Carla Gale Chenette is a Yankee-Okie cross-bred now working at the University of Kentucky as State Beef Cattle Breeding Extension Specialist. Dr. Chenette was born and raised on an 800-acre dairy farm in Connecticut; moved to Stillwater, Okla., in 1976 to pursue M.S. and Ph.D. degrees from Oklahoma State University in beef cattle breeding and genetics; and started on faculty at the University of Kentucky in July 1981. She was the first woman to receive the FFA American Farmer Degree, was named OSU Outstanding Graduate Teaching Assistant in 1981, has over 50 articles in various scientific and popular press publications and serves as advisor to the Kentucky BCIA. She also provides leadership to the Kentucky "Performance-Progress" Central Bull Test Station and performance programs.

In her own words, "I've worked at a lot of different things from shoveling manure to working at the White House and found beef cattle are my line of work! I'm dedicated to the improvement of beef cattle through performance testing and selection." And her motto sums it all up, "Building Better Beef Through Breeding".

In the following article she comments on the value of frame, then discusses measurements, adjustments and frame scoring. Her sources of information and research data are cited at the end of the article—they might provide further reference for those interested.

THE GREAT BEEF FRAME UP

by Dr. Carla Chenette
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Whether one agrees with frame scoring beef cattle or not, frame is an economically important trait for the industry. Commercial producers are demanding large-framed, growthy bulls to sire calf crops and are willing to pay the price for additional frame. In a study done by Daley and Winder (1980) on a recent sale of national importance in the Hereford breed, each additional inch of height resulted in an increase of $2,830 in sale price; and analysis showed "sale price was determined to a greater extent by hip height than overall index".

Another study conducted by John Crouch of the American Angus Assn. involved Angus and Polled Hereford bulls sold in 1979 and 1980 at the Red House (Va.), Clemson (S.C.), Rocky Mount (N.C.), Tifton (Ga.), Calhoun (Ga.) and Statesville (N.C.) bull test stations. This study showed an average increase in sale price of $875 for each additional one inch of hip height. Analysis of the recent Kentucky Central Bull Test Sale held this past spring showed similar, but not quite as dramatic, results. Looking at only Angus and Polled Hereford bulls in the sale, each additional inch of hip height added, on the average, $192 to the sale price. Range of frame scores for these bulls was 3.2 to 6.1.

These studies and others indicate the correlation between selling price and hip height is currently quite high (.60 +). And since hip height is a moderately to highly heritable trait (.4 to .6), it can be changed by selection fairly rapidly.

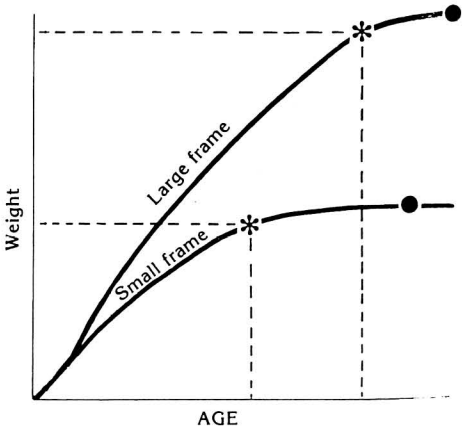
Linear measurements such as hip heights are objective and serve as a tool for describing cattle. The idea of linear measurements is not new. Research published as early as the 1930's refers to wither and hip height measurements and data from that time to present show relationships between frame and other production traits. With today's trend toward larger-framed cattle, how will other economically important traits be affected?

By increasing frame size, cattlemen are increasing body size (frame and weight) at a given age. At birth this is undesirable, causing a higher incidence of dystocia or calving difficulty. A phenotypic correlation of .60 was reported by Flock et al. (1962) between wither height at weaning and birth weight in British breed cattle. On the average this indicated as height increased, birth weight also increased. The scientific literature also estimates that at birth wither height is approximately 50% of eventual mature height. Other researchers have reported positive relationships between body weight and height at various ages, ranging from correlations of .38 to .83 (Brungardt, 1972; Gregory, 1933; and others).

Considering other important traits such as gain and efficiency of gain, positive relationships with frame size seem to exist. Brown et al. (1973) reported a genetic correlation of .77 between height and pre-weaning gain, indicating up to weaning, larger-framed calves tended to gain more rapidly than smaller-framed calves. Other studies show this relationship also holds post-weaning. The growth curves in Figure 1 explain this positive relationship between weight, frame and average daily gain. Larger-framed, later-maturing cattle are growing at a faster rate (as depicted by a greater upward slope of the curve) than smaller framed cattle. They reach physiological maturity at heavier weights and at an older age.

Brungardt (1972) reported that if weights were held constant, larger-framed cattle were more efficient than smaller-framed cattle. In general, research studies have shown positive and reasonably high relationships between frame measurements and performance traits such as birth weight, weaning weight, yearling weight, average daily gain and mature size. Correlations range from .4 to .7 (Eller, 1979).

FIGURE I. Growth Relationships of Weight, Age and Frame for Beef Cattle



* Physiological maturity
• Mature size

TABLE I. Frame Scores for Bulls—Beef Improvement Federation Live Animal Evaluation Committee Recommendations (Eller, 1979)

MONTHS OF AGE	FRAME SCORES 1	2	3	4	5	6	7
5	34.00	36.00	38.00	40.00	42.00	44.00	46.00
6	35.00	37.00	39.00	41.00	43.00	45.00	47.00
7	36.00	38.00	40.00	42.00	44.00	46.00	48.00
8	37.00	39.00	41.00	43.00	45.00	47.00	49.00
9	38.00	40.00	42.00	44.00	46.00	48.00	50.00
10	39.00	41.00	43.00	45.00	47.00	49.00	51.00
11	40.00	42.00	44.00	46.00	48.00	50.00	52.00
12	41.00	43.00	45.00	47.00	49.00	51.00	53.00
13	41.75	43.75	45.75	47.75	49.75	51.75	53.75
14	42.50	44.50	46.50	48.50	50.50	52.50	54.50
15	43.00	45.00	47.00	49.00	51.00	53.00	55.00
16	43.50	45.50	47.50	49.50	51.50	53.50	55.50
17	44.00	46.00	48.00	50.00	52.00	54.00	56.00
18	44.50	46.50	48.50	50.50	52.50	54.50	56.50

We now have to pose the question of skeletal growth rates of various frame size animals and learn if they all grow at similar rates. Much of the early research was done with smaller-framed, earlier-maturing cattle, but this is still of value because many (perhaps too many) of our cattle still are in that category. Guilbert and Gregory (1952) reported hip height growth to be linear up to 12 months of age (0.338 inches per day), then slowing at a constant rate until maturity. Other studies reported growth rate of bulls to one year of age as .03 inches per day (Massey, 1979), .031 inches per day (Maino et al., 1981) and .033 inches per day (Healy, 1979).

Recent data from Oklahoma State University (Baker, 1981) showed hip height growth rate from on test to off test at the central bull testing station was not different among breeds, ranging from .0318 to .0339 inches per day. The study involved a total of 497 Angus, Brangus, Charolais, Hereford and Polled Hereford bulls.

Although difficult to believe, it appears that at a given age bulls or heifers grow at the same rate, regardless of frame score. Studies conducted by Healy on cattle ranging in frame score from 3.5 to 5.5 and by the University of Missouri on cattle ranging from 1 to 7 on the frame scoring system both agree with the above statement. In research done in his own Hereford herd, Healy reported that daily growth rate from 205 to 365 days on the top ten and bottom ten frame score bulls in each of four consecutive calf crops did not vary! And heifers showed the same results!

However, as we push towards even larger-framed cattle, will this relationship hold? And does it hold over *all* breeds of cattle? These questions still have to be answered and we must not overextend results of research to even larger frame sizes and assume that all relationships still hold.

Most work has been done on growth rate of skeletal size between weaning and one year of age; few studies have been conducted looking at growth rates to maturity. Healy reported correlations of .84 ± .02 and .88 ± .02 between 205-day hip height and 365-day hip height in Hereford bulls and heifers, respectively. Brown et al. (1956) showed that in Angus and Hereford cattle about 80-90% of mature skeletal frame was reached by one year of age.

Much of the first height data was collected at the University of Wisconsin and University of Missouri; research and the concept of a frame scoring system focused on wither heights. Today, the emphasis has changed to hip heights. Brown's work at the University of Arkansas showed hip height measurements were most highly correlated to performance of all other measures taken and hip height measurements are easily taken and repeatable. Kidwell (1955) and Lush (1928) both reported very high correlations (.9+) between wither and hip heights. Differences between wither and hip heights at a given age have been shown in several studies to range from 1.5 inches to 2.0 inches. During growth, hip height increases slower than wither height, but they tend to reach equality at maturity.

There is some controversy as to exactly where the hip height measurement should be taken. The newest Beef Improvement Federation Guidelines (1981) recommend the measure be taken halfway between the hook and pin bones. Others prefer to measure exactly over the hooks because it is a true measurement of the skeleton (taken directly over a solid ball and socket joint) that is less apt to vary, making the measurement more repeatable.

It is also important to emphasize that if hip height measurements are to be meaningful, they must be accurate and repeatable. Care and patience are important in taking these measures. For best results, cattle should be on a solid, level floor and in a natural stance. Hip heights will vary if the animal is pushing forward or back in a head gate or not standing squarely. It is also best for your measuring device to have a horizontal bar with a level in it to increase accuracy.

Once the hip height measurements are taken, they should be adjusted before comparisons are made. Just as with weights, adjustments are made for known sources of environmental variation such as age of dam and calf age. The latest Beef Improvement Federation (BIF) Guidelines recommend the following adjustments of hip heights.

205-day hip heights

1. Multiply number of days *under* 205 by .033 for bulls or .025 for heifers and *add* to the actual height.
2. Multiply number of days *over* 205 by .033 for bulls or .025 for heifers and *subtract* from actual height.
3. To adjust for age of dam, multiply the adjusted hip height for sex by the age-of-dam factor.

Age-of-dam adjustment factors for heights at weaning are:

Age of Dam (years)	Bulls (weaning height)	Heifers (weaning height)
2 and 13 or older	1.02	1.02
3 and 12	1.015	1.015
4 and 11	1.01	1.01
5 through 10	-----(no adjustment)-----	

365-day hip heights

1. Multiply number of days *under* 365 by .033 for bulls or .025 for heifers and *add* to the actual height.
2. Multiply number of days *over* 365 by .025 for *both* bulls and heifers and *subtract* from actual hip height.
3. There are no age of dam correction factors recommended for yearling hip height.

We have established that hip heights are important, but most often they are referred to by frame score. Although the BIF Guidelines do not include frame scoring charts for bulls or heifers, the recent meeting of BIF decided standard frame charts were needed and will be forthcoming. Most frame charts that currently are being used are in agreement, with some variations in growth rate between 12 and 18 months of age in bulls. However, these differences are self-correcting after that six month period as they tend to be the same after that point regardless of chart used. Tables I and II refer to bull frame scores. Table I is based on the Missouri system which was developed from Missouri and Wisconsin research and considered by the 1979 BIF linear measurements committee. Table II was developed by Burke Healy and is based on over 20,000 linear measurements on Hereford cattle. Discrepancies occur between 13 and 18 months of age. Both charts agree for heifers (Table III), however the one based on the Missouri system only goes to 18 months of age. It should also be noted that it was an arbitrary decision to have two inch increments between frame scores at any given age.

Since one does not always carry a frame chart, but still may want to calculate adjusted weaning or yearling frame scores, the following formulas may be used to get from ad-

Continued on Page 270

Continued from Page 267

TABLE II. Frame Scores for Bulls (Healy, 1979)

Age In Months	Frame Score 1	Frame Score 2	Frame Score 3	Frame Score 4	Frame Score 5
5	34.00	36.00	38.00	40.00	42.00
6	35.00	37.00	39.00	41.00	43.00
205 Days	35.75	37.75	39.75	41.75	43.75
7	36.00	38.00	40.00	42.00	44.00
8	37.00	39.00	41.00	43.00	45.00
9	38.00	40.00	42.00	44.00	46.00
10	39.00	41.00	43.00	45.00	47.00
11	40.00	42.00	44.00	46.00	48.00
12	41.00	43.00	45.00	47.00	49.00
13	41.50	43.50	45.50	47.50	49.50
14	42.00	44.00	46.00	48.00	50.00
15	42.50	44.50	46.50	48.50	50.50
16	43.00	45.00	47.00	49.00	51.00
17	43.50	45.50	47.50	49.50	51.50
18	44.00	46.00	48.00	50.00	52.00
19	44.25	46.25	48.25	50.25	52.25
20	44.50	46.50	48.50	50.50	52.50
21	44.75	46.75	48.75	50.75	52.75
22	45.00	47.00	49.00	51.00	53.00
23	45.25	47.25	49.25	51.25	53.25
24	45.50	47.50	49.50	51.50	53.50
MATURITY	47.00	49.00	51.00	53.00	55.00

justed hip height measurements to frame scores.

205-day frame score
Frame Score for Bulls =
3 – [(39.75-adjusted hip height) ÷ 2]

Frame Score for Heifers =
3 – [(39.00-adjusted hip height) ÷ 2]

365-day frame score
Frame Score for Bulls =
3 – [(45.00-adjusted hip height) ÷ 2]

Frame Score for Heifers =
3 – [(43.00-adjusted hip height) ÷ 2]

The key points to remember are a frame 3 bull at 205 days of age measures 39.75 inches and a heifer measures 39.00 inches. At one year of age the corresponding values are 45.00 inches and 43.00 inches for bulls and heifers, respectively.

With current emphasis on frame, a good working knowledge of adjustment of hip heights and the frame scoring system is a must for most cattle producers. However, frame should be used as a supplement to other performance data as a tool for selection. A combination of height and weight in the form of ratios may be a valuable calculation to use in selection procedures.

Regardless of individual opinions on selection for increased frame size, the cattle industry is demanding height along with other performance traits. Purebred breeders are getting loud and clear message from commercial producers of "We need large-framed cattle that *also* perform, bulls that will sire larger-framed, but heavy-muscled calves. Calves that gain rapidly from birth

Continued on Page 272

TABLE III. Frame Scores for Heifers (Healy, 1979)

Age In Months	Frame Score 1	Frame Score 2	Frame Score 3	Frame Score 4	Frame Score 5
5	33.75	35.75	37.75	39.75	41.75
6	34.50	36.50	38.50	40.50	42.50
205 Days	35.00	37.00	39.00	41.00	43.00
7	35.25	37.25	39.25	41.25	43.25
8	36.00	38.00	40.00	42.00	44.00
9	36.75	38.75	40.75	42.75	44.75
10	37.50	39.50	41.50	43.50	45.50
11	38.25	40.25	42.25	44.25	46.25
12	39.00	41.00	43.00	45.00	47.00
13	39.75	41.75	43.75	45.75	47.75
14	40.25	42.25	44.25	46.25	48.25
15	40.75	42.75	44.75	46.75	48.75
16	41.25	43.25	45.25	47.25	49.25
17	41.75	43.75	45.75	47.75	49.75
18	42.25	44.25	46.25	48.25	50.25
19	42.50	44.50	46.50	48.50	50.50
20	42.75	44.75	46.75	48.75	50.75
21	43.00	45.00	47.00	49.00	51.00
22	43.00	45.00	47.00	49.00	51.00
23	43.25	45.25	47.25	49.25	51.25
24	43.25	45.25	47.25	49.25	51.25
MATURITY CALVED AT 2	44.00	46.00	48.00	50.00	52.00
MATURITY CALVED AT 3	45.00	47.00	49.00	51.00	53.00

Continued from Page 270

to slaughter, then put more total pounds of red meat on the rail."

Yes, someday we may have cattle too big, but we are far from it right now. If you do not believe it, just stop by any feeder calf sale, feedlot or slaughter plant—we are still producing too many "shorty" type cattle and that must change.

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