Non-Genetic Factors that Affect Quality Grade of Fed Cattle

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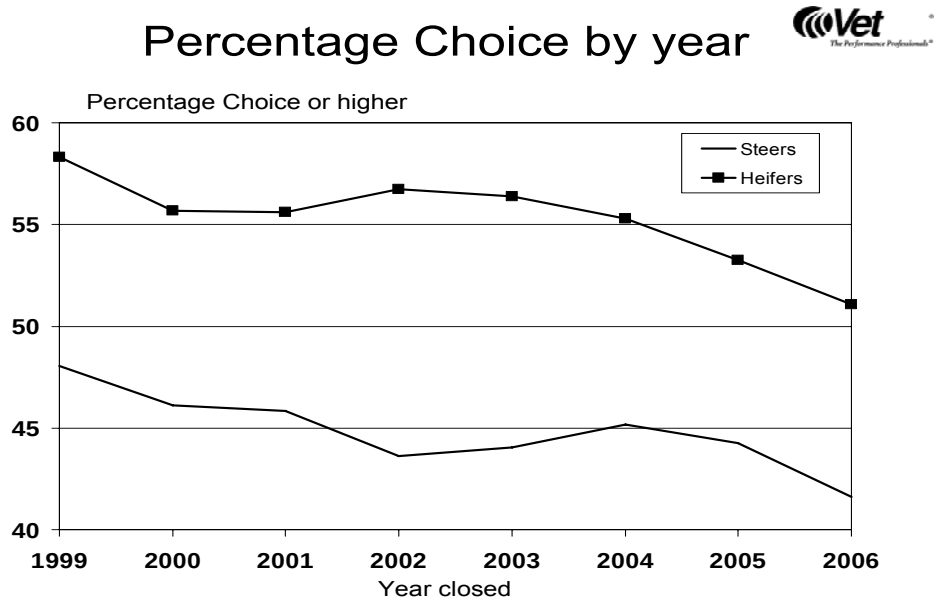
Introduction

Quality grade of fed cattle is an important economic trait since approximately half of US fed cattle are marketed through value-based systems where carcasses are priced individually based on quality grade, yield grade and other factors. Quality grade of young cattle is primarily determined by marbling, a complex biological trait that has multiple controls and is not well understood. Once the genetic capability of the animal has been determined, there are still numerous factors that can negatively influence the quality grade. Recent research has indicated that there are other influences that can positively influence grade as well.

Trends in quality grade of US fed cattle

The VetLife Benchmark Performance Program collects live performance, carcass and financial data from approximately 40% of all US fed cattle. The volume and diversity of the data provide an estimate of industry-wide results. Benchmark data allow more specific analyses than use of USDA or other sources because of the amount of detail collected.



The percentage of cattle grading Choice or higher in the Benchmark database has declined slightly since 1999. This has occurred despite heavier harvest and carcass weights and increased days on feed. During this time the percentage of carcasses receiving USDA yield Grades of 4 or 5 (overfat) has increased as well. All indications are that carcasses are heavier and fatter than they were a decade ago, yet USDA quality grade has not increased.

While percentage Choice and marbling score are the most commonly reported response variables in fed cattle research, the percentage of other quality grades should be considered as well; since both premium grades like Prime and CAB, and penalty grades like Standard and no-roll, greatly influence carcass value.

Non-genetic factors that affect quality grade

Non-genetic factors that affect quality grade will be grouped into four categories:

- Placement factors (demographics)
- Pre-feedyard nutrition, health and management
- Feedyard nutrition, health and management
- Endpoint

Within each of these categories, several factors that could potentially affect quality grade will be discussed. Another area of significance is post-mortem treatment and handling but that subject is beyond the scope of this paper.

Placement factors (demographics). Quality grade results differ based on sex, placement weight, and season fed. Below are carcass results from over 20 million steers and heifers fed since 2000 in the two largest Benchmark regions, the Central Plains and the High Plains. These regions include all of Kansas and Oklahoma as well as most of Texas and Southern Colorado. Most of these cattle were sold on grids, but cash (non-grid) cattle are included as well.

	Steers	Heifers	dif
Dressing percentage, %	64.1	64.2	0.1%
Hot carcass wt, lb	803	734	69 lb
Premium QG, %	4.8	8.1	3.3%
Choice or higher, %	42.8	54.0	11.2%
Penalty QG, %	6.3	4.6	1.7%
YG 1 or 2, %	64.5	57.2	7.3%
YG 4 or 5, %	4.0	6.7	2.7%
Dark cutters, %	0.5	0.7	0.2%
Light, %	0.6	1.6	1.0%
Heavy, %	3.8	0.5	3.3%

In terms of carcass value, approximately half of the differences between the sexes favor heifers. Differences that result in increased carcass value for heifers are underlined. On a population basis, heifers grade higher than steers with more premium quality grades and fewer penalty quality grades. Heifers also have fewer YG 1 and 2's and more YG 4 and 5's, indicating that they were fatter and less muscular. At least a portion of the higher grade of heifers is due to industry practice of feeding them to fatter endpoints than steers.

Placement weight of steers and heifers affects quality grade as well. In general, cattle placed at heavier weights grade lower than those placed at light weights. This is particularly true of cattle placed at 900 lb or higher.

In the Benchmark database, steers with placement weights of 500-599 lb graded higher than steers placed between 800 and 899 lb. Some caution is necessary when interpreting data of this type. It cannot be assumed that the genetic capabilities of the two populations are similar. The wisdom and experience of cattle producers influence decisions regarding management strategies for groups of cattle. There are reasons that some cattle are fed as

calves and others as yearlings and the objectives for the groups are not often the same.

With population data we can assess statistically whether two groups are different, and these are. What cannot be assessed is the causality of those differences. While results from 500 lb steers were different than from 800 lb steers, we must turn to research to determine if the variable that caused the difference in results was the initial weight or some other factor. In research, weight and age generally cannot be separated as variables so we are still left to decide on our own. While weight differences can be accounted for statistically using blocking or covariate analysis, age differences are typically unknown and unaccounted for.

	Placement weight of steers	
	500-599 lb	800-899 lb
Dressing percentage	64.3	63.8
Hot carcass weight, lb	774	833
Choice or higher, %	46.2	42.1
Premium grades, %	5.5	5.5
Penalty grades, %	6.1	6.5
Yield grade 4 or 5, %	5.0	5.5

While placement weight of feedlot cattle is easy to quantify, incoming age is not. Greater quality grade in 500 lb steers than 800 lb steers is not quite proof that younger cattle grade higher, but certainly can be used to oppose the common viewpoint that older cattle grade higher. On average, a population of 400 lb steers will be younger than a population of 800 lb steers at the time of harvest but the range within either population could be substantial. The practical application of this is that numerous people believe calves don't grade, proving that numerous people can be wrong. Research has shown that calves reach subcutaneous fatness endpoints at lighter weights and younger ages than cattle fed as yearlings. In other words, calves grade better!

The authors believe that feeder cattle are younger, although not lighter than they were 10 years ago and that youth has not contributed to poorer grade. Experiments at the University of Illinois provide strong evidence that youth does not necessarily inhibit grade. Early weaned (approximately 100 days of age) calves are placed directly on feed, consuming high energy diets, with no growing program. These cattle are harvested at approximately 1 year of age and regularly grade 90% Choice or higher with a high incidence of premium grades.

Another placement factor with a significant effect on quality grade is season. Quality grade of the US slaughter population follows a predictable seasonal trend. Grade is highest in January and February and lowest for cattle harvested in September and October. Several analyses of population databases have shown this to be true and Benchmark data indicate that both sexes and all weights behave the same way. Clearly, the effect is due to some seasonal aspect and not just changes in the demographic characteristics of the harvest population.

There are at least two seasonal factors that are likely to influence quality grade. The first of these is photoperiod. In all species, animals entering short daylight times of the year deposit fat and as they enter longer daylight periods they deposit more lean mass. The benefit of this pattern for survival is pretty obvious and it makes sense that it would occur in domesticated animals, even after generations of selection. A chart of percentage Choice of the harvest population would resemble a chart of the total hours of daylight that cattle were exposed to in

the four or five months prior to harvest. The same could be said of heat units, but experiments with controlled lighting and temperature have shown that seasonal effects on both reproduction and composition of gain are due to photoperiod, not heat. Also, Vitamin D has been shown in vitro to inhibit conversion of undifferentiated cells to pre-adipocytes. The conversion of undifferentiated cells to pre-adipocytes results in greater intramuscular fat when adequate energy is present, so preventing the conversion could limit marbling.

A less obvious factor might be the seasonal influence on pre-feedyard nutrition as reviewed by Berger (2005). Recent research has shown that Vitamin A also inhibits conversion to pre-adipocytes. Most cattle harvested during the low grading months spent time on lush pastures prior to entering the feedyard and consumed high levels of Vitamin A during that period. Cattle that are harvested during the high grazing months likely did not consume the same levels of Vitamin A during their growing phase. Depletion of high levels of stored Vitamin A requires about 100 days. The implication is that pre-feedyard consumption of lush forage, with its high Vitamin A content, combined with exposure to daylight (Vitamin D) while on feed, is a worst-case scenario for marbling. Heifers are slightly less impacted by the seasonality, adding credence to both theories. In other species estrogens and progestins have been shown to modulate gene expression in ways that could make females more tolerant of Vitamin A.

Pre-feedyard nutrition, health and management. An area of great interest in recent years is that of pre-feedyard health and nutrition and its affects on marbling of fed cattle. This is the result of a significant paradigm shift among scientists. Most of us were taught that marbling was a late maturing fat depot. After all other fat depots were about as full as they could get, the animal decided to deposit some marbling if there was any energy left over. This line of thinking placed great emphasis on the last 30-45 days of the feeding period as the time that most marbling deposition occurred. We now know that the situation is much different and that marbling can be deposited at any stage of growth. Marbling deposition can also be impaired at any stage of growth.

Key Point #1: Marbling deposition is a lifetime event, not just the late stage of the feedyard phase.

Key Point #2: Marbling is separate from subcutaneous fat. They are different tissues with different regulatory pathways.

Intramuscular fat (marbling) has been shown to result from a different embryonic tissue layer than subcutaneous fat (backfat). At birth, cattle have non-differentiated cells within their muscle that have at least three choices: turn into muscle cell nuclei, turn into fat cells, or do nothing. The various stimuli that determine which direction they go are not fully understood, but this is an active area of current research. What we do know is that those cells can be coerced to increase either the muscling or the marbling of the animal and that this coercion may occur at any time in the life of the animal. We also know that the signals that stimulate development of intramuscular fat cells, resulting in increased marbling, do not necessarily require high levels of empty body fat. In other words, the potential exists to preferentially stimulate marbling without making the cattle excessively fat.

Key Point #3: Any nutritional insult, at any time in the life of the animal, will reduce marbling.

Nutritional insults include drought, poor milking cows, etc. Research has shown that creep feed improves grade if the calves are on poor milking cows but not so much if the cows milk well. Corn-based creep improves marbling but not other energy sources. Use of feedstuffs that preferentially make glucose available to the

muscle can increase marbling to a greater extent than external fatness.

Health and Quality Grade. One of the strongest statistical relationships in the Benchmark database is a negative correlation between either death loss or medicine use, and percentage Choice. Those lots of cattle that have high morbidity and mortality invariably grade poorly, relative to the rest of the population.

Cattle that get sick often go off feed and expend more energy fighting the negative effects of the disease. This can result in reduced or even negative energy balance, even in the presence of a well formulated, highly palatable diet. This condition can persist for days or even weeks in individual animals. Cattle that are sick while on grass could lack the energy to graze and consume adequate energy. Data are limited on the relationship between pre-feedyard health (calves or stockers) and quality grade but it stands to reason that those cattle that suffer disease at any time in their lifetime could have an impaired ability to deposit marbling, regardless of how fat they ultimately get.

One source of lifetime data is the Texas A&M University and New Mexico State University Ranch to Rail Programs. Yearly summaries show similar results in terms of the effects of morbidity on ADG and profitability, but the effects on carcass traits are more variable. For instance, the 1999-2000 summary of the Texas A&M Ranch to Rail Program (McNeill, 2000) showed that cattle treated at least once for BRD had 31% fewer carcass grading Choice. However, data summarized by Waggoner et al. (2007) for cattle on feed from 2000 to 2003 indicated no differences in carcass grade relative to morbidity. Certainly changes in genetics and environment could explain a portion of the discrepancy between years, but a definitive explanation is not readily apparent.

Indirect evidence that poor health is related to reduced carcass quality comes from the Benchmark Program. Many Benchmark member feedyards assess the health risk of incoming feeder cattle. High risk cattle could result from all types of pre-feedyard stress but weaning, extended transit and evidence of disease are among the most likely causes. While these risk scores are arbitrary, we have confidence in the wisdom and experience of the cattle producers and death loss and medicine consumption data bear out that the cattle were indeed higher risk in most cases. Increased risk is associated with poorer grade, even when the cattle get straightened out and achieve carcass weights equal to or greater than the lower risk cattle.

	--Assigned health risk category--		
	Low	Moderate	High
500 lb steers			
HCW, lb	755	766	772
Choice or higher, %	52.1	46.7	44.0
600 lb steers			
HCW, lb	789	778	792
Choice or higher, %	44.6	43.2	38.7

We can't tell from these data which aspects of the high risk designation are related to the poorer grade. Numerous factors are likely involved.

Many nutritional insults are deliberate. Feeder cattle buyers have long preferred cattle that are at least slightly thin. Research has shown that thin cattle will often have compensatory gain during the early part of the feeding period,

which improves feed efficiency and lowers the cost of production in the feeding phase. Feeder cattle producers have responded by giving the buyers what they want – thin cattle, or at least not cattle that could be described as fleshy. While this industry-wide strategy is likely positive for feedyard performance, we need to study whether it has negative impacts on grade.

For example, Grona et al. (2002) determined that cattle classified as slightly- to very-fleshy had higher marbling scores than cattle that were leaner at the beginning of the feeding period. This supports early weaning research that shows that cattle placed on feed earlier will develop marbling sooner than cattle that are grown on diets with less energy concentration (Wertz et al., 2002 and Myers et al., 1999).

As discussed previously, management of body condition is used by most cattlemen to achieve various outcomes. Although research has indicated higher marbling scores for cattle that are placed on feed at an earlier chronological age or cattle that enter the feedyard with more condition, the effects of early condition on the lifetime marbling potential and subsequent feedlot performance is still not clear. Brethour, 2004 showed that carcass backfat is a poor indicator of carcass marbling score. In addition, backfat measurements taken 43 or 50 days prior to slaughter did not predict feedlot performance, ADG and F:G. Therefore, beef producers should not assume that body condition will not predict future feedlot performance, nor will body condition accurately predict the ability of an animal to grade Choice.

Feedyard nutrition and management. The primary reason that cattle are fed in feedlots is so that they can receive large amounts of high energy feed, in order to gain weight efficiently. By definition, feedlot diets are high in energy and 100 days or more of high energy feed results in fatter, more highly marbled carcasses and a product that consumers prefer. In general, the more energy cattle consume above their maintenance requirement, the fatter they will get. There are five ways to increase the cumulative quantity of energy available in excess of the maintenance requirement:

- Increase daily feed consumption.
- Increase the energy concentration of the feed.
- Increase the number of days fed.
- Improve efficiency of digestion or absorption.
- Lower the maintenance requirement.

Effects of Feed Intake on Quality Grade. Daily feed intake has shown mixed results on carcass traits in various research settings. Management strategies that limit intake have decreased quality grade and/or marbling score in feedlot cattle (Hicks et al., 1990 and Erickson et al., 2003). However, others have shown no difference in carcass characteristics when intake is deliberately restricted (Rossi et al., 2001) or between cattle that have low or high relative feed intakes (Castro Bulle et al., 2007). Variation in carcass characteristics among research trials demonstrates the inherent variability in cattle populations and their ability to express marbling. It should stand to reason that in order for cattle to express their genetic potential to marble they have to have daily caloric intakes adequate to sustain normal levels of growth. Recent interest in slick bunk management has again posed the question, 'will limited intakes; although slight, cause a change in quality grade?'

Using the Benchmark database, we assessed the importance of five performance parameters relative to percent USDA Choice: average daily gain, daily intake, feed conversion, final weight, and percent yield grade 4's. Seven hundred to 749 lb steers and heifers from the four largest Benchmark regions from 1996 through March 2007 were included. The results are summarized below.

Item	R^2
Average Daily Gain	0.0043
Daily Intake	0.0372
Feed Conversion	0.0055
Final Weight	0.0146
% YG 4	0.0039
Total Lots: 22,090	Total Carcasses: 3,484,149

It is clear that substantial variation exists in the population, and our ability to predict carcasses grading Choice relative to basic feedlot production parameters is poor. As managers of a diverse population we have to manage for the worst in the population to make sure the best in the population can express their genetic potential.

Increased processing of grain, such as steam flaking makes starch more available and is a common means of increasing the energy content of the diet. The effects of grain processing on carcass characteristics have been measured in numerous research trials. Most often as cattle are harvested at equal endpoints (e.g. percent empty bodyfat) they tend to have similar carcass traits (Brown et al., 2000 and Scott et al., 2003). Differences in energy concentration among diets and within grain sources are most often compensated by daily intake. Steam-flaking corn, compared to dry rolling, increases its energy content and improves feed efficiency by 10% compared to dry rolling (Owens et al., 1997). Improvements in feed conversion are also noted for steam-flaked sorghum and wheat compared to dry rolling but not for steam-flaked barley or oats (Owens et al., 1997). Although differences in feed efficiency are observed with various grain processing methods, the effect is determined by changes in intake, not changes in daily gain.

Different feed sources have been implicated as being detractors of quality grade. Duff et al., (2002) evaluated two steam-flaked grain sources, corn and sorghum, and found no differences in carcass traits of feedlot cattle between the two grain sources. In a recent analysis of published research (69 trials), it was determined that increasing level of metabolizable energy in beef cattle diets increases subcutaneous fat and KPH. No differences in other carcass traits were observed (Kreihbiel et al., 2006). Therefore, it may be assumed that cattle fed rations with higher energy will become fatter, but the increased energy content does not affect muscling, as indicated by ribeye area, or marbling score.

It appears that by providing the beef animal with nutritionally consistent feedstuffs at levels that enable them to gain at normal production levels their ability to marble is not limited nutritionally. Certainly differences exist in growth rate, but if cattle are harvested at similar endpoints there is no difference in marbling characteristics among differently processed grains.

Effects of implants and other growth promotants. Use of implants and other growth promotants in feedyards are an important consideration in quality grade. Implants are used in more than 95% of all fed cattle. With the exception of cattle fed for natural programs (and not all of them) it is safe to say that virtually all feedlot cattle are implanted at least once.

Research has shown that implants reduce quality grade in most studies. The VetLife Implant Research Database includes data from 325 published implant studies. These studies include 579 treatments groups in which ADG of implanted steers or heifers was compared to a

negative control, and 356 treatment groups in which percentage Choice was compared to a negative control. Across all treatment groups, the average increase in ADG due to implants was 16.2%, the average reduction in percentage Choice was 10.8 percentage units (i.e. from 65% Choice to 54.2%). Across a wide spectrum of use and practices, implants can have a negative impact on quality grade but many highly efficacious implant programs have only minimal effects on quality grade.

Percentage change vs. negative control
Published implant research

	ADG	Choice+
Number of comparisons	579	356
All steers or heifers	16.2	-10.8
Steers, no TBA	14.4	-8.7
Steers, TBA	20.2	-14.3
Steers, TBA < 200 mg	19.2	-4.3
Heifers, no TBA	10.2	-3.1
Heifers, TBA	12.2	-4.6

Source: VetLife Implant Research Database, 2007.

As usually happens though, the simplest answer can be somewhat misleading for three reasons. First, many of the implant treatment groups used in studies do not reflect what actually happens in the industry. Thus, using broad averages of studies could paint an inaccurate picture of what commonly occurs. For example, products containing 200 mg of TBA are used in only a small percentage of steers. When these products are excluded, the effect of TBA-containing implants on steers is only a reduction of 4.4 percentage units. Second, steers are disproportionately represented in study results. The negative effect on grade of heifers is less than steers.

Third, among commonly used programs, many studies did not employ management practices that could reduce the negative impact of implants on grade. Examples of these include altered nutrition, extended days on feed, etc. Research (Anderson, 1991) has shown that higher protein levels ameliorate the negative marbling effects of potent implants. In addition, several studies have shown that grade of implanted cattle can often equal that of non-implanted cattle if they are fed to greater weights.

Anderson (1991) calculated weight and days on feed differences required for animals implanted with multiple doses of TBA to reach marbling endpoints, relative to non-implanted animals (see below). Cattle used in this study were large framed, exotic crossbred steers, the type that were common in 1991 but can hardly be found today. In this work, cattle of that type required 235 lb more live weight to achieve an average marbling score of small 50.

Increased days on feed or live weight required to reach average marbling scores.

	Slight 50	Small 0	Small 50
Days	+2	+8	+15
Weight	+112	+174	+235

Source: Anderson, 1991.

Industry implant practices have changes only slightly in the past decade. The table below includes Benchmark data since 1999. To

smooth out year to year variation, each mean includes two years of data. While the number of implant doses per head has increased slightly during that time, it is largely a reflection of more days on feed. The number of days per dose has not decreased. While the percentage of cattle that receive TBA has increased, it is largely due to use of lower potency (intermediate dose) products. Thus when implant programs are scored according to potency (1 = no TBA, 2 = intermediate doses only, etc.) the average implant potency score has trended downward.

Industry implant practices:

	Two years beginning with…			
	1999	2001	2003	2005
Implant doses	1.85	1.96	2.09	1.96
Percentage TBA	90	94	95	96
TBA doses	1.13	1.21	1.28	1.29
Implant score	3.15	3.08	3.11	3.06
Days on feed	154	169	164	170
Days/dose	83.5	86.4	78.3	86.8

Source: VetLife Benchmark Performance Program, 2007.

In short, implants do reduce quality grade as commonly used, but the effect has probably not changed much in the past decade. The key to minimizing implant effects on quality grade is to look for favorable risk:reward trade-offs. Here are some examples:

- TBA has almost no effect on grade in heifers and multiple doses of TBA have only a small effect. Heifers can be aggressively implanted for performance with limited effect on grade. The same is not true in steers.
- Programs containing 120 mg of TBA products in steers deliver near-maximum performance with only moderate effects on marbling.
- Delayed implanting may result in increased marbling in some production situations but can result in reduced performance if not tightly managed.

As a rule, implant potency should be matched to the genetic capability of the animal to deposit muscle, and the energy consumption above maintenance. Moderate potency implants should be used for low consuming cattle or those with high maintenance requirements due to disease, weather, etc.

Nearly all U.S. heifers are fed melengestrol acetate (HeifermaX® or MGA®) because the estrus suppression and improved behavior make management of heifers much easier and provide excellent economic return. In the most recent research, representing the average result in 13 studies, melengestrol acetate increased ADG by 7.9% and improved feed conversion by 4.3%. Hot carcass weight (HCW) was 18 lb heavier for treated heifers and they had 4.5% more Choice or higher grading carcasses. The improvement in quality grade is greater than would be predicted by carcass weight alone, suggesting that grade is preferentially improved. The percentage of feedlot heifers that received melengestrol acetate is very high (estimated at 85-90%) and has not changed much in the past decade.

	ADG	F/G	HCW	Choice+
Control	2.95	6.52	674	65.3
Melengestrol acetate	3.18	6.24	692	69.9

An industry practice that has changed in the past few years is use of the beta-adrenergic agonist, ractopamine (Optaflexx®). Ractopamine is a potent muscle growth stimulant that is typically fed for the last 28 days of the feeding period. HCW is increased by 14 lb, on average with ractopamine and it is reasonable to ask whether that could result in reduced marbling or quality grade. A series of published studies indicates that marbling score of steers or heifers is unaffected by feeding 200 mg per head per day of ractopamine (see below). The same may not be true of other beta agonists with greater potency.

Marbling scores of steers or heifers fed Optaflexx or control diets:

	Control	Optaflexx	SEM	P
Steer studies	495.8	495.4	3.6	NS
Heifer studies	503.7	501.0	6.4	NS

Corn co-products. Another industry practice that has changed is feeding of corn co-products generated by the ethanol industry. Co-products could potentially affect marbling because they are: high in NDF (negative for marbling), high in fat (-), palatable (+), and comparatively inexpensive (+). The site of digestion and profile of metabolic products could result in reduced glucose availability to the muscle and thus less marbling, despite equal or greater fatness.

Co-products have received a great deal of scrutiny regarding their potential negative effects on marbling but as often happens, the truth is too long to fit on a bumper sticker. Reinhardt and DiCostanzo (2006) reviewed 21 studies which included 106 co-product treatment groups and provided the following summary relative to carcass quality:

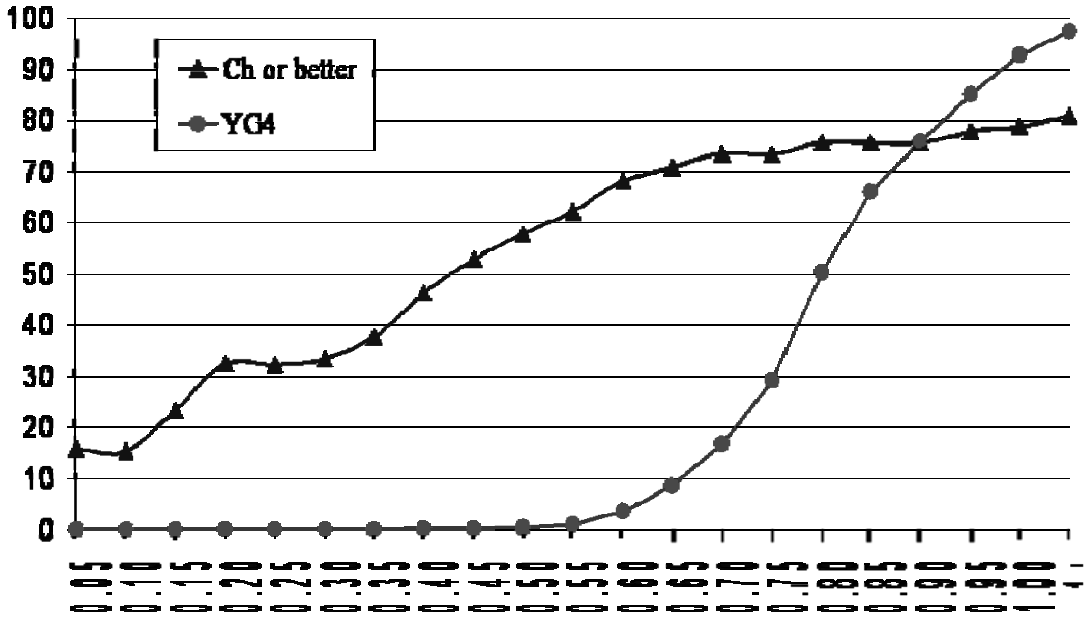
- At low yield grade endpoints (low energy or lean cattle) co-products reduce marbling at any inclusion level.
- At an endpoint of yield grade 3, co-products have no effect on marbling up to 20% inclusion rate.
- At high yield grade endpoints (high days on feed, early-maturing cattle or heifers) co-products increase marbling at low to intermediate inclusion rates.

It is uncommon, but not unheard of, to feed more than 20% of the diet as co-products. In addition, plant to plant variation, differences between wet, dry and modified sources, etc. make blanket statements regarding co-products dangerous at this point (except that one).

Endpoint selection. As cattle fatten, subcutaneous fat increases in a fairly predictable manner. While marbling is highly correlated with external fatness, neither can perfectly predict the other. In addition, since quality grades are based on marbling thresholds, percentage Choice does not increase in a straight line, either with increased weight or increased external fatness. The chart below, from Lawrence et al., 2001, displays the relationship between fat thickness (horizontal axis) and percentage Choice or percentage yield grade 4 (or 5). These data are taken from individual measurements of over 65,000 steer carcasses.

In this data set, as fatness increased to around .65 inches, grade increased in more or less a straight line. Beyond that level of fatness grade continued to increase, but at a slower pace. At no level of fatness were all of the carcasses (or none of them) Choice. Fatness alone will not guarantee grade. YG 4's were nonexistent at fat thickness below .5 inches and at .8 inches, 50% of the carcasses were YG 4's, as the yield grade equations would have predicted.

Depending on the premiums and discounts in a given system, carcass value would be maximized at approximately 0.6" of average fatness. Feeding cattle to a fatter endpoint would increase grade but any increases in value would be likely offset by a poorer yield grade profile. The average fatness can be misleading since the range is as important. Carcass value will probably be maximized if most carcasses within a group have between 0.4" and 0.6" of external fat. Recent data from the Certified Angus Beef® program indicate that if premium grades receive a high premium, the ideal range could be slightly fatter. In any system, narrowing variation and getting more carcasses near the mean will increase value.



Summary

Among commonly measured traits in beef cattle production, marbling has about the poorest relationship between understanding and economic importance. Many factors contribute to an animal's ability to express marbling. The current feeding environment includes high grain and roughage prices, extremely volatile markets, strong consumer demand for high quality beef products but slowing demand for mid and low quality products, and international trade limitations. In this environment, producers and managers have to be aware of how changes in management and selection affect the beef business as a whole.

Since marbling deposition is a lifetime event, all segments of the industry will have to focus on quality in order to make significant progress. Research has shown that early weaning and consumption of diets high in concentrates will increase marbling. The health status of cattle, especially early in the feeding period, appears to

have an effect on performance and carcass characteristics. Growth promotants can affect marbling, but the effects are dependent upon sex and dosage of the product. Endpoint selection influences quality grade, yield grade, and other economically important carcass traits.

The complexity of marbling allows some opportunity. While traditional wisdom states that marbling can be reduced by negative lifetime events but not increased, recent research indicates that opportunity exists to increase marbling. This should be an active area of future research.

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