Against a Stacked Deck

White paper reviews factors reducing marbling deposition in beef cattle.

*Compiled by **Larry Corah** and **Mark McCully***

Considering all of the factors that combine to reduce marbling deposition in cattle today, it is no wonder *Certified Angus Beef*® (CAB®) acceptance levels are on the low side. Most of these factors relate to management and environment rather than genetics, but confronting them should help to overcome their negative effect.

Fig. 1: Percentage of A-stamped cattle accepted into the CAB® brand

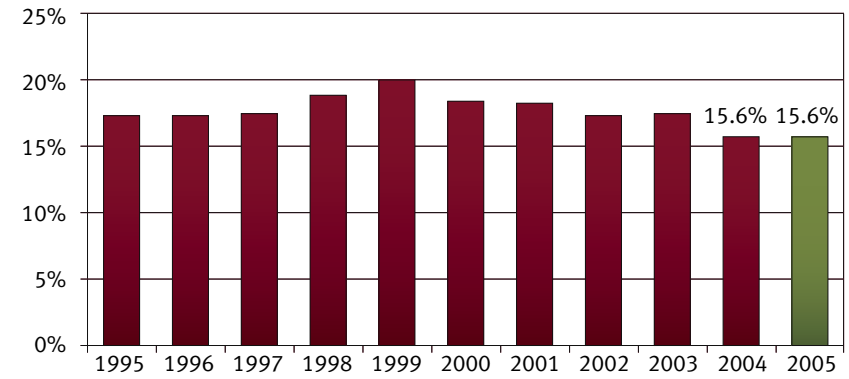


Fig. 2: USDA Yield Grade 4 beef as a percentage of the total graded, 1985-2004

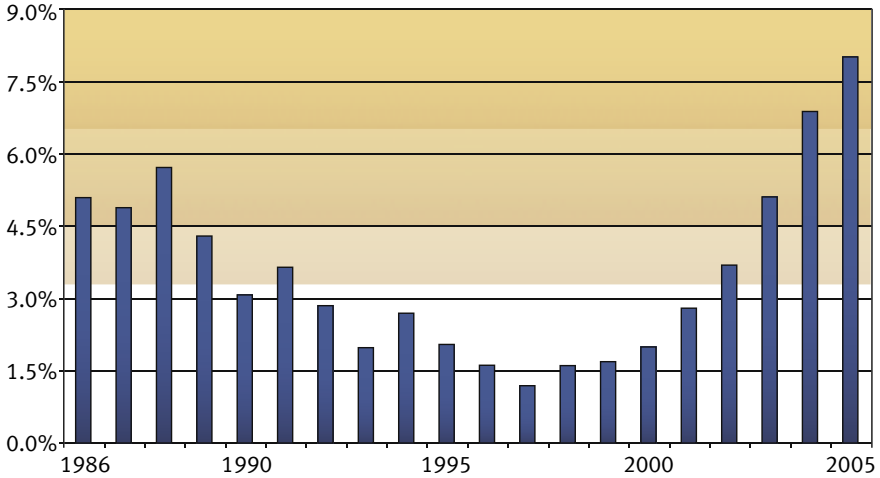


Fig. 3: Percentage of carcasses falling near Choice-Select grade breakpoint

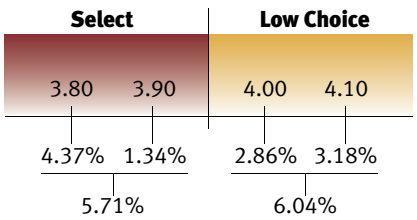
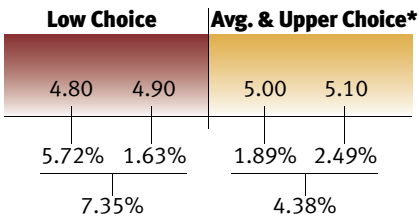


Fig. 4: Percentage of carcasses falling near Choice-CAB® grade breakpoint



*YG 1-3 are CAB® eligible.

That's why CAB Supply Development created the white paper, "Declining Quality Grades: A Review of Factors Reducing Marbling Deposition in Beef Cattle," now available on the Web at *cabpartners.com/news/whitepapers*. A more reader-friendly version is provided here.

Marbling and eating quality

Three factors govern consumer acceptance of beef — tenderness, flavor and juiciness. All add to the eating experience in their own way. Consumers want some tolerable level of tenderness, but the overriding factor behind the desire to eat beef is its unique flavor.

Meat flavor has been extensively researched, and the flavor profile by animal species is well-understood. Beef's unique flavor and aroma come from the carbonyl compounds found in marbling. That's why, as quality grade increases from USDA Standard to Prime, flavor intensifies and improves.

The problem is quality grades are in decline. In 1986, nearly 97% of federally graded cattle were Choice or Prime, but in 2005 that had declined to 60%. The related decline in consumer demand was only reversed by the influence of premium brands and utilization of new cuts and products in the past eight years.

It's true that only part of all fed cattle were graded in the 1970s and 1980s; many carcasses that would be called Select today went through as "no rolls." Today, very few steer and heifer carcasses are not federally graded. The 2005 National Beef Quality Audit (NBQA) adjusted for those factors, but still showed a 1-percentage-point decline in Prime and a 6.2-percentage-point decline in Choice, comparing 1975 to 2005.

Recent VetLife Benchmark data (see Fig. 9, page 137) shows the same magnitude of downtrend in those quality grades in the past seven years. These data also illustrate the marbling advantage of heifers, although the percent of heifers in the harvest mix trended lower over that time.

Moreover, many thousands of cattle fail the industry's new dentition maturity test. That alone may account for 1.5 to 2 full percentage points of CAB acceptance. To capture this "over-30-month" CAB product, packers would have to create separate fabrication breaks and product codes, adding costs that cannot be recouped.

On the line

The peak CAB acceptance year, 1999 (see Fig. 1), coincided with the lowest levels of Yield Grade (YG) 4 and 5 carcasses (see Fig. 2), which are not allowed into the brand. Since then, CAB acceptance rates have declined while finished cattle violated the YG 4-5 line and expressed less marbling.

In 2004, CAB worked with all major packers to characterize Angus-type cattle in the harvest mix. Marbling scores, to the nearest tenth, were determined on 26,707 carcasses. A marbling score of 4.00 equates to a Small degree of marbling, qualifying for low-Choice. A marbling score of 5.00 equates to Modest marbling, the minimum marbling requirement to qualify for the CAB brand.

What stands out is the great numbers of cattle that — with a slight "tweak" from management, nutrition, health or genetics — easily could have improved grade and realized premiums (see Fig. 3). For example, 61.33% of all carcasses graded Choice, but 6.04% had a marbling score of 4.00 to 4.19, meaning they easily could have changed the portion grading Choice to 55%. However, a nearly equal percentage of Select-grading cattle could easily have become Choice with the right genetics and management.

Of the Choice cattle, 7.35% scored 4.80-4.99, almost on the line for CAB acceptance (see Fig. 4). If all such cattle advanced slightly, the current 15% CAB acceptance rate would be 22.5%. On the negative side, 4.38% were scored 5.00-5.19 for marbling, and if they had slipped across the line without any advancement from the other cattle, the CAB acceptance rate would be only 10%.

The economics

In spite of all-time-high beef prices, consumer demand for the best has resulted in distinct price differentiation between quality grades. That showed first in the dramatic spread between Choice and Select cutout values. In the early 1980s, that spread was typically $3-$4 per carcass hundredweight (cwt.). The spread increased to $7 per cwt. in the 1990s, and it averaged near $10 per cwt. for 2004-05.

The evolution is further illustrated by the spread between Choice and CAB, as now reported by Urner Barry and Cattle-Fax. Consistent throughout the year (see Fig. 5), that spread ranges from $6 per cwt. to $10 per cwt. of boxed beef. Net prices are affected by seasonal variation in overall supplies of higher-quality cattle.

As the percentage of cattle marketed on a grid increases — now at 40%-50% and expected to hit 70% predicts Cattle-Fax — the economic importance of quality grade grows. Today, the spread between a Select carcass and a CAB-qualifying carcass of the same weight is $150-$200.

Anyone would wonder why there is a drop in marbling scores despite market incentives. Increasing health problems may be a primary factor.

Declining health

Iowa State University research published in 2004 showed the striking effect of health on quality grade. Calves treated two or more times for bovine respiratory disease (BRD) had a 44% reduction in Prime-grading carcasses, 33% fewer Premium Choice and an 18% drop in ability to grade low Choice when compared to healthy calves.

With all of our technology, greater cooperation and a rise in preconditioning of calves, you might think feedlot death losses are on the decline. That is not the case.

A 13-year (1992-2004) evaluation of Kansas feedlots showed an annual trend of increased death loss in both steers and heifers. It was linked to a decrease in placement weight, and there were consistent seasonal variations, with April and May closeout months having the highest death losses. That coincides with a wave of calves going straight from the cow to the feedlot in the fall.

Vetlife Benchmark Performance Program data support these results (see Figs. 6 and 7), showing a seven-year increase in veterinary medicine costs per head and mortality, with only 2002 defying the upward trend.

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Fig. 5: Boxed beef premiums over USDA Select, 2004-2005

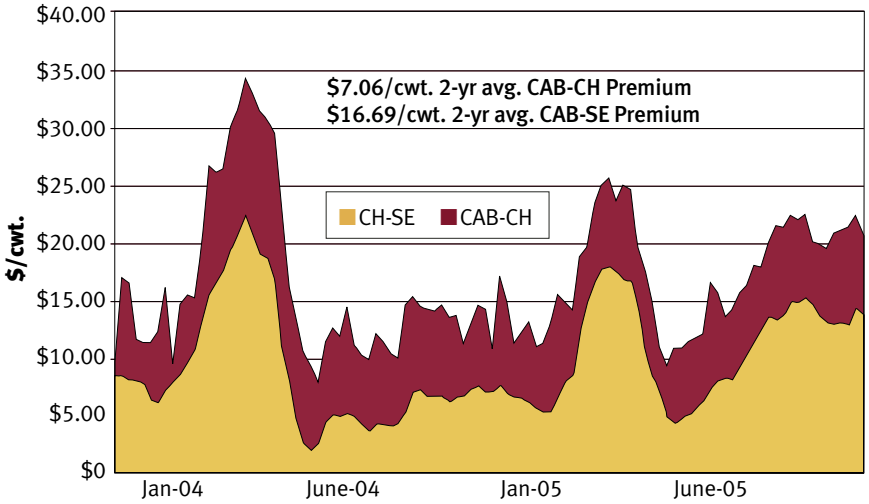
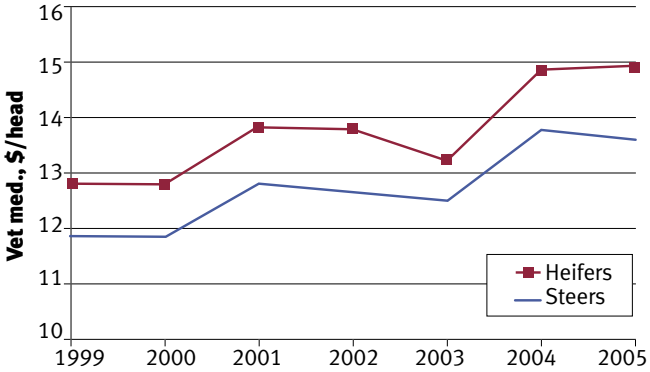
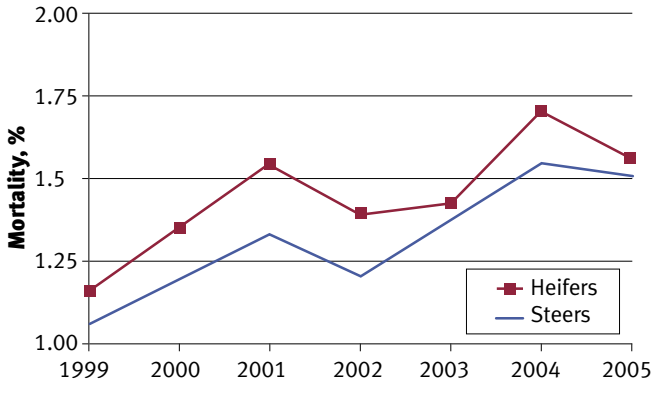


Fig. 6: Veterinary medical expense, $, for steers and heifers, by year



Source: Vetlife Benchmark Performance Program.

Fig. 7: Mortality of steers and heifers, %, by year



Source: Vetlife Benchmark Performance Program.

Again, the only documented reasons for this are lighter placement weights and the consistent annual trend of feeding younger cattle. Those may be compounded by the feeding industry consolidation that reduces the labor-to-cattle ratio in the larger feedyards. Health management of calves in particular may be compromised.

Ethanol's mixed blessing

From a small cottage industry of 175 million gallons (gal.) in 1980, the ethanol industry has grown to produce 3.9 billion gal. in 2005. It has grown 265% since 1999, mainly in Nebraska, South Dakota and Iowa. By 2015, the industry expects to produce 9.8 billion gal., and 14.6% of the 2005 corn crop was already used for ethanol production.

Along with this growth came the availability of ethanol coproducts such as distillers' dried grains, corn gluten meal and wet distilled feeds. Most Nebraska feedlots with more than 2,000-head capacity feed some ethanol coproducts, with average dietary inclusion estimated at more than 20% on a dry-matter (DM) basis.

It is often cheap and relatively good feed, but there are tradeoffs, including slightly negative effects on grade. A review of 13 studies that included wet or dry distillers' grain at varying levels, using YG as a covariate, found a decline in marbling (see Table 1).

Maybe that's because of the lower level of available starch in distilled products as compared to corn. Feedlot performance is generally not reduced, but the lower level of starch digestibility could affect marbling adipocyte differentiation.

Concentration

The past 35 years have seen a complete relocation of the cattle feeding industry and a distinct change in the size of feedlots. In 1970, 40% of the cattle were fed in the four Midwest states of Iowa, Minnesota, Illinois and Indiana, while Texas fed 14.4%. Today, the four Midwest states combined feed 16%, while Texas feeds 26.1%.

Besides location, size has increased. Ten years ago, a 60,000-head feedyard was rare. That's not so today. Those with more than 32,000-head capacity feed 2% more cattle each year. They already account for more than half of all cattle fed.

That trend is not friendly to net beef quality. The CAB Feedlot Licensing Program (FLP) database, classifying yards by size, shows those with more than 20,000-head capacity had a 41% reduction in CAB acceptance rate compared to smaller yards (see Table 2). There also was a 20-percentage-point reduction in cattle grading Choice or higher.

Part of the reason could be that smaller yards are mostly in Iowa and Nebraska, and tend to focus on higher-quality cattle. The larger yards of Kansas and Texas are more likely to try upgrading mismanaged or poorer-quality cattle.

A more logical reason may relate to larger yards' almost exclusive use of steam-flaked grain. Smaller yards use rolled or cracked grain and almost always feed corn. A review of 552 studies in the 1999 American Society of Animal Science (ASAS) proceedings showed the significant effect of flaking on quality grade (see Table 3). Grain type also had an effect (see Table 4).

The work suggested these effects might relate to a shift in the site of digestion. The yield grade change may be due to less ruminal escape of dietary starch. Reduced quality grade for cattle fed milo may be related to lower starch availability.

The effect of steam flaking on marbling is not fully understood. More ruminal starch digestion should increase the organic acids that are later converted to glucose, a precursor for marbling. Steam flaking was shown to increase ribeye area, but not

Fig. 8: The "window of opportunity" for marbling

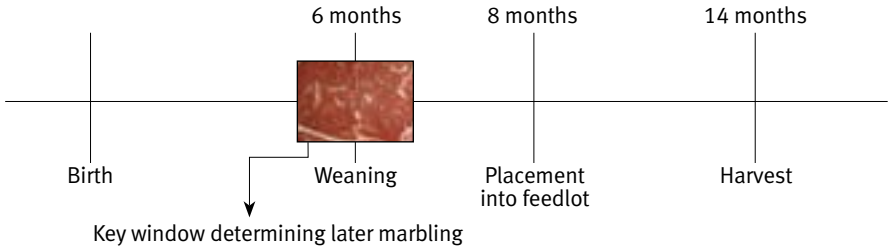


Table 1: Effect of dietary level of distillers' grains on yield grade

Distillers' grain level, DM basis	Marbling score*	Calculated YG score
None	5.55[a]	2.96[a]
1%-15%	5.49[a]	3.08[b]
16%-29%	5.46[a,b]	3.05[b]
>29%	5.35[b]	3.06[b]

[a,b]Differing superscripts in same row (P<0.05).
*Quality Grade: 4.00 = Slight degree of marbling, 5.00 = Small degree of marbling, etc.
Source: Chris Reinhardt, Kansas State University.

Table 2: Percent grading Choice and CAB acceptance rate by feedyard size

Size classification	No. cattle	% Choice and above	% CAB®- accepted
<10,000	41,078	77.0	27.0
10,000–20,000	21,030	74.0	27.8
>20,000	77,518	57.8	15.8

Source: CAB Feedlot Licensing Program (FLP) database.

Table 3: Effect of grain processing method on performance and carcass traits

	Whole-grain	Dry-rolled	Steam-flaked
ADG, lb.	3.15[a]	3.12[b]	3.48[b]
HCW, lb.	708[b]	713[b]	737[a]
Feed/gain*, lb.	6.37	6.37	5.43
Marbling score**	5.12[a,b]	5.24[a]	4.82[b]
REA, sq. in.	12.3[c]	12.6[b]	13.1[a]
Yield grade	2.75[a,b]	2.69[b]	2.85[a]

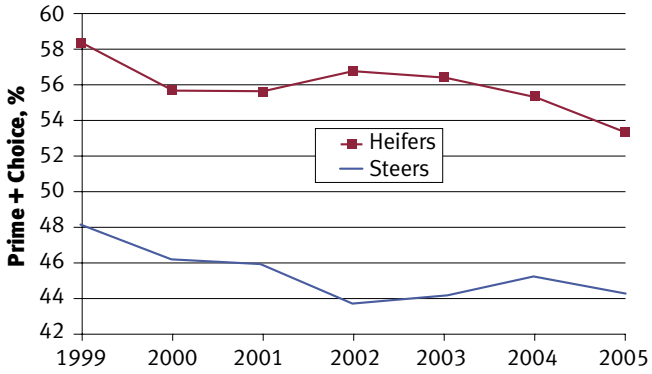
[a,b,c]Differing superscripts in same row (P<0.05).
*Recalculated from the authors' gain/feed for consistency in this paper.
**Quality Grade: 4.00 = Slight degree of marbling, 5.00 = Small degree of marbling, etc.
Source: Ownes and Gardner, 1999 ASAS proceedings.

Table 4: Effect of grain type on performance and carcass traits

	Corn	Milo	Wheat
ADG, lb.	3.26[a]	3.15[a]	3.26[a]
Feed/gain*, lb.	6.06[a]	6.49[b]	5.65[a]
Marbling score	5.12[a]	4.99[a]	4.98[a]
Yield grade	2.72[b]	2.92[a]	2.86[a,b]

[a,b]Differing superscripts in same row (P<0.05).
*Recalculated from the authors' gain/feed for consistency in this paper.
**Quality Grade: 4.00 = Slight degree of marbling, 5.00 = Small degree of marbling, etc.
Source: Ownes and Gardner, 1999 ASAS proceedings.

Fig. 9: Percent grading Prime and Choice, by year



Source: Vetlife Benchmark Performance Program.

relative to carcass weight, and it's possible that increased muscle area actually dilutes marbling. Fewer days on feed from the faster gains on a steam-flaked ration could also reduce marbling.

What if both distillers' coproducts and flaked grain were included in the same ration? Work at the University of Nebraska using rations of 30% wet distillers' grain (DM basis) and varied by grain processing method for the rest of the corn ration (61.4% DM basis), showed combinations quite detrimental to marbling deposition (see Table 5).

Where marbling begins and ends

Once considered a feedlot-phase phenomenon only, evidence now shows marbling is a lifetime event. As cells proliferate in early fetal development, they start to differentiate into either muscle or fat cells. Many physiological factors control this, but androgen and similar endocrine factors exert a great influence. They promote muscle and inhibit adipose conversion. Genetics and nutrition are other keys in early development.

Upon birth, these cells continue to specialize. The earliest pre-adipocytes differentiate into subcutaneous fat or intramuscular fat (marbling) cells. Nutrition affects the outcome. If the diet contributes high levels of acetate, subcutaneous fat cells develop, while propionate-to-glucose availability stimulates marbling cell formation. For those animals destined for harvest, this process ultimately determines the quality grade of the carcass.

Recent research in Illinois, Ohio and South Dakota adds credence to the idea that marbling development is a lifetime event. Weaning time seems to be an especially critical period in a calf's life because of the management events and potential stress (see Fig. 8).

Management strategies at that time — early weaning, creep feeding, delayed implanting and maintaining health — all contribute to the subsequent quality grade and level of CAB acceptance.

At harvest, most cattle are marketed at a compositional target of 0.4-0.8 inch (in.) of external fat cover to optimize quality and yield grades. However, based on nearly 140,000 cattle in the FLP database, marketing below 0.5 in. of fat cover reduces marbling level and CAB acceptance rates (see Table 6, page 140).

Table 5: Effect of corn processing method in finishing diets containing wet distillers' grain on cattle performance

	Grain processing method		
Trait	Dry-rolled	Whole	Steam-flaked
ADG, lb./day	4.05[a]	3.85[b]	3.59[c]
Feed/gain	5.68[a]	6.07[b]	5.76[a]
Quality grade:			
% Choice or higher	63.5	60	48.3
% Premium Choice	29.4[a]	23.3[a]	6.7[b]
Marbling score*	5.40[a]	5.34[a]	4.96[b]
Yield grade	3.62[a]	3.49[a]	3.22[b]

[a,b]Differing superscripts in same row (P<0.05).
*Quality Grade: 4.00 = Slight degree of marbling, 5.00 = Small degree of marbling, etc.
Source: Vander Pol et al., University of Nebraska, 2006.

Implant strategy

Growth-promoting implants are some of the most cost-effective tools used by beef producers to improve feedlot performance. Documented equally well is the negative effect of implanting on quality grade. Research in South Dakota and Nebraska shows that the percentage of cattle grading Choice and higher can be reduced by 15%-20%, with the percentage of CAB-accepted cattle being reduced by 8%-10%, by aggressive implanting. Increased feeder calf cost and high breakeven prices have likely increased implant frequency and potency used over the last few years.

Can the negative effect be at least partially offset? Research offers some possibilities.

Delay implanting. A consensus of studies suggests waiting to implant can improve marbling without losing the performance benefits. On the other hand, the research says implanting used early in the feedlot phase, at the start of the growing period, or even preweaning may negatively affect the cellular differentiation process, reducing marbling adipocyte formation or growth.

Delaying the implant by 30-50 days at the start of the feedlot phase can improve quality grade without significant effects on growth rate and feedlot breakevens, according to South Dakota State University (SDSU) work.

Delaying or even foregoing an implant during the growing phase is another opportunity to improve quality without risking gain. Research has shown such strategies had little or no effect on an animal's total weight gain (growing and feedlot), while improving marbling potential.

Nebraska research supports the advantage of avoiding implants prior to weaning. Implanting at a preconditioning or preweaning phase may also depress later weight gain responses to implants during

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the growing and feedlot phases. The effect of preweaning implants on subsequent marbling levels and quality grades has been variable, but heifers may be most affected.

Reduce number. There are a couple of ways to avoid the negative implant effect on carcass quality, yet receive the growth benefits. Besides limiting or avoiding use during the preweaning and growing phases, producers can limit the number of times feedlot cattle are implanted to a single time and delay administration.

The FLP database shows that the number of implants may in fact affect CAB acceptance rates (see Table 7).

Reduce potency. Yet another method of reducing negative effects is to use a less aggressive implanting strategy. Classifying the implant potency into varying categories indicated potency had a great impact on CAB acceptance rates (see tables 8 and 9).

Other contributors

Genetics. Marbling is highly heritable, allowing selection to have a significant effect on quality grade and CAB acceptance rates. Both genetic selection within breed and differences between breeds will dramatically affect marbling levels (see tables 10 and 11).

Early weaning. Calves are traditionally weaned at 6-8 months of age, but weaning earlier — as early as 90 days — has shown dramatic positive effects on quality grade and CAB acceptance. In these studies, early-weaned calves often graded 50%-75% average Choice and above, with up to twice as many qualifying for added premiums when compared to calves weaned at traditional ages. Early and steady use of a high-grain ration, preferably corn, was the key to success. The mode of action likely relates to high-grain diets yielding more propionate, a gluconeogenic precursor, resulting in greater marbling deposition.

Creep-feeding. Research has, however, clearly shown that when calves are placed in an accelerated production system for harvest at 13-15 months of age, creep-feeding accentuates marbling potential. Corn-based creep-feeding increases marbling levels, and 100 days of creep-feeding is capable of raising final marbling by a full score. Corn is ideal because it increases starch absorption in the small intestine.

Disposition. Often overlooked is the effect of poor disposition on marbling potential. Recent Iowa research showed aggressive cattle had greatly reduced quality grades (see Table 12).

Vitamin A levels. U.S. and Japanese research suggests high levels of Vitamin A may reduce marbling deposition. The mode of action is such that marbling-related adipocyte development could be reduced by increasing dietary fat-soluble Vitamin A. Research results have been variable, and the authors have recommended further studies.

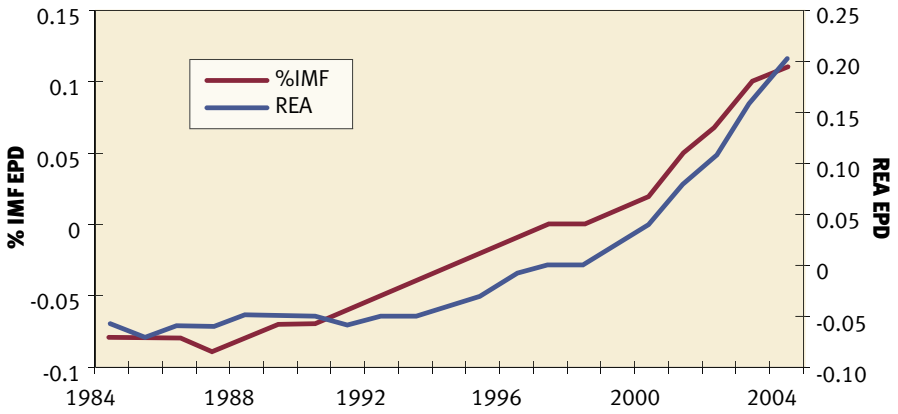
Gender of animals. Numerous studies have shown that heifers consistently outgrade steers by 8 to 10 percentage points in Choice levels (see Fig. 9), with CAB

Table 7: Effect of number of implants on CAB acceptance

CAB acceptance rate	No. times implanted
0.1%–9.9%	1.24[a,b]
10.0%–19.9%	1.29[a,b]
20.0%–29.9%	1.42[a]
>30%	0.91[b]

[a,b]Differing superscripts in same row (P<0.05).
Source: CAB FLP database.

Fig. 10: Angus percent intramuscular fat (IMF) and ribeye (REA) EPD trends



Source: American Angus Association.

Table 8: Implants classified by potency

Potency		Implant products
Score	Description	
1	Low	Ralgro, Synovex C, Component EC, Encore, Compudose
2	Medium	Synovex S & H; Component ES, EH
3	Medium high	Finaplix S,H; Revalor IS, IH; Synovex Choice; Component TE-IS and RE-IH
4	High	Revalor S,H; Component TE-S and TE-H
5	Aggressive	Synovex Plus, Revalor 200

Source: Reinhardt, 2006.

Table 6: Marbling score and quality grade by level of external carcass fat cover

	External fat cover, in.								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Marbling score*	3.68	3.92	4.09	4.30	4.50	4.60	4.70	4.78	4.77
% Choice and Prime	28.3	42.4	50.4	60.1	69.2	73.6	75.4	79.8	79.6
CAB® acceptance rate, %	2.2	4.5	9	13.2	17.7	22	21.4	17.4	12.7
Yield Grade, % 4s and 5s	.7	.2	.3	.7	2	5.6	18.8	35.2	56.1

*Quality Grade: 4.00 = Slight degree of marbling, 5.00 = Small degree of marbling, etc.
Source: CAB FLP database.

acceptance rates 6 to 8 percentage points higher in heifers. The cattle cycle and the resulting percent of heifers in the harvest mix influences grade and CAB acceptance rates. A 1-point change in the heifer harvest percentage correlates to a 0.1-point change in CAB acceptance percentage.

Calves vs. yearlings. Traditionally, the average age at harvest has been 18-20 months of age. However, because of short cattle supplies, widespread drought and some management changes, age has decreased in recent years. Nebraska research suggests 30%-35% of all cattle are placed on feed as calves, but that likely relates to Northern and Midwestern cattle rather than all fed cattle.

The widely held industry belief that yearlings out-grade calves is likely a product of the production system. Again, Nebraska work showed calves of common genetics split at weaning had drastically different quality grades based on the production system. Of the calf feds, 32.5% graded Prime and Premium Choice vs. only 1.2% for the yearlings that endured a winter growing diet that held gains to 1.16 lb. per day for 197 days. Equally important, 19% of the yearling carcasses were classified as "tough" by a sensory panel vs. 0% for the calf feds.

The CAB data suggest calves may slightly out-grade yearlings. In the 2005 FLP data, calves averaged 13.9% CAB acceptance while yearlings were at 13.0%.

Sorting feedlot cattle. Anecdotally, quality grade can be improved if cattle are sorted during the feedlot period, but solid research data is not available. To support this claim, the FLP data on 32,187 cattle suggest limited value from sorting (see Table 13). Only YG appeared to benefit.

Antagonistic traits. An average from several databases finds the correlation between marbling and ribeye area is –0.2 (negative), inferring genetic selection for muscling could reduce marbling levels. However, selective breeding may overcome this antagonism.

Just as random genetic selection for yearling weight increases birth weight, selective genetic selection can increase yearling weight while holding birth weight constant. The same logic may be applied to selection for marbling and ribeye area. Using the Angus breed as an example, Fig. 10 shows the simultaneous improvement over the last 20 years for both marbling and ribeye area.

Summary

It is clear that no one factor solely contributes to the decline in marbling, but numerous factors are having an effect. Because of this trend, the economic value received for cattle sold through a value-based marketing system is affected and, on a large scale, the demand for beef is threatened.

Author's Note: *Authors Corah and McCully express appreciation to the following individuals for assistance: Pete Anderson, Vetlife Inc.; Rob Cooper, Cattlemen's Nutrition Services LLC; Jim Drouillard, Kansas State University (K-State); Francis Fluharty, Ohio State University; Brad Johnson, K-State; D.J. Jordan, Cattlemen's Nutrition Services LLC; Terry Mader, University of Nebraska; Robbi Pritchard, SDSU; Chris Reinhardt, K-State; and Steve Smith, Texas A&M University.*

Table 9: Effect of implant potency on CAB acceptance rates

CAB acceptance rate	Total implant potency score*
0%	5.25[a]
0.1%–19.9%	4.16[a]
20.0%–29.9%	4.17[a]
>30%	2.53[b]

[a,b]Differing superscripts in same row (P<0.05).
* Total implant potency score is the number of times an animal is implanted, multiplied by the mean implant potency score.
Source: CAB FLP database.

Table 10: Genetic selection within the Angus breed

	Top 10%	Bottom 10%
No. sires	110	110
% Choice and higher	94.4	44.2
% Standard	0.1	16.7
% CAB® acceptance rate	48	13
Fat cover, in.	0.49	0.54
$B value	>$43	< $9

Source: OSU data report, Schutte et al., 1998.

Table 12: Effect of disposition on quality grade

	Docile	Restless	Aggressive
% CAB acceptance	29.1	22.8	14.3
% Select/Standard	19.8	25.1	37.0

Percent CAB accepted and % Select/Standard different at P<0.001.
Source: Iowa Tri-County Steer Carcass Futurity, 2005.

Table 11: Feedlot and carcass traits by percentage of Angus genetics

	<25%	26%-75%	>75%
Feedlot gain, lb./day	3.05	3.12	3.29
Morbidity rate, %	24.2	17.8	14.1
Quality grade:			
Prime	0.4	1.0	3.1
Premium Choice	9.7	19.4	34.3
Low-Choice	46.0	52.2	50.2
Select	38.3	25.0	11.7
Standard	5.6	2.4	.8
Yield grade:			
% 4s & 5s	1.0	1.5	3.0

Feedlot gain, morbidity rate, quality and yield grade value all different at P<0.02.
Source: Iowa Tri-County Steer Carcass Futurity, 2005.

Table 13: Effect of number of times groups were sorted on quality grade

	Sort Number		
	0	1	2 or more
Quality Grade:			
Prime	0.9	0.9	0.9
CAB®	22.7	25.1	24.2
Low-Choice	47.2	48.4	48.0
Select	28.2	24.8	26.3
Yield Grade:			
4	11.9	11.8	10.3
5	1.4	1.3	.8

CAB® acceptance rate, % low-Choice, and % Select different at P<0.05
Source: CAB FLP database.