BODY SIZE AND PRODUCTION EFFICIENCY*

EARLE W. KLOSTERMAN
Ohio Agricultural Research and Development Center
Wooster, Ohio

Beef cattle selection and performance testing procedures in recent years placed much emphasis upon rate of gain. In a search for fast gaining animals, numerous new breeds of larger type have been introduced and selection for gain has increased mature size in a number of herds of existing breeds. The National Association of Animal Breeders has identified 68 breeds of cattle in this country.

A tremendous variation in type of cattle is now available to the beef producer. This variation has led to many questions. How big should cattle be, how fast should they gain, what is the relationship between rate of gain and feed efficiency, how much milk should they give, what carcass weight and grade is most desirable, are there interactions among types of cattle and available feed supplies, etc.

A number of experiments have been conducted at The Ohio Agricultural Research and Development Center to obtain information on these questions. Results of these experiments have been prepared for publication by Klosterman and Parker (1976)[1]. Detailed data obtained in these experiments will not be repeated here but only the conclusions which appear justified.

Maintenance

Energy requirement for maintenance is a tremendous overhead which the beef industry must carry. Do cattle differ in their requirements for maintenance? If so, this variation does not appear to be genetic. Per unit of metabolic weight ($W^{0.75}$), Hereford and Charolais cows did not differ significantly in amount of feed required to maintain constant weight. However, fat cows required less feed per unit of weight than this cows. A beef cow varies widely in weight depending upon her condition, a variation which may be greater than the actual variation in maintenance needs of that individual. If, for example, a 1,000 pound cow is fattened to 1,200 pounds and then fed as a 1,200 pound

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[1] Klosterman, E. W. and C. F. Parker. 1976. Effect of size, breed, and sex upon feed efficiency in beef cattle. Ohio Agricultural Research and Development Center, Research Bulletin, (in press).

cow she is likely to continue to gain weight. If, however, she is starved to 800 pounds and then as a 800 pound animal, she is likely to continue to lose weight. Does the so-called "easy-keeping" cow have a slower maintenance requirement or does she eat more than her share of feed? I suspect the latter may be true.

Cow Size

An experiment was conducted at OARDC to measure the total feed efficiency of beef cows of different sizes and breeds. Individual feed consumption records of cows for a full year and their calves to choice slaughter condition were obtained during a 4 year period for 133 cow-calf pairs. Milk production of the cows and weights, gains and carcass data of their calves were recorded. These included Hereford, Hereford x Angus, Hereford x Charolais, and Charolais cows varying in size. One-half of the cows of each breed were bred to Hereford bulls and the other half to Charolais bulls.

The results obtained were studied according to three weight classes with the effects of breed removed and according to breed with effects of weight class removed. Some cows of all breeds were included in each of the weight classes which averaged 874, 1022 and 1210 pounds. The heavier cows had greater weight-to-height ratios (a measure of condition) and weaned significantly heavier calves. They required more total feed and their calves ate more feed prior to weaning. The differences among weight classes in total digestible nutrients (TDN) required per pound of weaning weight were small. Differences in post-weaning performance were not significant among weight classes, but calves from the larger cows produced carcasses which were significantly heavier. Hereford x Angus cross cows produced the most milk weaned the heaviest calves and required the least TDN per pound of weaning weight. However, their calves were the least efficient on feed post-weaning.

Differences in carcass traits among calves out of the cow breeds were significant at the 5 percent level. Calves from the Hereford x Angus cross cows graded one-third grade higher than those from Charolais cows and were two weeks younger at slaughter. 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. Irrespective of condition as it affects cow weight, calf production by cows of different sizes appears to be in proportion to the size of the cow. Thus, size of cow *per se* seems to be of minor importance in calf production.

In these experiments, only 13 percent of the metabolizable energy fed to the cow and calf was recovered as net energy in the calf at slaughter. Thus, 87 percent was required for maintenance and other non-productive functions. These data include only those cow-calf pairs which completed the experiment and hence are based on a 100 percent calf

crop slaughtered. Actual efficiency of production is somewhat lower than this and emphasizes the importance of culling non-productive cows from the herd.

Maturing Rate

Rate of growth has been highly emphasized as an important production trait in beef cattle. However, the relationship between growth rate and efficiency of feed utilization among cattle of various types and sizes fed to similar carcass grade or degree of finish has not been significant. The important difference among individual cattle is not their rate of absolute gain but rather their rate of gain per unit of weight, relative gain. When fed to a constant grade, there is a highly significant relationship between relative gain and feed efficiency.

Feedlot studies at OARDC and elsewhere have shown that earlier maturing types of cattle (small vs. large or heifers vs. bulls) eat more feed per unit of weight and finish at younger ages and lighter weights than later maturing types. The market generally prefers a certain degree of finish and discounts those cattle which are under-finished or over finished. Excessive finish can easily be avoided by slaughtering when the cattle are ready, however, under-finished cattle must be fed for longer periods of time. Hence, rate of maturing becomes an important trait in beef cattle.

C. F. Parker at OARDC has derived a measure of maturing rate from an expression of relative gain as follows:

$$\frac{\text{Weight per day of age}}{\text{slaughter weight}} \div \text{Slaughter weight}$$

which reduces to:

$$\frac{1}{\text{Age of slaughter}}$$

This function measures rate of growth relative to the body weight at which time the desired degree of finish is attained.

Feed consumption data obtained in the cow-size experiment, where calves were fed to a constant low choice grade, were used to correlate the term 1/Age at slaughter with feed efficiency. The correlation between this term and total TDN consumed by the cow and calf was -0.52, indicating that animals with faster rates of maturity were more efficient. This relationship was highest with TDN required by the calf on feed following weaning ($r = -0.63$) and less ($r = -0.22$) with TDN required by the cow. This expression of maturing rate simply means that those cattle which produce the most carcass weight of the desired grade at the youngest age are the most efficient.

Energy Requirements for Gain

NRC, Nutrient Requirements of Beef Cattle, indicate that heavier steers and heifers require more NE gain per unit of gain than lighter weight calves. These increases are generally considered to be due to changes in body composition and a question was raised if different sizes of cattle of different weights but with similar composition have different requirements. A three-year experiment was conducted to study this problem.

Three groups, 212 head, of weanling heifer calves sired by Angus, Charolais, Jersey and Brown Swiss bulls out of Angus and Charolais dams were individually fed at either 1.5 or 2.0 times their maintenance energy requirement for 210 days. One-half of each breed type was fed each level of feed which was calculated from $W^{0.75}$ and increased with individual weight gain each 14 days. As would be expected, average daily gain and energy per unit of gain were significantly different between the two levels of feeding in favor of the higher level.

Although there were significant differences among breed types in initial weight and hence, in amounts of feed fed, there were no significant differences among them in absolute rate of gain. However, heifers with Angus breeding gained significantly faster per unit of metabolic size, relative gain, and required significantly less feed per unit of gain. There were no significant interactions among breed types and levels of feeding in rate or efficiency of gain. These results indicate that larger type calves require more net energy per unit of absolute gain and that NRC requirements are accurate when applied to different breeds, crosses and sizes of cattle.

Interactions Among Cattle and Feed Supplies

Data on interactions which may exist among types of cattle of the same sex and types of diet are somewhat limited. However, differences among bulls, steers and heifers in rate of gain, feed intake per unit of weight, rate of maturing and carcass weight and composition are very similar to differences which exist among different sizes of cattle. If this analogy between sex and size may be made and the two may be considered together, there appear to be definite interactions among types of cattle and either types of diet or feeding systems.

In a crossbreeding experiment, significant interactions between both breed (Hereford and Charolais) and sex (steers and heifers) and two systems of management were found. The two systems of management were: creep-feeding and finishing immediately following weaning vs. no creep-feeding, wintering, grazing for 60 days and finishing in dry lot. In combining the two sources of variation, breed and sex, it appeared that Charolais steers were best adapted to the early finishing system and Hereford heifers to the deferred system of management. It is well known that heifers finish more easily than steers and if bulls are to be finished at young ages they must be fed high energy rations.

It is, therefore, apparent that if it is most economical to feed lower energy rations, they will be best utilized by early maturing types of cattle which consume more feed per unit of weight and if high grain rations are to be fed, later maturing cattle will produce heavier, more desirable carcasses. If early maturing cattle are fed high grain rations at young ages, they must be slaughtered at light weights or they will become excessively fat.

Carcass Weight

Supplies of finished, slaughter cattle vary with cattle numbers and supplies of feed grains, however, a desired degree of finish is generally preferred with both underfinished and overfinished cattle selling at a discount. Much discussion has been given to a most preferred slaughter weight, however, in the market, size independent of finish appears to be of much less importance than the desired degree of finish.

It is my understanding that the packer is able to realize some net savings per pound of carcass beef handled by processing larger type cattle. Although of real economic importance to the packer, this saving may be minor when related to total costs of beef production. There is also some demand, perhaps limited, for lighter weight, finished cattle.

Summary

Experiments have been conducted with cattle of various breeds and sizes to determine their energy requirements for maintenance, growth and finishing. Differences in maintenance requirements of mature cows did not appear to be genetic but were influenced by condition. When total feed required by the cow for one year and her calf to slaughter condition were measured in pounds of edible beef produced per unit of energy consumed, there were no significant differences among cows of different sizes or breeds.

When fed to a similar degree of finish, there were no significant differences among sizes of cattle in feed required per unit of gain. There was a significant relationship between feed efficiency and relative gain, gain per unit of weight, but not between efficiency and absolute gain. It was concluded that NRC energy requirements are accurate when applied to different breeds, crosses and sizes of cattle.

Differences among types of cattle were similar to differences among sexes. Earlier maturing types were found to consume more feed per unit of weight and to finish at younger ages and lighter weights. Heifers of small type appear best suited to deferred systems of management or lower energy diets and steers of larger type to feeding high energy diets at young ages.

Traits which seem of importance for increasing energetic efficiency in beef cattle are feed intake or gain per unit of metabolic size and the ability to finish at a desirable carcass weight. Those cattle which will produce the most carcass weight of the desired grade at the youngest age will be the most efficient. This trait may be measured as the reciprocal of age at slaughter when carcass composition is constant.

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Dave Anderson: To begin this session is another good friend, Dr. Bill Moody, Professor of Animal Science, University of Kentucky. Dr. Moody received his Doctorate at Missouri. He has done Postgraduate work at Wisconsin and most recently at the Research Institute in England. Today, Bill will be reviewing a most timely topic in which he will discuss the differences in the characteristics of beef from animals fed on different feeding regimes.