Light Bulb Moment

Understanding Cow Size and Production Efficiency

by Bryan McMurry, Ph.D.

Cow/calf production is basically a manufacturing process, turning grass into high quality, edible protein for which there is a substantial and critical demand. Just like a 100-watt light bulb uses more energy than a 60-watt bulb, large cows require greater energy input than smaller cows.

The easiest way to think about and measure energy input for cows is in terms of *dry matter* (DM) *intake.* A cow's daily dry matter requirement increases 1.5 pounds for each 100 pounds of increase in total body weight (Table 1).

Table 1. Daily DM intake for cows of varying weights.

Cow	Daily DM intake	
Weight	% BW	Lbs.
900	2.33%	21.0
1000	2.26%	22.6
1100	2.19%	24.1
1200	2.13%	25.6
1300	2.08%	27.0
1400	2.04%	28.6
1500	2.00%	30.0
1600	1.97%	31.5
1700	1.94%	33.0

NRC, 2002

Larger cows have a higher maintenance energy requirement than smaller cows and because they operate in a grazing environment for much of the year they satisfy that higher energy requirement through higher DM intake. They simply consume more forage and have higher associated feed costs.

Let's compare our cow/calf business to another manufacturing business. Suppose we have a factory (ranch) with 100 machines (cows) and our goal is to produce 600 units (pounds of calf) per machine per year. Our most efficient machines in the factory are capable of producing at that level and more with the inputs we are providing.

At the end of each year we evaluate the performance of each machine by looking at the electricity (energy) used by that machine and then compare that to the number of units (pounds) produced. If one of the machines uses 1200 kilowatts of electricity and produces 600 units and another uses 1500 kilowatts of electricity and produces 600 units, which is more efficient?

Obviously the former is a more efficient user of energy inputs than the latter. This is mechanical efficiency; in the case of the cow this is akin to biological efficiency. The level of economic efficiency will depend on the cost per kilowatt of electricity and the price per unit received for the output. If the unit price remains flat and the cost of energy doubles, the machine that uses 1500 kilowatts becomes even less profitable than before the cost increase. In the case of cows the principle is the same.

It's an easy calculation

Unlike the machines in our factory example we do not know exactly how much energy each cow uses because she is grazing for much of the year. However, we do have a measure that very accurately predicts how much energy, in this case DM, she will use per year and that measure is simply her mature weight. The easy and practical surrogate metric for DM intake is the mature weight of the cow.

Annualized, the increase in DM intake is nearly 550 pounds for each 100 pound increase in mature weight. Consequently, the difference in DM intake between a 1200-pound cow and a 1500-pound cow in terms of DM requirements is over 1600 pounds annually. In the form of hay, at 85% DM, that is a ton of additional forage we must provide to the larger cow.

Table 2. Annual DM intake for cows of varying weights.

Cow Weight	Annual DM Intake, lbs.
900	7,654
1000	8,249
1100	8,793
1200	9,329
1300	9,870
1400	10,424
1500	10,950
1600	11,505
1700	12,038

Calculated from NRC, 2002

The fact is, big cows consume more energy in the form of DM per year than smaller cows. So an accurate way to evaluate individual cow performance efficiency is the weight of her calf relative to her mature weight. Where we set the standard for culling depends on the ranch environment. Our goal might be a calf weight of 50% of the cow's weight (not realistic in some environments, but it makes the math easy here). Realizing that not all environments can support that level we might establish a standard or culling threshold at a calf weight of 40% of the cow's weight. In some cow/calf production environments a cow that can't wean 40% of her own mature weight might find it difficult to pay her way, and thus should be removed from the system.

There is no question that the annual variable costs for a large cow are higher than a small cow. We have estimated that the annual DM intake increases approximately 550 pounds and supplement costs increase 15 - $20 for every 100 pound increase in body weight. The question becomes, can she wean a sufficiently heavier calf to offset these increased costs?

According to the data in Table 3 from North Dakota State University it appears that as cows become larger it becomes increasingly difficult for them to maintain a level of productivity to offset the increasing costs.

Table 3. Weaning weight performance for cows of varying weight groups

Weight Group	Average Weight	Weaning Weight	Percent
1200	1242	617	49.7%
1300	1357	611	45.0%
1400	1456	589	40.5%
1500	1549	598	38.6%
1600	1698	572	33.7%

K. Ringwall, 2008 *Beef Talk.* Dickinson Research Extension Center, Dickenson, ND.

At least for the year in question, not only did the heavier cows not produce heavier calves they actually produced lighter calves. If this were a dry year where quality and quantity of forage limited DM intake then it makes perfect sense that the larger cows with the higher maintenance requirements would suffer the most.

Let's go back to our factory example and replace the kilowatts with the cow weight groups from Table 3. The 1200-pound cows produced 617 pounds of output and the 1500-pound cows produced 598 pounds. It does not take long to figure out which cows are generating the highest net return once we realize that heavier cows incur higher costs. Even though we do not know the exact cost for each group the implication of a net return difference between the two is intuitive. As forage costs increase, the net return difference increases between the two weight groups.

If we do not know the weight of our cows then we simply look at calf weight to evaluate how good of a job the cow is doing. We would likely conclude that a cow that produces a 572-pound calf is "doing a good job" and would likely remain in the herd. However, her production efficiency is appreciably different than the one that produced a 617-pound calf. If calves return $1.00 per pound (again to keep the math simple) then the gross revenue difference between the two is $45. Additionally, we know the larger cow requires more inputs and likely incurs greater costs making the net economic difference between the two even greater. That net difference could be near $100 when one considers the cost of the higher level of energy consumption of the larger cow.

Arbitrarily assigning the average of the entire herd's per cow cost to an individual cow or one of the weight groups in the table is misleading. Doing so very likely overstates the costs for the 1200-pound cows and understates the costs for the 1600-pound group. The big cows may still be profitable if they are producing a calf near our 600-pound goal or the herd average, but we shouldn't let their calves' weights mask their excessive size and the fact that they are less efficient.

If heavier cows are profitable then they will likely remain in the herd, but they should not be provided extra inputs over those provided to the more efficient cows to keep them productive. These are the extra costs that efficient operations do not incur. When these larger cows are no longer generating a positive return they should be replaced with ones like those in the 1200-pound group. Doing so will help drive cost per cow lower in the operation and improve efficiency.

Those cows in the three heavier weight groups in Table 3 generated less revenue and likely incurred more cost than the two lighter groups. Information like that in the above table on individual cows provides sufficient information to evaluate which ones are the most productive and efficient. Using what we know about the relationship between cow size and nutritional inputs we can make sound decisions regarding which cows are making a positive contribution to the bottom line and more importantly those that are not.