RESEARCH UPDATE

Getting Rid of Excess Fat in the Beef Industry

It is apparent that reducing fat without lowering the palatability of beef is a more complex issue than many of us have realized. Nevertheless, there are emerging technologies which may enable us to have our cake and eat it too.

It's been estimated that the total cost of excess fat to the U.S. beef industry is a staggering $4.4 billion: $2 billion to produce it and $2.4 billion to ship it and remove it. The 1991 National Beef Quality Audit revealed that excess fat production accounts for an average loss in value of $219 per carcass. Consequently, the industry's "War on Fat" has intensified since it was initiated by the National Cattlemen's Association Value-Based Marketing Task Force in August 1990.

Following are some potential strategies which may be used to reduce excess fat, traits that may be negatively affected by a reduction in fat, and new technologies that could enable the industry to circumvent such antagonisms.

POTENTIAL STRATEGIES TO REDUCE EXCESS FAT

Limit-Feeding

In Europe, restricted or limit-feeding is a common management strategy to produce leaner animals. However, this practice is more labor intensive, animals gain weight more slowly, and require a longer time to reach acceptable market weight. While limit-feeding has been successfully used in Europe, U.S. livestock producers have not found the system to be cost-effective enough to adopt it.

Minimize Emphasis on Dressing Percentage

As fed cattle become heavier, dressing percentage (untrimmed carcass weight — live weight) increases. Moreover, as fed cattle become heavier and older, an increasingly higher percentage of their gain is composed of fat. Percentage of trimmed carcass weight is a better measure of carcass value than dressing percentage and would tend to discourage the feeding of cattle to heavier weights and increased fatness.

ILLUSTRATION BY ROBERTSON & WOMACK

Less Time on Feed

As noted above, when time on feed is extended, much of the additional gain is composed of fat rather than muscle. In fact, in a 1990 Michigan State University study it was reported that during the last 55 days of the finishing period, 80 percent of the average daily gain of Continental-cross steers was composed of fat and only 20 percent was protein. Nevertheless, when finished cattle prices are high and feed prices are low, the potential for profit in the feedlot is enhanced by feeding to heavier weights.

Although feeding longer and to heavier weights may improve feedlot profits under this situation, fat production is increased and net return to the total industry is decreased.

Reduce Emphasis on Marbling

Intramuscular fat (marbling) is the primary determinant of quality grade because of its association with palatability; however, this relationship is not as strong as we would like it to be. For the time being, it is the only one we have. When cattle are fed to reach the degree of marbling (small) needed to grade Choice, significant numbers of them are overly fat. If a more direct and precise measure of tenderness could be developed to replace marbling, it would provide the industry with an incentive to reduce the production of excess fat.

Within-Breed Selection for Leaner Cattle

From the late 1960s to the late '80s, purebred breeders selected for faster-growing, larger-framed, later-maturing cattle, especially in the British and Brahman-influenced breeds. When these cattle are compared with small-framed, earlier-maturing cattle of the same weight, they produce a leaner carcass with less trimmable fat. But in order to grade Choice, the larger cattle must normally be carried to heavier weights at which point they are similar in fat thickness to their smaller contemporaries.

Even though lean retail yield is a moderately heritable trait, it would require a significant amount of time to change it by within-breed selection. It has been estimated that if breeders were to hold other traits constant and select for improved retail product yield alone, it would take nearly 15 years to change the population by one yield grade.

Feeding Bulls

If it were considered a universally acceptable practice by the industry, the single fastest means of producing leaner beef would be to feed out male calves as bullocks instead of steers. Research has shown that at the same age bulls are about one-third leaner than steers of the same genotype.

Interestingly, some researchers have demonstrated that this comes about because bulls deposit significantly more protein per day, not less fat, and that daily

fat deposition (grams/day) is essentially the same as in steer mates of the same breed. If bull calves are full-fed a high energy diet from weaning to slaughter and are marketed prior to 16 months of age, the palatability of the meat is not greatly different from that of their steer mates.

Nevertheless, the disruptive behavior of bulls in the feedyard and the risk of dark cutters, along with the difficulty of pulling their hides at slaughter have all contributed to their lack of acceptance by the North American beef industry. However, a few innovative cattlemen have been successful in developing niche markets for young, lean, palatable bullock beef.

Crossing Breeds

Currently, the next fastest way to produce leaner cattle is to cross British and/or Brahman influenced females with more muscular Continental bulls in a terminal crossbreeding program. Research has shown that large-framed Continental breed types are leaner because they deposit significantly more protein per day. Analogous to the bull-steer comparison, there is little difference between breed types in the grams of fat deposited daily.

From an operational standpoint, commercial cow-calf producers using a terminal crossbreeding program must have a means of either purchasing or somehow raising replacement females within their herds. This can become unwieldy, especially in smaller herds.

Anabolic Steroid Growth Promotants

Dramatic changes could be made in carcass composition if there were a biological means of simultaneously increasing protein and reducing fat deposition. More than 90 percent of U.S. feedyards implant their cattle with anabolic steroids. In addition to boosting gain and feed efficiency, these products increase the proportion of lean tissue when implanted cattle are fed to the same weight as non-implanted cattle. This is brought about primarily as a result of an increase in protein deposition.

There is evidence to suggest that fat deposition is suppressed slightly, but their principle action is to increase protein accretion. When fed for the same length of time, implanted cattle will be significantly heavier than non-implanted cattle with no increase in fatness.

Other Partitioning Agents

In addition to anabolic steroids, there are two other classes of partitioning agents which have been heavily researched in recent years —bovine somatotropin (BST) or growth hormone (GH) and the beta-adrenergic agonists (BAA). To date, these products have not been approved by FDA for use in food animal production.

They are referred to as partitioning agents because they have the net effect of partitioning nutrients in the direction of protein deposition and away from fat deposition. In a recent review of research, Bergen and Merkel (1991) reported that fat gain in cattle is reduced 20 percent by the administration of either BAA or GH and that lean gain is increased 20 percent and 10 percent by BAA and GH, respectively.

It was suggested that because their modes of action are not the same, a judicious combination of BAA and GH may provide the best overall strategy to produce lean, low-fat meat products. It is obvious that these powerful compounds have the potential to dramatically increase the lean-to-fat ratio of the carcass.

POTENTIAL NEGATIVE EFFECTS OF REDUCING FATNESS

Reproduction

Research has demonstrated that there is a tendency for leaner biological types of cattle to reach puberty at a later age, have reduced maternal fertility, and more calving difficulty (Cundiff, 1986; MacNeil et al., 1984). Although the correlations are not high, they are strong enough to indicate that several generations of selection for increased leanness/muscling could be detrimental to cow productivity. Because average generation interval for beef cattle is long (5 to 6 years/generation), this is not apt to be a major concern for the time being.

Maintenance

Biological types of animals with greater lean body mass tend to have a higher energetic cost of maintenance. In other words, it takes more feed energy to maintain lean, heavy-muscled animals than it does to maintain animals of the same weight that have more body fat and less lean (dry matter basis).

Differences in maintenance costs can be significant when you consider the fact that 71 percent of the dietary energy expended in producing beef goes for body maintenance and only 29 percent for growth.

Marbling

Research at the U.S. Meat Animal Research Center and elsewhere has shown there is a strong negative(-.73 average for all studies) genetic correlation between marbling and percent lean retail yield. This simply means that leaner carcasses tend to have less fat in all major fat depots -marbling as well as external, seam, and kidney, heart and pelvic (KHP) fat.

However, an analysis of Angus field data showed there was essentially no genetic correlation between marbling and external fat thickness.

It is known that all breeds have a few "outlier" lines of cattle that possess the genetic ability to produce sufficient marbling without becoming overly fat in other parts of the carcass. The problem is that these lines have not been adequately identified in most breeds of cattle. It has been suggested that simultaneous selection for leanness and marbling will be difficult if they are treated as separate traits, but the task could be made easier if degree of marbling at a given level of external fatness were the trait of concern.

Cold Shortening (Toughening)

If beef carcasses have too little external fat, they are more vulnerable to cold-toughening when they move from the slaughter floor into the chill room. Cold-toughening is caused by a shortening of the muscle fibers resulting from too rapid a rate of chilling. It is generally agreed that from 0.25 to 0.30 inch of external fat is needed to insulate the carcass and protect it from cold-toughening.

Carcass Shrink

A minimum level of fat is needed to prevent undue shrinkage as well as to enhance the shipping qualities of boxed primal and subprimal cuts. The lower limit appears to be approximately 0.20 to 0.25 inch of external fat.

Dryness

Extremely lean cuts of beef are prone to drying out and becoming less palatable when prepared with dry cookery methods (broiling and roasting) than is the case with cuts containing more marbling.

TECHNOLOGIES TO CIRCUMVENT ANTAGONISMS

Partitioning Agents

Use of partitioning agents on feedlot cattle could potentially enable the cow-calf

industry to keep moderate-size, easy-fleshing cow herds having reasonable maintenance requirements and high fertility. By using partitioning agents on the progeny of these herds, the feedlot industry could conceivably produce carcasses having a more acceptable lean-to-fat ratio.

Recombinant DNA Technology

Research is underway to identify the gene(s) responsible for marbling. If successful, it would enhance our ability to produce cattle having a sufficient degree of marbling together with an acceptably low percentage of fat in the remainder of the carcass. Even better would be the identification of the gene(s) directly responsible for beef tenderness.

Instrument Evaluation of Tenderness

Tenderness is the most important factor contributing to the palatability of beef. As noted before, marbling serves as an indicator of tenderness but the relationship is not very strong. A direct objective measure of tenderness via instrumentation would be an important breakthrough that could help ensure consistent palatability of beef.

Selection Against Calpastatin

Calpastatin is a compound present in muscle that inhibits the enzyme, calpain, which breaks down muscle proteins during postmortem aging. At high levels of calpastatin activity, beef muscle becomes tougher. Researchers at U.S. MARC reported in 1992 that calpastatin activity was highly heritable (.70) and was strongly genetically correlated (.58) with toughness. This suggests that it may be possible to improve beef tenderness by selecting against calpastatin activity.

Injecting or Marinating with Calcium Chloride

Recent research has shown that calcium chloride treatment of beef activates the calpain enzyme system, resulting in an improvement in tenderness. This can be accomplished by either one of two ways — injecting calcium chloride into primal cuts or by marinating steaks with calcium chloride. This technology is already being tested on a limited basis commercially.

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