Does Cow Size Affect Efficiency?

by Paul Walker

Our guest author addresses technical terms regarding cow size and efficiency in an interesting and thought-provoking way. He proposes the most accurate measure of cow efficiency to weaning is an adjusted 205-day calf weight: metabolic cow weight ratio. This selection would favor the most efficient, regardless of size.

Beef cattle type, especially that of Angus, has always been in a state of change. Change, for the sake of change is not good, but Angus have had a good reason for changing. That reason has been profit. Fortunately, for Angus, the breed has had genetic variation with which to make these changes. Changing conditions have indicated that certain types of cattle were more profitable to produce and Angus breeders have changed type to meet the demand. Cattle of the 19th century were big, rough, patchy and slow maturing. During the early part of this century, when the market began paying a premium for smoother-fleshed cattle, these cattle were produced. More recently when a demand for smaller cuts developed due to smaller families, cattlemen responded by producing small, early-maturing cattle. (Note: The reason for a trend to the smaller cattle of the '40s and '50s is a topic all its own and too involved for discussion in this article.)

Today's modern type of Angus has emerged in response to changes in consumer demand and the cow-calf man's need for efficiency because of the cost-price squeeze. The shift to modern type has been toward cattle with greater size, faster growth rates, less fat and more lean, and higher levels of milk production.

Rate of growth has been highly emphasized as an important production trait. Through the use of performance records (such as the AHIR) cattlemen have strived to improve efficiency of their cow herds by increasing growth rate, i.e., increasing weaning weight. With the aid of adjusted 205-day weights and weight ratios, cattlemen have increased weaning weights. The improvement in weaning weights that the Illinois Beef Performance Testing program (IBPT) has had in the last 10 years is typical of the cattle industry as a whole. In 1972 the average adjusted 205-day weight of all breeds of cattle on the IBPT was 449 lb. In 1982 the average adjusted 205-day weight was 477 lb. This means that the average weaning weight of performance-tested cattle (all breeds included) in Illinois has increased 28 lb. the past 10 years. On the whole, this is a fairly good increase, but on a per year basis, this is only 2.8 lb. per year. Actually, this is a good yearly rate of progress when one considers all factors which affect weaning weight improvement such as heritability, generation interval and selection differential.

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Traditionally, the cowman has sought to improve his cow herd's production efficiency by increasing weaning weights. In this case, efficiency is defined as cost per unit of product (pound of calf) produced. Research conducted at Colorado State University in cooperation with the Livestock and Range Research Station at Miles City, Mont., concluded weaning weight was a good predictor of cow efficiency (though, as we will see later, it is not the best predictor). Nevertheless, this study supported the usefulness of adjusted weaning weights in evaluating cow productivity at weaning.

Selection for increased performance on the basis of weaning weight ratios has tended to increase the frame size of the cow herd. Past research has indicated that larger cows wean heavier calves. The difference between cows has not been as great as might be expected though. On the average, for each additional 100 pounds of cow weight an increase in 10 lb. to 12 lb. of calf weaned can be expected. There may be some bias in these results, however, since poor milking cows become fatter and therefore heavier and subsequently wean lighter calves. It is quite possible the advantage in weaning weight for heavier cows could be greater with the elimination of this bias. This point emphasizes that frame size of cows as a descriptive term must be properly defined. To many cowmen a large frame cow must be so many inches tall. To others a large frame cow must weigh so many pounds. Regardless of how tall or how heavy a cow is, the key to evaluating the relationship between cow size and cow efficiency is to maintain cows in moderate to average condition. Frame is three dimensional and should be thought of as a relationship between height, weight and body condition or fatness.

As the cost of production has risen, the interrelationships of mature cow size, calf rate of gain to weaning and cow efficiency have become more important. Many cowmen have begun to question whether or not cows can become so large framed as to decrease efficiency. Several cowmen and researchers alike have started talking in terms of optimum cow size.

If there is such a thing as an optimum size cow, what factors determine how big she should be? Actually, several segments of the

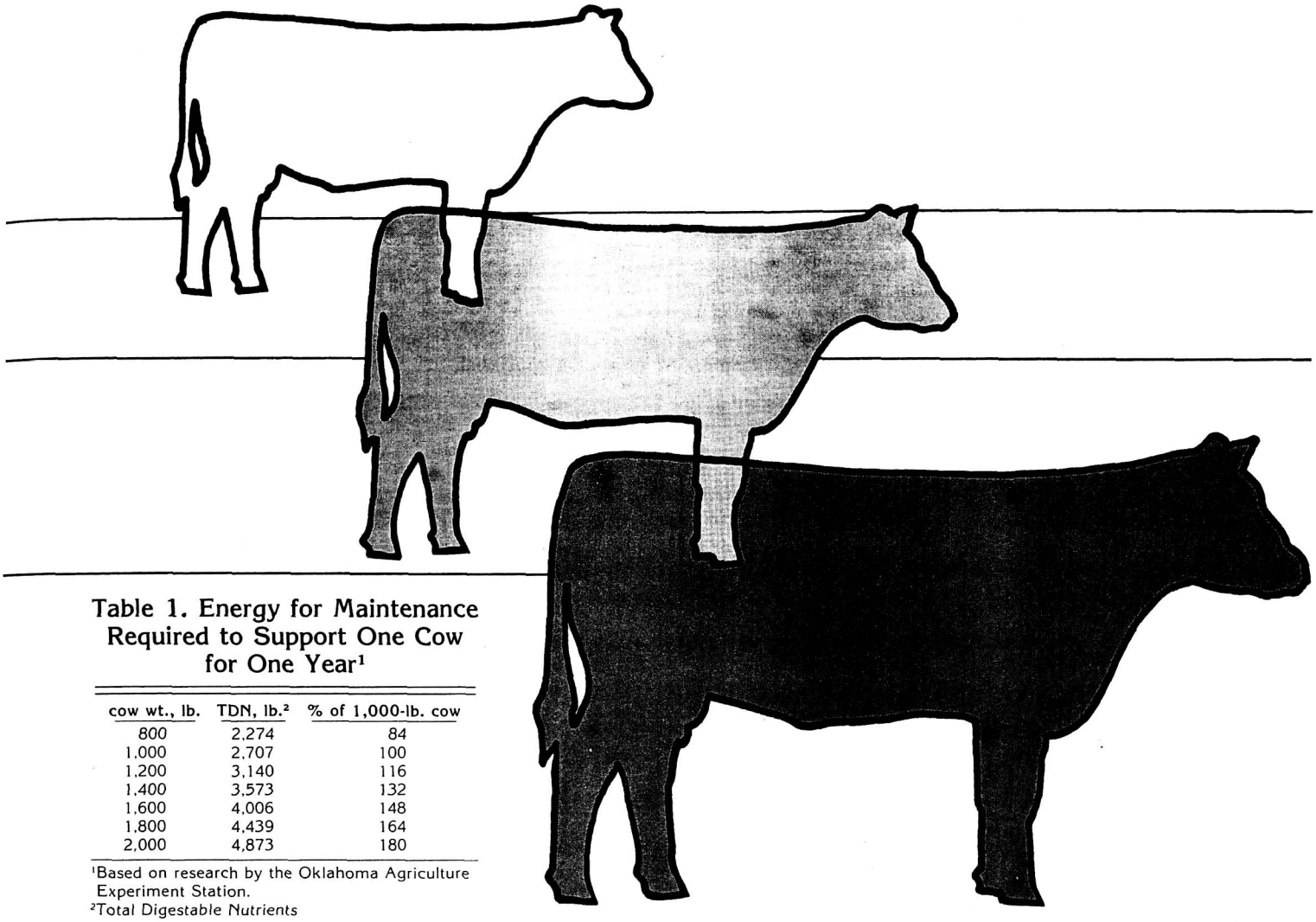

Table 1. Energy for Maintenance Required to Support One Cow for One Year[1]

cow wt., lb.	TDN, lb.[2]	% of 1,000-lb. cow
800	2,274	84
1,000	2,707	100
1,200	3,140	116
1,400	3,573	132
1,600	4,006	148
1,800	4,439	164
2,000	4,873	180

[1]Based on research by the Oklahoma Agriculture Experiment Station.
[2]Total Digestable Nutrients

industry are involved in the answer to this question, including the packer, the feeder and the cow-calf operator.

From the cow-calf operator's point of view, efficiency defines a small cow weaning a large calf because the cost of maintaining a cow is related to her size. Smaller cows require less energy for maintenance. However, the energy required to maintain a cow is not directly proportional to her size. By studying Table 1 we can see that it does not take twice as much energy to feed a 1,600 lb. cow as it does an 800 lb. cow. Rather it only takes about 76 percent more energy.

Independent studies conducted by South Dakota State University and the Montana Agriculture Experiment Station both report low correlations between cow weight (as a measure of cow size) and efficiency of the cow-calf unit at weaning. In this case, efficiency is defined as the pounds of feed required to feed the cow plus pounds of feed required to feed the calf. In other words, both of these studies demonstrate that there is little relationship between actual cow size and efficiency of beef production. Research conducted by Colorado State University also found the correlation between efficiency at weaning and measures of cow size to be generally small.

A similar type of study conducted by the Ohio Agricultural Research and Development Center to evaluate the total feed efficiency of beef cows of different sizes and breeds found the differences among cow weight classes in TDN required per pound of weaning weight were quite small. The interesting fact about this particular research was that when the calves of these different size cows were slaughtered at market weight the net efficiency (total TDN consumed by the cow and calf divided by pounds of edible portion produced) tended to be similar for all sizes and breeds of cows as there were no significant differences among them in this trait.

These results from leading universities suggest efficiency (total pounds of feed required per pound of calf weaned) at weaning is not related to a particular size or type of cow. In fact, they indicate that large and small cows may be equally efficient or equally inefficient.

Assuming the last statement to be true, one should then ask, "What is the best method for evaluating cow-calf unit efficiency at weaning?" The current selection method of using weaning weights and weaning weight ratios is biased in favor of large frame cows. Large frame cows generally wean heavier calves. When we select cows only on 205-day weaning weight ratios, we are favoring selection of larger cows—some efficient and some less efficient.

Some cowmen have, therefore, proposed that the most efficient cows in the herd are those that will wean a higher percent of their body weight as pounds of calf. This line of reasoning suggests that in order to select the most efficient cows in the herd, each individual calf's weight at weaning should be divided by his dam's weight, with the more efficient cows weaning a higher percent of their body weight. Though this method is a better indicator of cow efficiency than measuring weaning weights alone, it does have one serious flaw. If we select cows based on adjusted 205-day weaning weight as a percentage of cow weight at weaning (205-day wt./cow wt.) the selection program

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Under Dr. Walker's guidance, these cows are kept in confinement, on concrete lots, 24 hours a day, 7 days a week, 365 days a year. Their goal is to wean 800-lb. heifer calves, 900-lb. steer calves and to market the heifers at 10 months-of-age weighing 1,000 lb., and the steers at 12 months weighing 1,200 lb. This is a long-range goal, but Dr. Walker believes that if a cow herd is to survive in the Midwest during the next century, this goal must become a reality.

The 1981 calf crop had a 561-lb. adjusted 205-day weight. The 1982 calf crop calved in a 60-day time span and 93 percent of the cows exposed to a bull weaned a calf. The 1982 calf crop had a 628-lb. adjusted 205-day weight. The heifers from this crop were marketed at 10 months averaging 900 lb. The steers from this crop were marketed at 12 months averaging 1,050 lb. Incidentally, these calves were sired by the Angus bull named Creston Mr. America. ISU thanks Weaver Angus of Peoria, Ill., for donating the semen from this bull.

The 1983 calf crop calved in a 54-day time span and 97 percent of the cows exposed to a bull have a live calf at the present time.

is somewhat biased in favor of small cows. Small cows will wean a lighter calf than large cows, but because of the small cows smaller inherit size her calf's weaning weight will be proportionately larger than that of a large frame cow's calf weaning weight. This method favors selection of small cows relative to large cows, some of which would be more efficient and some of which would be less efficient. This measure of efficiency whereby calf weight is divided by cow weight assumes that cow weight is an accurate predictor of the nutrient requirements for the cow.

However, research indicates nutrient requirements are not directly proportional to cow weight (Table 1), but rather they are proportional to cow weight to the ¾ power. Cow weight$^{.75}$ is referred to as metabolic cow weight. This means that the yearly TDN required for maintenance is directly proportional to the cow's weight$^{.75}$. Any energy the cow consumes over and above this amount is then used for milk production to raise a calf. The most accurate measure of cow efficiency to weaning , therefore, is adjusted 205-day calf weight divided by the metabolic weight of the cow at weaning (referred to hereafter as calf weight: metabolic cow weight).

In a nutshell, calf weight: metabolic cow weight allows the cow-calf man to compare cows of different sizes, shapes and forms on an equal basis by accounting for the energy requirement of maintenance and the energy requirement of milk production. Metabolic cow weight is easy to calculate. Mathematically, it is the square root of the square root, cubed. Amost every $10 pocket calculator is capable of determining metabolic cow weight. As an example, a cow that weighs 1,100 lb. has a metabolic cow weight of 191 lb. $\sqrt{1{,}100} = 33$, $\sqrt{33} = 5.76$, $5.76 \times 5.76 = 33$, $33 \times 5.76 = 191$ lb.

Table 2 shows why calf weight: metabolic cow weight is a better predictor of cow efficiency than is selection based on calf weaning weight alone. Assume this table represents the weaning data from a hypothetical herd of 15 cows ranging in weight from 1,000 lb. to 1,400 lb. If we rank these cows in order from highest to lowest based on the weaning weight ratio of their calves, we can see that the larger cows wean the heaviest calves. If we were to keep only the five best cows in the herd, we would not keep any cows below 1,200 lb. except for cow 10 which weighs 1,100 lb.

More importantly, perhaps, is what happens to the cows on the other end of this column. If we were to cull only the five lowest ranking cows based on 205-day weaning weight, we would cull cows 9, 12, 14 and 15. Each of these five cows weighs 1,200 lb. or less. None of the 1,300 lb. or 1,400 lb. cows would be culled according to this system. Selection on the basis of weaning weight ratio alone primarily favors large cows.

If we rank the cows in order from highest to lowest based on calf weight: metabolic cow weight we can see this type of selection favors only the efficient cows. In this case, if we were to keep the five top ranking cows, we would keep one cow of each weight division. Notice what happens if the column which ranks the cows according to calf weight: metabolic cow weight is divided into thirds—the five most efficient cows, the five cows of average efficiency, and the five inefficient cows. One cow of each weight group is found in each efficiency division. Most importantly, the cows in the high efficiency group have nearly equal efficiency.

In other words, selection for cow efficiency on the basis of calf weight: metabolic cow weight favors only the efficient cows, some small frame, some medium frame and some large frame.

To answer an earlier question, "Is there an optimum (ideal) cow size for the industry as a whole?"—NO, there is not! In an interesting simulation study conducted at the Texas Agricultural Experiment Station, small, medium and large frame cows were compared under two management systems, drylot and pasture. In this study, large cows were found most profitable under drylot conditions, where small cows were most profitable under pasture conditions.

For the highly intensified beef production systems of today, individual herd management criteria will determine which size cow is most efficient if one of the selection tools used is calf weight: metabolic cow weight. Some producers will find large frame cows to be the most efficient while others will find medium or small frame cows to be optimum.

On the whole, if the IBPT program's weaning weight figures are typical of the U.S. cow-calf industry, weaning weights averaging somewhere less than 500 lb. are not big enough. Cow efficiency in terms of the energy cost required to produce a pound of calf at weaning is just one variable of the total cost of production. This suggests that the current trend of selecting faster growing, larger frame, more efficient cattle is still warranted, especially since larger cows generally wean larger calves and since large frame cows can be just as efficient as medium frame cows and small frame cows.

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Table 2. Weaning Weight vs. Calf Weight: Metabolic Cow Weight

Cow No.	Cow Wt.	205-day Calf Wt.	Cow Rank Based on 205-day Calf Wt.	Metabolic Cow Wt.	Calf Wt./ Metabolic Cow Wt.	Cow Rank Based on Calf Wt./ Meta. Cow Wt.
1	1,400	700	1	229	3.1	1
2	1,400	600	4	229	2.6	4
3	1,400	500	2	229	2.2	7
4	1,300	650	7	216	3.0	10
5	1,300	550	5	216	2.6	13
6	1,300	450	10	216	2.1	2
7	1,200	600	3	204	2.9	5
8	1,200	500	8	204	2.5	8
9	1,200	400	13	204	2.0	11
10	1,100	550	6	191	2.9	14
11	1,100	450	11	191	2.4	3
12	1,100	350	9	191	1.8	6
13	1,000	500	14	178	2.8	9
14	1,000	400	12	178	2.3	12
15	1,000	300	15	178	1.6	15