Managing FAT

Iowa State University researchers offer insights as to how to best manage fat deposition.

*by **Gene Rouse** and **Doyle Wilson***

Beef cattle are an important link in the food chain, turning roughage and byproducts into highly digestible complete protein, energy, minerals and vitamins. Nearly half of the land in the United States is best utilized to produce forage as a conservation measure to prevent erosion, and much of that forage can be harvested only by ruminants. Two-thirds of the land in the world fits this same description.

Ruminants, especially beef cattle, can be made a more efficient link in the food chain by managing fat. As cattle grow, tissue develops in the following order: (1) organs, (2) skeleton (bones), (3) muscle, and then (4) fat.

A normal growth curve for beef cattle is shown in Fig. 1. This particular curve represents a feedlot steer that would be expected to grade Choice at 1,250 pounds (lb.). Cattle grow rather slowly initially, then most rapidly during the phase when they are depositing muscle. The rate of gain normally declines during the fattening process.

Fat deposition can be divided into four common types: internal fat, the fat surrounding organs; seam fat, the fat between the muscles; subcutaneous fat, the fat on the surface of the animal under the hide; and intramuscular fat, the fat within the muscle between the muscle fiber bundles (often referred to as marbling).

In beef, the seam fat, subcutaneous fat and internal fat are referred to as *waste* fat, while intramuscular fat is considered *taste* fat. The relationship between waste fat and taste fat and the inability to identify amounts of intramuscular fat in live cattle has led to inefficiencies in the beef cattle industry.

The 10:1 concept

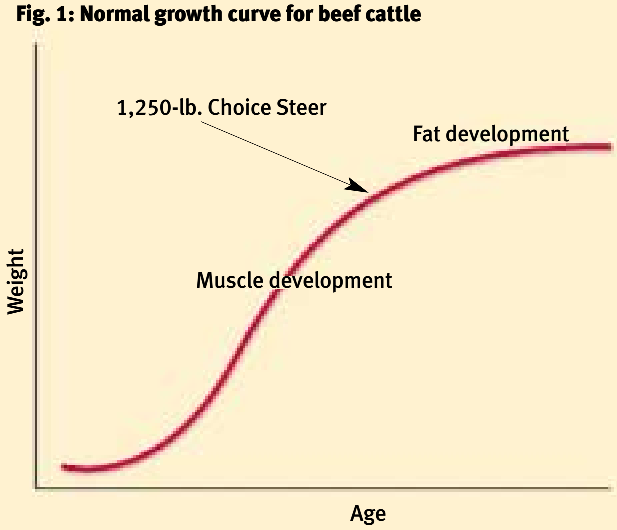
During normal growth of cattle in the finishing phase, 10 lb. of waste fat is deposited for each 1 lb. of taste fat. Fat cell numbers have most likely already been determined by this time, so "fattening" becomes a matter of filling up the existing adipocytes to maximize their size.

This concept is probably true for both subcutaneous and intramuscular fat deposition. However, there is some research indicating new populations of cells may be recruited for fat deposition — particularly that of intramuscular fat.

The 10:1 concept, coupled with the inability to know the existing level of taste fat relative to the amount desired, results in excess fattening by the beef industry.

Cattle producers and cattle buyers use their "well-trained" eyes to sort cattle for market based on subcutaneous fat, with very little knowledge or ability to determine the level of intramuscular fat, or marbling. If producers and buyers are concerned about quality grades, they may feed the cattle longer, particularly when the Choice-Select price spread is large, to try

Fig. 1: Normal growth curve for beef cattle



Source: Prepared by Gene H. Rouse and Doyle E. Wilson, Iowa State University.

Table 1: Carcass trait heritabilities and correlations

	CW	Marb	RE	Fat	%RP
Carcass wt. (CW)	0.30[1]	-0.04[2]	0.52	0.12	-0.13
Marbling score (Marb)	0.10[3]	0.36	-0.09	0.05	-0.07
Ribeye area (RE)	0.40	-0.04	0.27	-0.21	0.58
Fat thickness (Fat)	0.26	0.16	-0.10	0.24	-0.85
% retail product (%RP)	-0.28	-0.18	0.53	-0.81	0.24

[1]Diagonal elements represent trait heritabilities.
[2]Upper off-diagonals are genetic correlations.
[3]Lower off-diagonals are phenotypic correlations.

Table 2: Genetic parameters estimated from the Angus ultrasound data records

Trait	WT	IMF	REA	FAT	RFAT	%RP
Scanning wt. (WT)	0.57[a]	-0.09[b]	0.45	0.32	0.29	-0.23
% Intramuscular fat (IMF)	0.06[c]	-0.37	-0.05	0.20	0.17	-0.17
Ribeye area (REA)	0.46	-0.07	0.36	0.26	0.20	0.61
Rib fat thickness (FAT)	0.43	0.18	0.25	0.37	0.65	-0.44
Rump fat thickness (RFAT)	0.43	0.17	0.23	0.55	0.41	-0.45
Retail product (%RP)	0.27	-0.19	0.64	-0.41	-0.40	0.36

[a]Heritability estimates on the diagonal.
[b]Genetic correlations above the diagonal.
[c]Residual correlations below the diagonal.

to ensure that the cattle will grade better.

Contributing to the tendency to feed to heavier and fatter end points is the concept of selling pounds, with only small and uncertain premiums based on red meat yield. Cheap feed resources relative to replacement cattle costs also contribute to overfeeding.

The question becomes: How does the cattle industry provide adequate levels of taste fat without the added expense of waste fat? There is a way to achieve this; however, several concepts must be implemented:

- The genetic correlation or relationship between subcutaneous fat and intramuscular fat is low ($r_g \cong$ 0.2).
- Large numbers of yearling bulls and replacement heifers in the seedstock industry must be evaluated with real-time ultrasound for body composition traits, including subcutaneous fat and intramuscular fat.
- Ultrasound expected progeny differences (EPDs) for body composition traits need to be developed for a large number of seedstock bulls and replacement heifers.
- Beef carcasses must be priced for their individual meat based on retail product and quality grade.

Data from the American Angus Association carcass database, consisting of more than 50,000 carcasses, would suggest that the genetic correlation between subcutaneous fat and intramuscular fat in finished cattle is low, $r_g \cong 0.05$ (see Table 1).

Small relationship

Additional carcass data sets on other breeds would suggest a similar relationship. The "Angus Body Composition Genetic Evaluation Using Ultrasound Measures on Yearling Bulls and Replacement Heifers," which includes 85,951 head, relates a similar relationship (see Table 2). These ultrasound data substitute the genetic relationship between subcutaneous and intramuscular fat. The narrower age range and more clearly defined contemporary groups make genetic correlation estimates more accurate with this data set.

What does this relationship suggest and how can it be used to its best advantage in the beef cattle industry? The analysis of both carcass and ultrasound data indicates that the genetic correlation, or relationship, between marbling and subcutaneous fat is very low, indicating that the genetic control of these two fat depots is relatively independent for each one and controlled by different sets of genes. Therefore, it is possible to select cattle that will change the rate of intramuscular fat deposition relative to subcutaneous fat deposition.

Research results from the Iowa State University (ISU) Beef Cattle breeding project shown in Fig. 2 indicate that the rate of intramuscular fat deposition may vary markedly between progeny of different sires. Each line on the graph represents the pattern of intramuscular fat deposition for a sire. Each sire has at least 10 progeny represented at each of five serial scans to fit the line for each sire from weaning to yearling time.

Note that the change in percent intramuscular fat from weaning (220 days) to yearling (360 days) for sire A is compared to sire B. Sire A increases from 3.6% IMFat to 4.5% IMFat, or 0.9%, while Sire B increases less than 0.1%. The slopes of the lines for Sire A and Sire B are markedly different. Sire A is nearly linear from weaning to yearling, while Sire B appears to mature earlier, and the graph flattens as the progeny approach a year of age.

The data to develop Fig. 2 were obtained by scanning bull progeny at approximately 30-day intervals utilizing real-time ultrasound to determine levels of intramuscular fat. This research demonstrates that sires may dramatically differ in intramuscular fat deposition rate and pattern.

These same sires appear to deposit subcutaneous fat at a similar rate (see Fig. 3). These subcutaneous fat changes from weaning to a year of age were also determined by serial scans with real-time ultrasound.

Implementation

The authors recommend implementing the "managing fat concept" into each segment of the cattle industry as follows.

Seedstock sector: Identify sires and replacement heifers with the highest percent intramuscular fat (%IMF) and

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Fig. 2: Rate of intramuscular fat deposition among progeny of two Angus sires

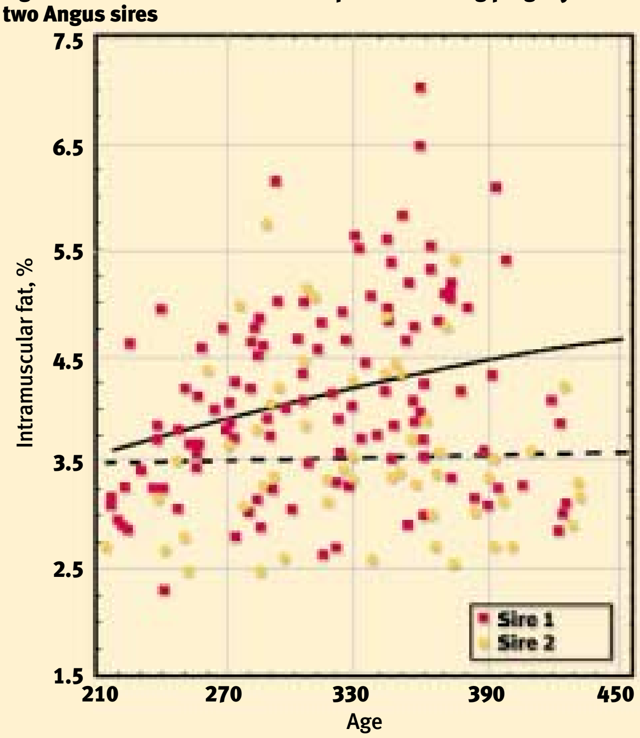
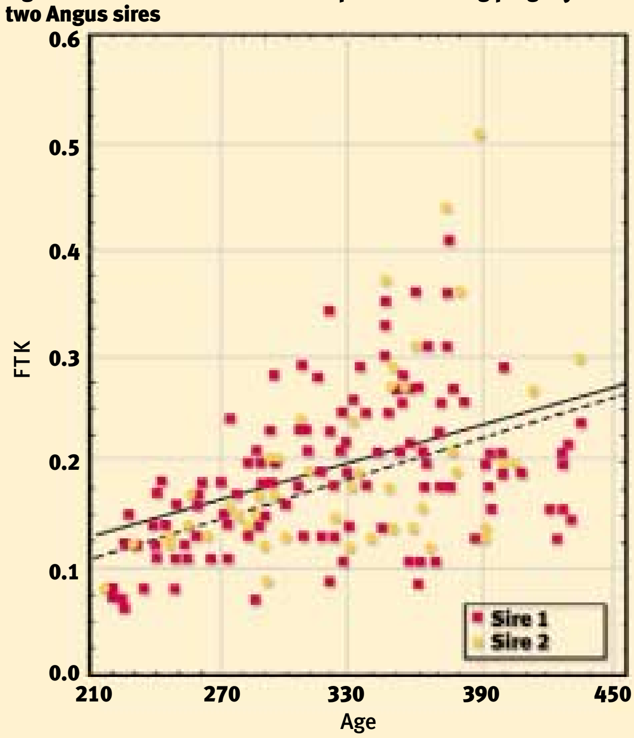


Fig. 3: Rate of subcutaneous fat deposition among progeny of two Angus sires



ribeye area (REA) EPDs that fit production and reproduction scenarios for commercial herds in your geographical region.

The subcutaneous fat EPDs, both rump fat and rib fat, are more difficult to know how to use in selection. Selecting against subcutaneous fat cover may have a negative effect on female fleshing ability and, thus, reproduction. Positive EPDs for fat cover suggest fatter body composition and perhaps earlier maturity. Faster-growing bulls will have heavier weights at 365 days of age and thus will be fatter; however, the fat thickness measurements are adjusted for both age and weight at yearling time.

It would be the authors' opinion that more emphasis be placed on EPDs for %IMF and REA than on the EPD for subcutaneous fat.

Because of the relationship between subcutaneous fat, REA and the retail product EPD, there is concern about how to use the retail product EPD in selection. Are we selecting for increased muscle or reduced subcutaneous fat? Can we tell what is driving the system? Perhaps we should be calculating body-composition EPDs and to a fat-constant end point (0.30 in.). Provided cattle have the genetic potential to "press adequate levels of intramuscular fat, subcutaneous fat can be managed. This concept will be discussed in feedlot implementations.

In 2001, %IMF, subcutaneous fat and REA will be determined with real-time ultrasound on 100,000 yearling seedstock cattle. EPDs for their body-composition traits are now reported on American Angus Association performance pedigrees, just like performance. Thirteen additional breeds are collecting ultrasound body-composition measurements on large numbers of yearling seedstock.

Commercial cow-calf sector. Utilize identified sons of bulls with the highest %IMF EPD and REA EPD within an acceptable frame-size window that meets production and reproduction specifications.

Allow breeds to complement each other — depending on production, reproduction and dictated product market.

Maintaining heterosis is important in the commercial segment of the industry. Cattle with desirable body composition must be identified in all breeds.

Feedlot sector. Identify feeder cattle of known genetic potential for body-composition traits and feed them to fit a given value-based market. Manage fat by grouping cattle based on their ability to deposit marbling then harvesting them when they have reached their targeted marbling level.

Figs. 4-6 show the concept of "managing fat in the feedlot." The first example, shown in Fig. 4, represents what normally happens in the industry today with industry-average cattle of unknown genetic potential for fat deposition. Cattle are normally very lean [0.1 in. subcutaneous fat] when put on feed, then deposit fat cover during the feeding period.

Figure 4: Relation between intramuscular fat and subcutaneous fat in a traditional system with industry-average cattle of unknown genetic potential for fat deposition

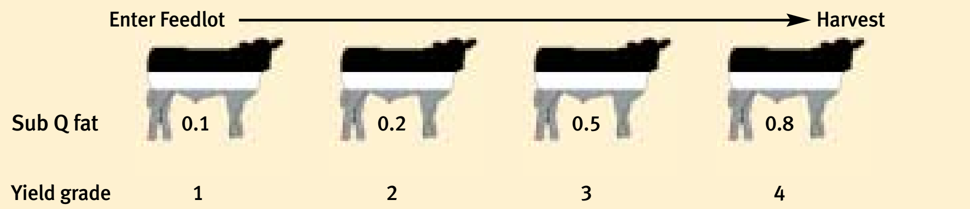


Fig. 5: Relationship between intramuscular fat and subcutaneous fat in a system possible today in which fat is managed

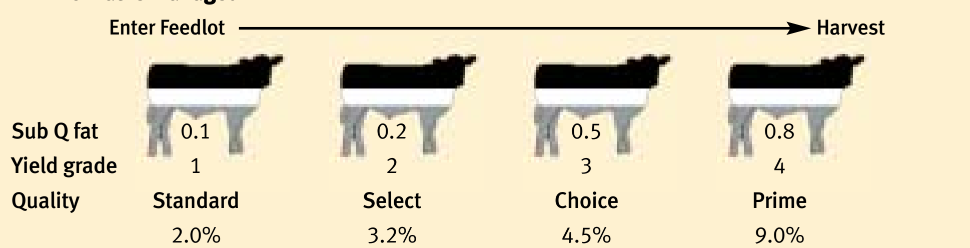


Fig. 6: Relationship between intramuscular fat and subcutaneous fat in a system possible in the future where fat is managed

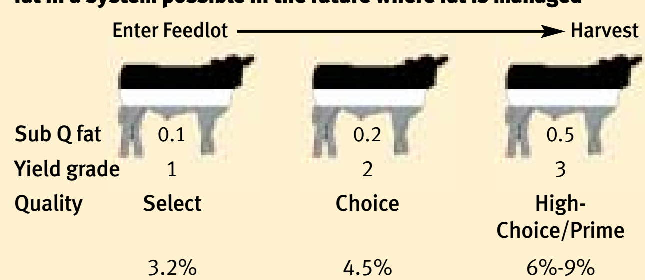


Fig. 5 indicates what could be the typical corresponding quality grades for a typical lot of feedlot cattle. Fig. 6 represents feeder progeny of sires that have been selected for increased marbling, while maintaining subcutaneous fat levels. Consequently "fat can be managed" to produce cattle with a desired level of marbling and less subcutaneous fat, essentially resulting in a shift in the relationship between the two fat depots.

Packer sector: Be able to evaluate objectively, and pay premiums for, quality and lean yield. Current methods to determine red meat yield and quality are very subjective measures. These systems need to become more accurate and more objective. Instrumentation is available to create this change. Longer premiums and discounts, particularly for retail product yield, will hasten implementation of the managing fat concept.

Implementing the managing fat concept will require coordination among industry segments. Perhaps the most difficult step in managing fat has been initiated by the widespread use of real-time ultrasound measurements to calculate body-composition EPDs in seedstock cattle, especially for intramuscular fat.