of muscle fibers is determined when the egg cell is fertilized. Consequently, good feeding or management practices can only exploit the potential muscular development. It is quite evident then, that the cows and bulls used for breeding purpose must have the potential for transmitting these muscle development characteristics.

Aside from visual appraisal, one may use carcass indices for appraising muscle development. Size of the loin eye muscle is one of the practical indications of the degree to which muscle has development. A correlation of .85 between the surface of the eye muscle and the separable lean in the carcass has been reported to exist. Heritability estimates have been reported to account for three-fourths of the variation in the size of the loin eye muscle. Consequently, the surface area of the loin muscle of animals at a given age may serve as a production tool.

The loin eye size is also influenced by animal age. Evidence in Table 2 indicates that the loin eye area increased rather rapidly up to 42 months with little increase between 42 and 90 months. This would indicate that maximum muscular development would likely occur prior to the time the animal reaches 42 months. These and other data indicate that such a point occurs between 12 to 18 months. Breed and animal differences will cause some variation. Further work is now planned to investigate the rate of muscle development as influenced by age.

The Growth and Development of Beef Calves From Weaning to Slaughter Weight with Reference to the Effect of Plane of Nutrition

J. J. Guenther, L. S. Pope,
G. V. Odell, and R. D. Morrison

During the last decade, advances in our living standards, working conditions, human nutrition, and medical science have brought about drastic changes in the eating habits of most Americans. As far as the livestock industry is concerned, the most important of these changes has been the great "purge" of fat from our diets—particularly animal fats. The "modern" consumer is demanding, and getting, retail cuts with an absolute minimum of waste or external fat. The retailer, in turn, is exerting considerable pressure upon meat packers to supply him with trim wholesale cuts and the packer, naturally, is letting this pressure fall squarely on the shoulders of the producer. Consequently,

today's cattleman is faced with the task of producing (economically) the kind of cattle that still yield high percentages of high priced, high quality, tender, flavorful, juicy retail cuts; but that have only small amounts of "waste" fat trim.

These circumstances have pointed up the need for more basic information concerning the effects of various breeding and feeding practices. In order to effectively cope with today's production problems, it is imperative that we obtain more fundamental information on the growth, development, and deposition of the major carcass tissues throughout the growing period of the beef calf. First we need to know how and when these tissues (muscle, fat, and bone) are being developed in the beef animal and then we must develop techniques to control them to produce the type of cattle demanded by present day and future markets.

Research is currently under way at the Oklahoma Agricultural Experiment Station to obtain such information. The following data represent a portion of the initial results of this study.

Procedure

Twenty closely related Hereford steer calves were used in the initial test. Calves were sired by two half-brother bulls and were selected on the basis of age and productivity of dam, weaning weight and age, and weaner grade. All calves were individually fed a standard fattening ration throughout the study. The high level calves received as much feed as they would consume, while those on the moderate level were fed to gain about 1.3 lbs. per day. Four calves each were randomly assigned to one of the following treatment lots:

Lot W—These calves were slaughtered at weaning and data obtained were used as a baseline for subsequent growth and development comparisons.

Lot H-1—Fed on a high plane of nutrition to make 200 lbs. post-weaning gain, then removed and slaughtered.

Lot M-1—Fed at a moderate rate. These calves were removed from the test and slaughtered at the same time as those from from Lot H-1.

Lot H-2—Fed on a high plane to make 400 lbs. post-weaning gain.

Lot M-2—Fed at a moderate rate and removed from test with the H-2 calves.

Nutritional data obtained were: feed consumption; average daily gain, and efficiency of feed conversion. Slaughter and carcass data included: weight of dress off items; stomach compartments and internal fats; dressing percent; grade; marbling scores; ribeye area; fat cover; cutout and specific gravity; and chemical chomposition of all wholesale cuts.

Results

The average carcass quality data and feed conversion results are given in Table 1. Calves on the high plane of nutrition (Lots H-1 and H-2) were considerably heavier than the M-1 and M-2 calves when slaughtered. Consequently, their carcasses were, on the average, 50 and 86 lbs. heavier than the M-1 and M-2 chilled carcasses. This is reflected by the differences in average daily gains of the two groups, 1.53 and 2.07 lbs. respectively, for the high level calves. Though these differences were small, small differences here can account for large differences in total carcass weight.

Carcass grade of the high level steers was increased by one full unit at the H-2 period, i.e., from average standard to average good; whereas no grade change was encountered feeding calves at the moderate level.

Another important factor in evaluating carcass quality is the marbling content. In this respect, results indicate that the H-2 calves increased three full units (practically devoid to small), while the M-2 steers showed only one unit of increase. Since under present federal grading standards marbling plays such an important part in final grade determination, it is apparent that beef calves must be full-fed during the early periods of life if maximum marbling (hence grade) is to be attained at an early age.

Ribeye area, which is indicative of muscle development, was greater for the faster gaining steers. These data also point out that the ribeye muscle develops at its maximum rate during the early part of the calf's life—a fact that should be exploited.

Table 1.—Average Carcass Data and Feed Conversion

	Weaning	High-1 W+200	Mod-1	High-2 W+400	Mod-2
No. of Steers/Treatment	4	4	4	4	4
Age at Slaughter (days)	261	403	390	452	447
Weight at Slaughter	491	716	631	880	738
Carcass Weight	265	424	374	527	441
Average Daily Gain	1.88	1.53	1.08	2.07	1.18
Chilled Carc. lbs/day age	1.02	1.06	0.98	1.17	0.98
Carcass Grade	Avg Std	Low Good	Low Std	Avg Good	Avg Std
Marbling Score	Pract. Devoid	Slight	Traces	Small	Traces
Area of Ribeye[1]	6.47	8.19	7.91	9.14	8.81
Average Fat Cover[2]	1.52	1.00	0.62	1.47	0.77
Lbs Feed/lb Gain	---	12.10	11.00	10.10	11.60
TDN/lb Gain	---	7.93	7.16	6.58	7.60

[1] Square Inches-Average Right and Left Side.
[2] Inches-Average Three Measurements on Right and Left Side.

No great differences were noted in efficiency of feed conversion, however, the H-2 calves appeared to require less TDN per pound gain than did the moderates.

The weight of various dress-off items together with the overall skeletal growth and development data are presented in Table 2.

Table 2.—Average Slaughter Data and Carcass Measurements

	Lot W Weaning	Lot H-1 W+200	Lot M-1	Lot H-2 W+400	Lot M-2
Head Weight	18.2	25.2	24.2	28.9	26.9
Hide Weight	41.2	66.5	58.2	75.4	70.4
Shank Weight	10.4	13.9	13.2	16.0	14.8
Total Stomach Weight	61.1	84.4	66.9	99.5	75.7
Internal Fats[1]	14.0	26.8	16.1	41.6	25.4
Length of Body[2]	39.9	43.8	43.1	44.8	44.5
Length of Leg[2]	25.5	28.0	28.0	29.0	28.4
Length of Loin[2]	21.5	23.1	23.2	24.3	23.7
Chest Depth[2]	13.4	15.1	15.0	16.1	15.6
Width of Shoulder[2]	4.6	7.2	6.8	8.1	7.3
Width of Round[2]	5.2	7.8	7.5	8.3	7.7
Length of Cannon Bone[2]	6.67	7.53	7.57	7.58	7.58
Area of Cannon Bone[3]	1.09	1.22	1.17	1.50	1.41
Weight of Cannon Bone	3.07	3.50	3.33	4.05	3.84

[1] Kidney knob, Caul, Ruffle, and Channel fat.
[2] Measured in inches.
[3] Square inches.

On a percentage basis, calves fed at a moderate rate tended to have larger heads and shanks, but less internal fats. Little difference was noted in percent hide or total stomach; however, rumen development appeared to favor the full-fed animals.

Plane of nutrition had little affect on the linear skeletal growth. Results show that skeletal development proceeded at a maximum rate until 200 lbs. post-weaning gain (10-11 months of age), but after this time little increase in size was noted. This does not mean that bone ceases to grow after this particular age period, for such is not the case. An examination of the cannon bone data in Table 2 shows very clearly that while bone stops increasing in length at the 10-11 month period, it certainly continues to develop in thickness and in weight. This may be an important consideration in long term grain-grazing operations.

The data in Table 3 depict the general carcass development from the standpoint of wholesale cut yield. These cuts are grouped into five "Top Line Cuts" and five "Bottom Line Cuts". The high gaining calves showed greater development in all cuts, but particularly so in the rib, loin, rump, flank, plate, and brisket.

Table 3.—Average Yield of Wholesale Cuts and Chemical Composition of Carcass

	Lot W Weaning	Lot H-1 W+200	Lot M-1	Lot H-2 W+400	Lot M-2
"Top Line Cuts"					
Chuck	66.6	105.3	96.3	132.4	118.1
Rib	21.7	36.3	32.1	45.8	35.9
Loin	43.5	69.1	62.8	85.7	69.5
Rump	13.7	22.5	19.3	26.8	22.6
Cushion Round	44.4	62.7	58.8	70.5	65.9
"Bottom Line Cuts"					
Hind Shank	15.2	20.6	19.1	24.4	21.7
Flank	10.4	18.3	14.1	27.7	18.9
Plate	18.4	31.6	25.8	43.2	30.6
Brisket	11.9	22.6	19.7	30.5	21.3
Fore Shank	14.6	19.8	18.8	22.9	21.3
Carcass Composition[1]					
Moisture	132.0	189.9	176.1	224.0	206.8
Ash	1.8	2.6	2.4	2.9	2.5
Fat	29.3	78.7	56.8	122.3	65.6
Protein	35.1	53.5	49.0	63.7	57.8
Bone	49.2	65.5	61.5	74.0	69.8

[1] All data in total pounds.

Table 3 also shows the carcass composition in terms of total pounds of moisture, ash, fat, protein, and bone produced. These data further point out that the maximum rate of lean development occurred during the first 200 lbs. of post-weaning feed lot gain.

Summary

Results indicate that perhaps the most important period in the growth and development of the feeder calf is during the first 200-250 lbs. post-weaning gain. It is during this time that the beef calf attains its greatest potential skeletal size. Maximum rate of lean production also occurs during this period. These results suggest that beef calves must be full-fed during the early periods of life, if maximum marbling and carcass grade are to be realized.