COW SIZE AS RELATED TO EFFICIENCY

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The question of optimum cow size has been discussed, debated, and researched since the early 1800's. The pendulum has swung all the way from the early "Durham Ox" that weighed about two ton to the "comprest" cattle that matured at less than one-fourth that weight. Currently, we are back on the road towards big cattle, both within breeds and by the introduction of new breeds.

Interest in cow size and how it relates to overall efficiency is probably at an all time high because of the cost-price squeeze. Efficiency is a trait of livestock that will become more important as the world's food problem becomes more acute and as the raw materials for meat production become more expensive and less plentiful.

For each calf produced, the cow's responsibility ends at weaning, However, the cost of maintaining the cow throughout the year must be charged to the calf. Feed expense constitutes a large portion of the variable costs of producing a market animal and a very high proportion of the total feed required is attributable to the cost of maintenance of the cow. It takes about two animals in the breeding herd to produce one slaughter animal, so efficiency of the cow herd is extremely important and this would include energetic efficiencies of various size groups.

Data presented here were collected from a cow-calf confinement system at the University of Missouri. The studies were designed to look at cow size efficiency and to a partition energy utilization. Experimental animals consisted of 100, 12 year old, Charolais and Hereford cows. Cows were divided into large or small groups with cow size measured by body weight and with body composition determined by measuring the radioactive istope K^{40} Cows were individually fed, mechanically, a corn silage ration plus appropriate supplements. Cows were artifically bred with Charolais cows bred to Hereford bulls and vice versa. Calves were creep fed.

A summary of results from the maintenance trials are presented in Table 1. Requirements were substantially higher during the winter than in the summer. Most, or all, of this difference was probably due to severe environmental conditions. In addition to cold windy weather, precipitation levels were also high during the winter causing extremely muddy and sloppy lot conditions. This undoubtably erased any energetic savings due to less traveling in confinement.

Table 1. Maintenance requirements

Item	Large	Small
	lb	lb
Average weight maintained	1221	895
Weight 0.75 power	206	163
Summer		
Maint. reg/lb wt. (TDN)	.0069	.0069
Maint. reg/lb wt. 0.75 (TDN)	.0415	.0378
Winter		
Maint. reg/lb wt. (TDN)	.0078	.0092
Maint. reg/lb wt. 0.75 (TDN)	.0456	.0506
Combined		
Avg. maint. reg/lb wt. (TDN)	.0073	.0081
Avg. maint. reg/lb wt. 0.75 (TDN)	.0436	.0442

Comparing results of the summer and winter trials we see that small cows required less energy in relation to large cows over the summer period than they did in the winter. This difference may be due to differences in degree of fleshiness. The whole body K^{40} count data indicate that large cows were about 3% fatter than small cows. Additional fat cover in the summer may have acted as a detriment to large cows and as an advantage to them during the winter months. Fat may serve as an insulator and help reduce heat loss during the winter and conversely make it more difficult to eliminate heat in the summer months. Also body surface area would be greater per unit of body weight with small cows and this may cause them to lose more heat in the winter and enable them to cool themselves more efficiently in the summer.

The combined results of the winter and summer trials presents a good analysis of year round maintenance requirements and indicates that requirements increase proportionately by body weight to the 0.75 power. This relationship between differences in size and expected maintenance energy is often expressed in terms of the concept of "metabolic size" (weight to the 0.75 power). Maintenance requirements vary in proportion to this metabolic size rather than actual size. In other words a cow twice as big as another does not require twice as much feed. Metabolic weight reduces this discrepancy and allows us to predict relative requirements.

Table 2 presents the calf data and shows the large cows' calves gaining slightly more per day, requiring more total TDN, eating less creep feed and receiving more milk than the calves from small cows. Table 3 shows the TDN requirements for maintenance and lactation for large and small cows and presents the estimated milk production values. These results indicate that the small cows gave less milk, but were somewhat more efficient in terms of energy requirements to produce a given unit of milk.

Table 2. Calf data

Item	Large cows	Small cows
Days	176	170
Avg. daily gain (lb)	2.07	1.96
TDN required (lb)	5.17	4.60
TDN from creep (lb)	1.67	1.87
TDN from milk (lb)	3.50	2.73
Daily milk consumption (lb)	14.1	11.7

Table 3. Lactation data

Item	Large	Small
	lb	lb
Initial wt.	1155	924
Initial wt.$^{0.75}$	198	168
Final wt.	1151	926
TDN req. for maint. & lact.	14.1	12.1
Estimated maint. (TDN)	9.0	8.5
TDN left for lactation	5.1	3.6
Estimated milk production	14.1	11.7
TDN/lb of milk produced	0.36	0.31

Cow size efficiency data are presented in Table 4. Calves from large cows were only 13 pounds heavier at weaning. Total TDN over a year's time shows that large cows required 785 pounds more than small cows. In terms of energy conversion to product. However, the lowered energetic efficiency of the fatter, large cows may be partially due to increased maintenance requirements due to this fat, rather than a difference in the utilization of the surplus feed over maintenance. However, it is doubtful that this would have made up for the total differences.

Table 4. Projected cow size efficiency

Item	Large	Small
Dam weight, after calving (lb)	1155	924
Adjusted 205 day calf wts. (lb)	508	495
Daily TDN for maintenance (lb)	8.69	7.35
Total over 365 days (lb)	3170	2682
Daily TDN for lactation (lb)	5.06	3.61
Total over 205 days (lb)	1038	741
Total TDN, maint. & lact. (lb)	4208	3423
Carrying capacity/unit of feed - excluding creep	100	123
Daily TDN from creep (lb)	2.29	2.57
Total over 205 days (lb)	469	528
Total TDN, dam & calf (lb)	4677	3951
TDN per lb of calf (lb)	9.20	7.98
Wt. of calf req. for equal efficiency (lb)	585	495
Carrying capacity/unit of feed - including creep	100	118

With the current trend and promotion towards larger cattle, we tend to believe that because of higher rates of daily gain, large animals are more efficient. However, there is nothing in the literature that would indicate that any size or type of animal is any more energetically efficient than another. Increased efficiency requires that an animal gain more in relation to its maintenance requirement. Feed efficiency and rate of gain are highly correlated only when animals of the same size, on the same stage of the growth curve and of the same potential size are being compared. Otherwise, rate of gain is not a measure of comparitive efficiency.

To again emphasize the importance of the efficiency of the cow herd let us consider that less than 15% of the total energy fed to cattle is recovered in the final product. This means that over 85% of the energy is being used to simply maintain the cow-calf unit. Therefore, efficiency of the producing cow herd is more important efficiency of the sale calves, even if the producer keeps them to slaughter.

It should be emphasized that energetic efficiency does not represent the total picture of economic efficiency. Economic efficiency is dependent on percent calf crop, rate and economy of gain, ability to utilize available feedstuffs, performance under various environmental conditions, consumer demands, marketing conditions, salvage value of cows, system of production, type and cost of feedstuff, and energetic efficiency along with many other factors. The optimum size of cows under one set of conditions may be different under a different set of circumstances. All other things being equal, the large cow may have an inherent economic advantage in that any cost that is derived on a per head basis, such as taxes, breeding costs, veterinary costs and in some situations even feed costs, will favor the large cows because there will be fewer of them. However, it is questionable whether these advantages will make up for the reduction in efficiency.

Reproductive efficiency is probably the most important consideration of all. It makes little difference how efficient the cow may have been or how good her calf would have been if she doesn't have one. When we go to extremes in any trait, reproductive problems seem to follow and this may hold true for cow size. Many advocate retaining small cows and using large bulls. However, if calving problems arise due to large calves, then increased calf losses, cow losses, veterinary costs, reduced or delayed conception, labor costs, etc., may more than wipe out the advantages. Extremely large cows may not be able to consistantly produce a calf every 12 months but may require 13 or 14 months instead and again reduce any advantage the large cow may offer.

When it is all said and done the most profitable cow is the one which has a calf every year, is efficient, and her offspring is capable of producing lean and economical gains. One may conclude that medium is the size, simply because one will end up with some large and some small cows and many in between, which all averages out to medium. So select for overall reproductive and productive performance, taking into account all the previously discussed considerations, and the size of cow you end up with more than likely will be the "optimum" size.