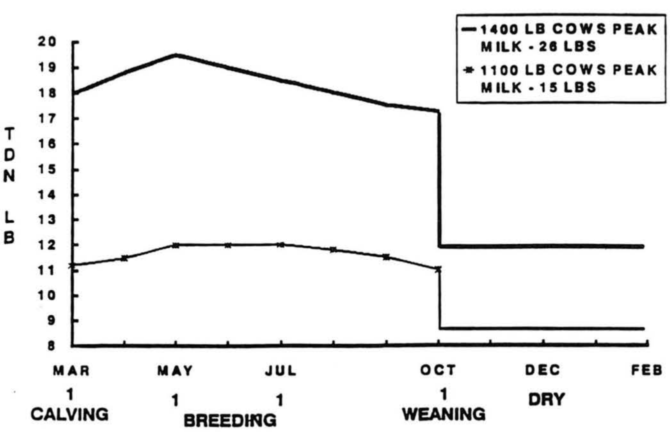
1. Market plans for the calves - do we want them bigger?
2. Cost of increased weaning weight vs cost of adding gain to the calves after weaning.
3. Value of added gain.
4. Feed resources for the cows - how much milk can we produce without reproductive problems or high feed bills?
5. Land costs, hay costs, cow supplement costs, creep feed costs, fertilizer costs, etc.

Although there are a large number of factors entering into the decision about optimum milk production, reproduction rate of the cow herd usually determines the maximum.

Matching Cow Size, Milk and Feed Resources

The lactation curves shown in Figure 3 can be useful for determining how cow energy requirements match the potential for energy intake. The large cows used to develop Figure 3 weighed about 1400 lbs and produced a peak of about 26 lb/day of milk. The moderate cows weighed about 1000 lbs with a peak milk production of 15 lbs. While yearly averages are valuable, it is more important to know how requirements match potential energy intake at key times during the year. TDN requirements for each of these five times are shown in Figure 5. As expected, the larger cows giving the most milk require substantially more energy than the small, moderate milking cows, especially during early and mid-lactation when milk production differences are greatest.

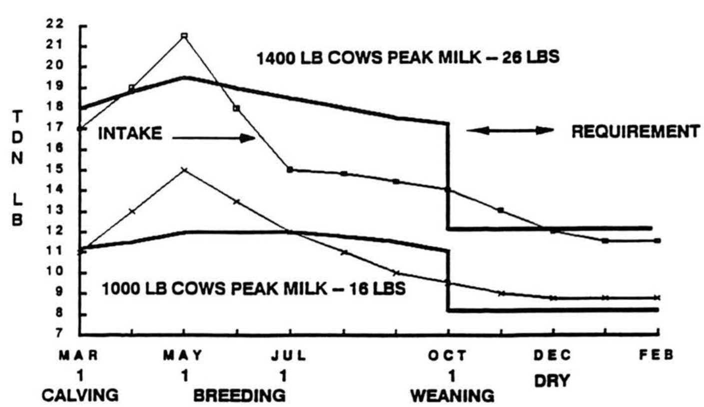
Figure 5. TDN Requirements for Cows in Figure 3.



However, forage quality changes throughout the year and much more can be learned if the ability of the cow to meet requirements is compared to her potential energy intake at key times during the year. The forage program used in this example is assumed to be native range with prairie hay (5% protein, 45% TDN) fed during March and early April. The five key reference points chosen are calving, beginning of breeding, end of breeding, weaning and 90 days prior to calving, The large, heavy milking cows are fed 4 lbs of 20% supplement during October, 6 lbs during November and December and 8 lbs from January until spring. This is a large amount of supplement but may represent a practical minimum for these cows on native forage. The moderate size cows are fed 2 lbs of 40% protein supplement from November through December and fed 3 lbs from January until spring.

Figure 6 shows the resulting estimates of total TDN intake from forage and supplements. It must be clearly understood that these are only estimates because of the large number of variables that affect energy intake (state of lactation, forage quality, level and type of supplement, temperature, etc.). Beginning at calving, the most critical time in determining when cows will rebreed, moderate cows can meet their requirements with low quality hay and protein supplement. Large cows with the great increase in energy requirements with heavy milk are energy deficient even with a full feed of low quality hay. Native forages are very high in quality during early spring and both classes of cows can actually be in a positive energy balance. However, by July, native range is slightly inadequate for moderate cows and very inadequate for large, heavy milking cows. Cow weight changes and the decline in milk production (Figure 3) shows this to be true. After weaning in early October, both classes of cows can again be in a positive energy balance if the large cows are fed additional supplement to compensate for summer weight losses. Improvements in body condition, especially with the large, heavier milking cows, must be made up during the dry period because it is virtually impossible to improve body condition during early lactation.

Figure 6. TDN requirements vs estimated intake for spring--calving cows grazing native range.



Although protein requirements are not shown in Figures 5 or 6, protein levels are a vital concern when milk production is increased. The protein requirement for a 1400 lb cow producing 20 lbs of milk is over 11% of diet dry matter. Native range only contains 11% protein for about 6 weeks each spring and early summer. In fact, only forages in the class of wheat forage, alfalfa, bromegrass, some well-managed bermuda, and fescue-clover mixes will consistently meet protein needs for heavy milking cows.

In summary, the large, heavy milking cows could be maintained on a forage system such as native range if ample adjustments are made for decreased stocking rate (large cows eat more forage) and supplement (and hay) levels are increased to rates required to sustain reproduction.

Other considerations for milk

Milk production during early lactation is very important to calf weight gain because calves eat little else than milk until they are about 2 months old. This is the reason that poor milking cows stunt their calves, and therefore there is a practical minimum limit to milk production. Stunted calves will not reach acceptable weaning weights even when excellent forage is provided during the last half of lactation. Poor milk production cannot be completely overcome with creep feed because calves will not consume much dry feed until they are about 3 months old.

At the other end of the scale, cows producing very large amounts of milk may suffer reproductively. Increased suckling frequency and intensity has a direct negative feedback on estrus.

Great increases in milk production may affect longevity. The 6 year old Holsteins used in the cross fostering study shown in Table 2 were the same cows that as 3-year-olds produced the lactation curves shown in Figure 4. The drop in milk production between 3 and 6 years of age is obvious. At 7 years of age, the Holstein cows were producing about the same level of milk as the Hereford x Holstein crosses. Mastitis and udder problems are also increased with heavy levels of milk. Although using Holsteins as beef cows is clearly extreme, it shows the consequences of overmatching cows to their environment.

Abstracts

Production of bovine identical twins by embryonal microsurgery.

M. Monaci, U. Chicchini and P. Chiacchiarini.

Atti della Societa Italiana Buiatria (1989) XXI, 330.

The authors describe the procedures concerning bovine embryos microsurgery to produce identical twins and then they examine the results obtained by the transfer in the recipients. The transplantation was carried out immediately after the micromanipulation (Tr.I), also after 36 h. in culture (Tr.II). The pregnancy rate was 40% and 72% in Tr. I and Tr. II, respectively.

Arthroscopy for the treatment of septic arthritis in calves

Munroe, G. A. & Cauvin, E. R.

British Veterinary Journal (1994) **150,** 439

Septic polyarthritis is common in calves and the infection is often difficult to eliminate by systemic treatment with antibiotics. Similarly, more invasive procedures such as drainage of the joint and arthrotomy, are often ineffective either because they fail to cure the condition or because they cause complications. This article describes the application of arthroscopy to the treatment of infectious arthritis and osteomyelitis in two calves. In one them, two joints were explored and debrided in one operation. The advantages of the technique are discussed.