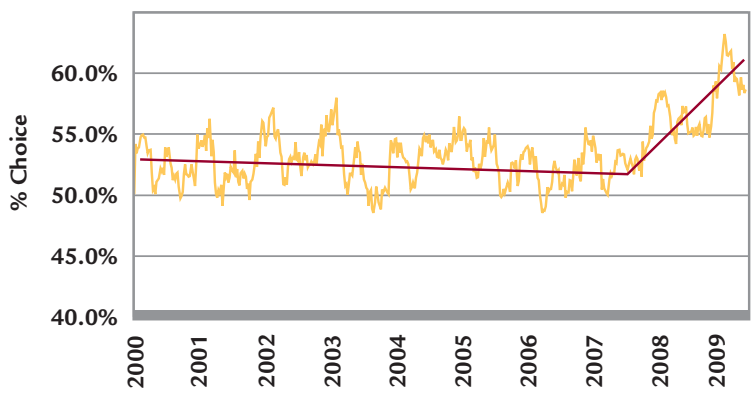
# **Quality Grade:** What is driving the recent upswing?

## Quality Grade concerns addressed in this paper:

- **What are the regional trends?**
- **What about levels of Premium Choice (CAB®) and Prime?**
- **How can these shifts occur so rapidly?**
- **Why are cattle grading so well?**
  - Distiller's by product influence
  - Improved feeding conditions
  - Change in cattle genetics
  - Increase in heifers on feed
  - Changes in USDA Choice grading
  - Changes in compositional end point
- **Other considerations**
  - Increased in-weight of feedlot cattle
- **What does the future hold for Quality Grade?**

Figure 1




Source: USDA data

## Perspective

Since its inception in 1923, the marbling-based USDA quality grading system has become a key economic driver for the beef industry and an even more vital indicator of eating satisfaction for the beef consumer.

Speaking at the 2009 Reciprocal Meat Conference, scientists (Johnson, 2009; Hocquette, 2009) illustrated the important contribution marbling makes to the three key components of consumer satisfaction – tenderness, flavor and juiciness. When tenderness is acceptable, the ultimate demand driver is beef's unique flavor, and perhaps the most significant contributor to that flavor profile is marbling.

Of concern to the beef industry was the documented fact (BIF, 2006) of a USDA-adjusted 30-year decline of 1 percentage point (ppt) in Prime and 6.2 ppt in Choice for all fed steers and heifers from 1975 to 2005. As described by Corah and McCully (2006), numerous factors contributed to that decline.

Cattle feeders selling on quality-based grids had been equally affected by the 25% to 30% decline in cattle qualifying for Premium Choice. As an example, *Certified Angus Beef®* (CAB®) brand acceptance declined from a peak of 20% in 1999 to months of acceptance rates under 14% by 2005. The bottom for the Choice grade share, as reported by Cattle-Fax (Sept.

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**Special appreciation is expressed to Elanco Animal Health for its feedlot performance data gathered in the Benchmark Program.**

Table 1

## USDA 6-Month Average Weekly % Choice

| | 2006 1st Half | 2007 1st Half | 2008 1st Half | 2009 1st Half | Change (ppt) '07-'08 | Change (ppt) '08-'09 | Change (ppt) '07 to '09 |
|---|---|---|---|---|---|---|---|
| Nebraska | 58.7% | 57.8% | 61.4% | 68.0% | +3.6 | +6.6 | +10.2 |
| Kansas | 43.1% | 44.8% | 54.4% | 58.4% | +9.6 | +4.0 | +13.6 |
| Texas | 43.1% | 43.6% | 46.9% | 47.4% | +3.3 | +0.5 | +3.9 |
| All U.S. | 51.7% | 52.7% | 56.6% | 60.1% | +3.9 | +3.5 | +7.5 |

2005) under the heading of "Where have all the Choice cattle gone," had reached 50% by 2005. Not surprisingly, the Choice-Select spread averaged an unprecedented level of $15.35 per hundredweight (cwt.) by 2006.

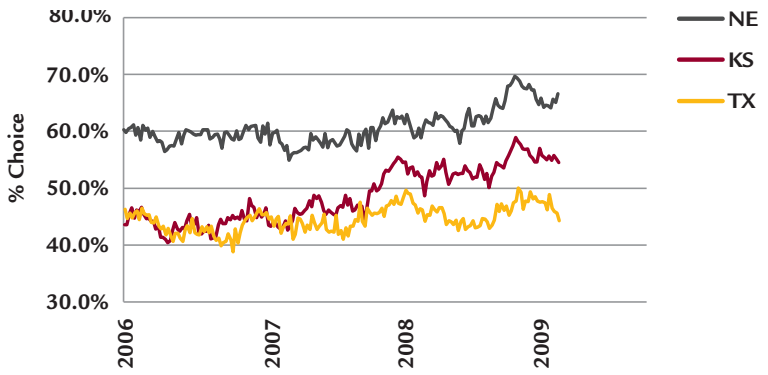
In the six months ending July 1, 2006, 51.7% of cattle graded USDA Choice. This had increased by a point to 52.7% by July 1, 2007, foreshadowing greater movement. After years of stasis or decline, a remarkable change in quality grade started to occur in late summer and fall of 2007 (Figure 1). By July 1, 2009, 60.1% of the federally graded cattle for the year to date had been given the USDA Choice stamp. It was a 7.5-ppt shift in grade in only two years (Table 1). Why?

## Regionality of the Shift

To understand this transition, it is important to study the trends by region. Although nearly all packing plants in North America are showing some increase in quality grade, the most dramatic shift has been for cattle harvested in plants located in Kansas and Nebraska. In the short span of two years, the percentage of Choice grading cattle increased by 13.6 points in Kansas plants and 10.2 in Nebraska plants. In contrast, there was only a 3.9-ppt increase in Texas plants.

Figure 2

### Weekly % Choice by State




Source: USDA data

The most significant shift started with cattle harvested in Kansas in the first six months of 2008 (Figure 2), where in the first half of the year, the Choice share of the mix increased by 9.6 ppt over the same time period of 2007. For the entire year of 2008, the average weekly Choice grade in Kansas had increased 8.4 ppt over 2007 (Table 2). Speculation as to why such a large change occurred ranges from an adjustment in the USDA Choice grading line coupled with the presence of instrument-grading devices (under test), to a simple improvement in cattle quality. A documented cause remains unknown at this time.

The second major shift in the USDA Choice grade share occurred the first half of 2009 when the industry improved another 3.5 ppt and posted a 63.2% Choice grade one week in late February. This level had not been reached in at least 15 years. Nebraska showed the largest increase of 6.6 ppt, and Kansas was up 4.0 ppt, but Texas was essentially unchanged.

Table 2

### USDA Annual Average Weekly % Choice by State

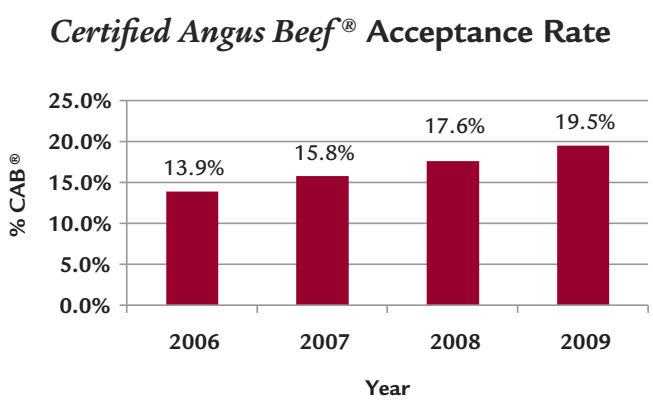
| | 2006 | 2007 | 2008 | Change (ppt) '07-'08 |
|---|---|---|---|---|
| Nebraska | 59.9% | 57.9% | 61.8% | 3.9 |
| Kansas | 43.1% | 46.0% | 54.4% | 8.4 |
| Texas | 42.0% | 43.3% | 45.3% | 2.0 |
| All U.S. | 51.7% | 52.8% | 56.2% | 3.4 |

## What about the levels of Premium Choice (CAB®) and Prime?

As striking as the 15% to 16% actual increase in supply of Choice cattle has been, the accompanying increase in Premium Choice and Prime has been even more significant. In 2006 to 2007, the share of Prime cattle in the fed mix averaged 2.2%, which has increased to 2.9% in 2009, representing a nearly 30% change. The acceptance rate for the *Certified Angus Beef®* program reached a low point in 2006 of 14%, but will average more than 19.5% in fiscal 2009, representing a nearly 40% increase in three years (Figure 3). It should be noted that about 1.5 to 1.8 points of that increase occurred due to the change in the brand's yield grade specifications that went into effect January 23, 2007.

The overall quality grade trend over the past two years is even more remarkable when one considers that economic conditions in the cattle feeding industry have stimulated more aggressive use of implant technologies. Equally, the clearance of a beta-I agonist in 2003 and a beta-II agonist in 2007 has resulted in 40% to 45% of the feedlots using these new repartitioning agents (Tatum, 2009). While the data suggest beta-I agonists have little to no impact on marbling, the more aggressive beta-II agonists can reduce marbling by 10 to 40 units (Tatum, 2009).

Figure 3

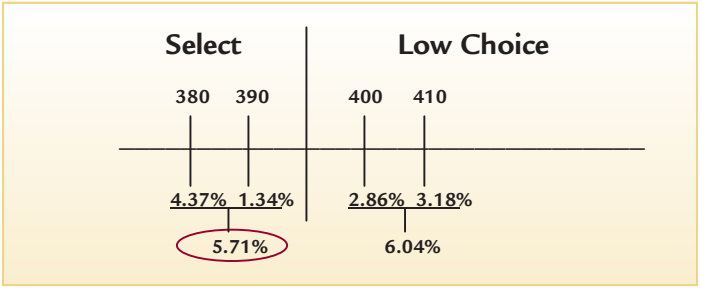



## How can these shifts occur so rapidly?

The main reason for rapid shifts in quality grade is the percentage of cattle whose marbling level resides very close to each of the USDA grading lines. For example, the seemingly tiny change of 20 units of marbling, such as Slight-80 to Small-0 (380 to 400), results in a change of 5.71% more cattle grading Choice (Figure 4). A similar or even greater impact may be seen in cattle qualifying for the CAB® brand, as a 20-unit change (Small-80 to Modest-0, or 480 to 500) in marbling results in a 7.35% shift (Figure 5).

Figure 4

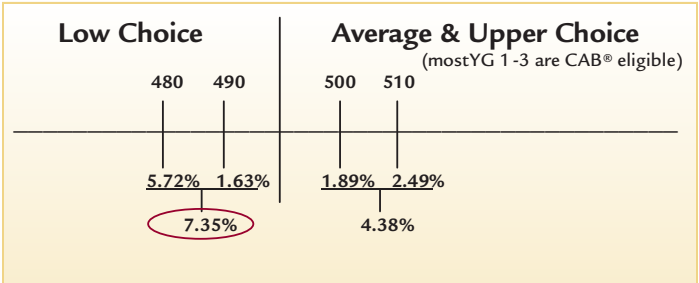
**Percentage of Carcasses Falling Near the Choice-Select Grade Breakpoint**




Source: 2004-05 Certified Angus Beef LLC Packing Consist Study

Figure 5

**Percentage of Carcasses Falling Near the Choice-CAB® Breakpoint**




Source: 2004-05 Certified Angus Beef LLC Packing Consist Study

## Why are cattle grading so well?

### Key Drivers

Although the growth in percentage of cattle grading Choice is a national phenomenon, the most dramatic change has occurred in cattle harvested in Kansas and Nebraska. As previously discussed, the first surge occurred in Kansas in the winter of 2008, with the largest recent change occurring in Nebraska. So why has this transition been so large in the Central Plains states?

## The distiller's by-product impact

In the 2006 quality grade decline paper (Corah and McCully, 2006), Reinhardt conducted a meta analysis of 13 studies, using yield grade as a covariate, and suggested distiller's levels above 30% could reduce quality grades. This and other early inquiries stimulated a plethora of research projects which, in general, support Reinhardt's initial summary suggesting a negative quality grade impact when distiller's by-products exceeded 30% to 40% of the ration's dry matter content.

But this same research may also explain why distiller's by-products could have a positive impact on quality grades. A feedlot survey (Vasconcelos and Galyean, 2007) reported that 82.5% of all feedlots were feeding by-products with an average inclusion rate of 16.5% of the dry matter intake (DMI). A greater availability of by-products likely has increased both of these percentages by 2009.

So how are the distiller's by-products exerting a positive influence? Utilizing a meta-analysis of the numer ous distiller's by-product studies, Calkins reported at the 2009 Joint ASAS ADSA CSAS meeting that feeding 20% to 30% (dry matter basis) of distiller's by-product, resulted in a 14- to 15-point increase in marbling score (Table 3).

This same research shows a varying effect of distiller's by-products on feed intake during the full feeding period, but recent Nebraska research has shown these products will have a big influence on the feed intake in starter feedlot rations (Table 4).

This study shows a nearly 30% increase in DMI, partially associated with an increase in how often the cattle eat. Scientists speculated that more frequent eating likely reduces potential levels of acidosis, a theory that is supported by the observed rumen pH values. Recent communication with feedlot consultants supports this concept as well, with nearly all suggesting that the use of by-products in starter diets has increased intake and reduced health problems in newly received cattle.

**Bottom Line**

These data would strongly suggest a key portion of the increase in cattle grading Choice and higher can be directly attributed to expanded availability and usage of distiller's by-products, especially in central states like Nebraska and Iowa. Using the packing consist data (Figure 4), the 14- to 15-point increase in marbling scores reported by Calkins means this ration change alone could result in a 5- to 5.2-ppt increase in the share of Choice grading cattle.

Table 3

**Effect of Dietary Inclusion of Distiller's By-products**

| % Distiller's By-product (DM) | Marbling Score |
|---|---|
| 0 | 518 |
| 10 | 528 |
| 20 | 533 |
| 30 | 532 |

Source: Calkins, 2009

Table 4

**Effect of Adding Distiller's Grains to Starter Rations**

| | Control | Corn Wet/distillers |
|---|---|---|
| DMI lb./day | 16.14 | 21.78 |
| Meals/day | 4.96 | 6.25 |

Source: 2009 Nebraska Beef Cattle Research Report

## In general, feeding conditions for cattle the past two years have been very good

Trying to differentiate the impact of feeding conditions from other factors is impossible, but likely a factor in the net change. Here are a few indicators of feedlot performance.

### a. Dry matter intake (DMI)

Utilizing excellent feedlot data shared from the Elanco Animal Health Benchmark® Program, we can see that DMI of feedlot cattle has shown a steady increase the past two years (Figure 6). The percentage of Choice grading cattle is influenced by DMI (Figure 7).

The relationship between DMI and marbling is not surprising, considering that added starch intake should result in more marbling. As reported by Enns (2009), there is a positive genetic correlation between marbling and DMI.

### b. Feedlot ADG

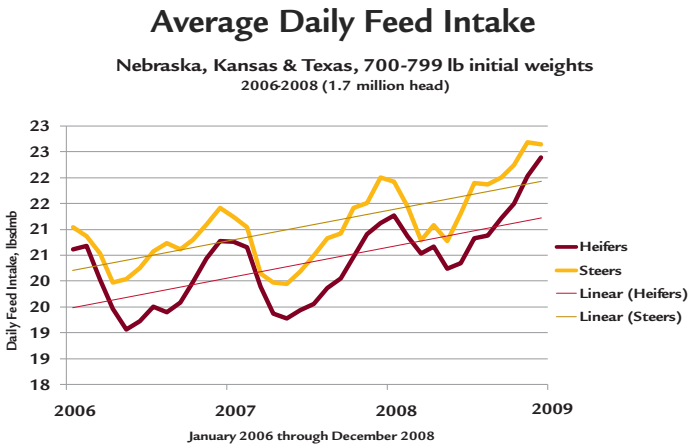
The correlation between feedlot ADG and marbling is not large (correlation = +0.1), but it is slightly positive (Figure 8). Again, as reflected by the Elanco Animal Health Benchmark Program data, the past two years there has been a slight increase in ADG of feedlot cattle, especially related to heifers, likely related to feeding conditions, genetics and implant programs.

### c. Feedlot health

Previous research (Busby, 2004) illustrated that those feedlot cattle which do not require treatment will have 16.5 ppt more Choice and higher (74.2% vs. 57.5%) when compared to cattle treated two or more times while on feed. This is confirmed by the Elanco Animal Health Benchmark Program data relating percent Choice to feedlot mortality rates (Figure 9).

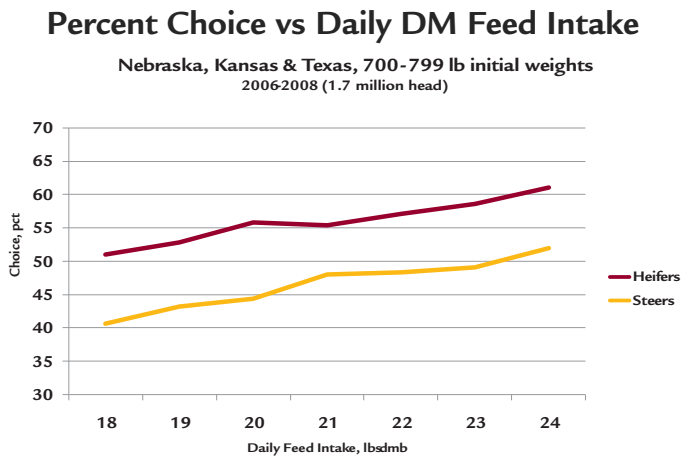
Although slight (Figure 10), the mortality rate the last two years is down (2009 Bench mark data).

Figure 6



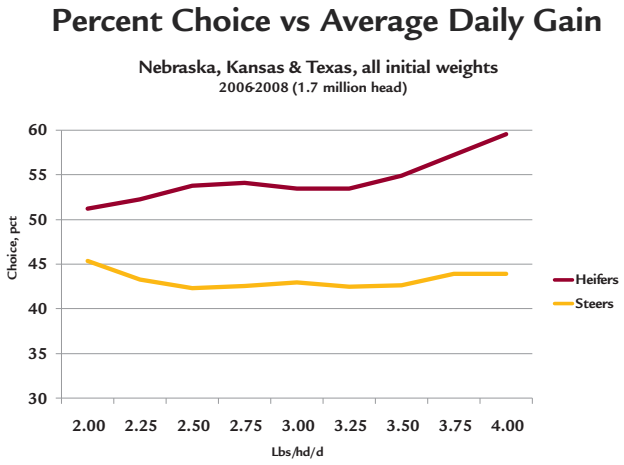

Source: Elanco Animal Health

Figure 7




Source: Elanco Animal Health

Figure 8




Source: Elanco Animal Health

### Bottom Line

While there are no definitive correlations, the trends within DMI, ADG and feedlot health would all suggest improved feeding conditions have had a positive influence on quality grade.

## Change in cattle genetics likely an important factor

The impact of change in the genetic make-up of cattle is somewhat hard to measure, but three changes have occurred that must be considered.

**a. A rapid increase in the marbling EPD (expected progeny difference) values for Angus bulls**

**b. The past 10 years have seen a steady increase in the percentage of Angus bulls being used**

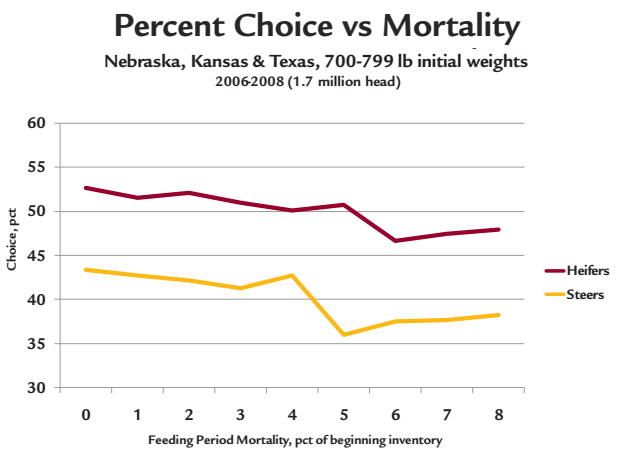
Utilizing bull turnout survey data, a 1995 national survey by the ABG Inc. research firm showed that 39% of bulls utilized were Angus, while a 2008 national Drovers survey showed that 55% of the bulls used were Angus, and that 70% of producers used at least some Angus bulls. Not only has the use of Angus sires increased, but the ratio of commercial cows being designated as "Primarily Angus" is nearing 70%.

The Iowa Tri-County Steer Carcass Futurity (TCSCF) data allow analysis of the percentage of Angus in the fed cattle mix. Even though the cattle were black-hided, only 52.7% of the calves with less than 25% Angus genetics graded Choice while those calves featuring 75% or more Angus genetics recorded a Choice and Prime ratio of 86.2%. The figures are even more dramatic for CAB® acceptance rates (Figure 12).

**c. The percentage of cattle with black hides has increased greatly**

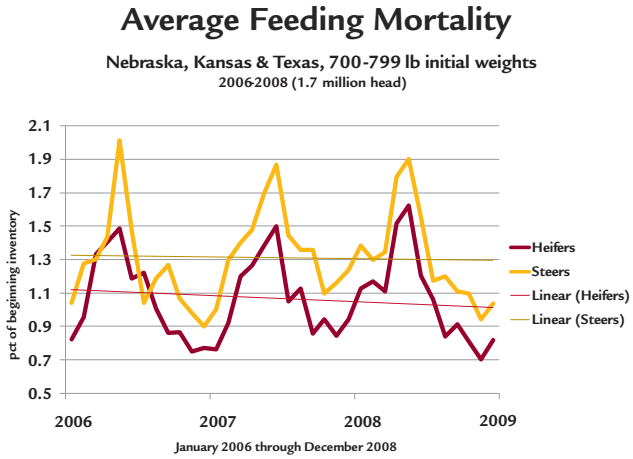
Starting in 2000, USDA has reported the percentage of cattle in the harvest mix that are black hided. The 48% share of black-hided cattle in 2000 increased to 60% in 2009. More important to the recent quality grade trend, those USDA numbers indicate

Figure 9



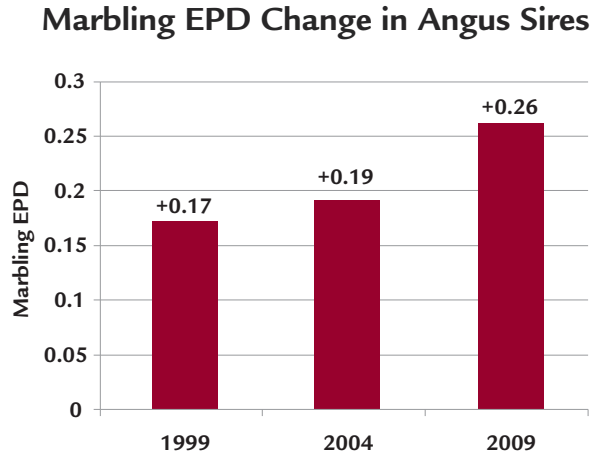

Source: Elanco Animal Health

Figure 10




Source: Elanco Animal Health

Figure 11




Source: 2009 American Angus Association® AHIR Sire Summary

that from 2000 to 2007, the annual increase in percentage black-hided cattle averaged 1 ppt per year, but in the past two years that increase has been 2.5 ppt per year (Figure 13). Industry observations would also suggest that this change has been more pro nounced in the Central Plains than in the South.

Utilizing the TCSCF data on 28,350 calves, there is an 18-point difference in the percentage of Choice or higher grade from black-hided vs. non-black cattle (Table 5).

**Bottom Line**

Quantifying the genetic impact is difficult, but it is definitely a factor in the trend toward higher quality grades. Using the past two years' percentage black at nearly 2.5 times the previous seven years' annual change and extrapolating from the TCSCF data, at least a half a percentage point of the Choice increase is due to the increase in black hides alone. The 10-ppt increase in Angus bull usage likely is having another .5- to 1-ppt impact on the Choice grade ratio.

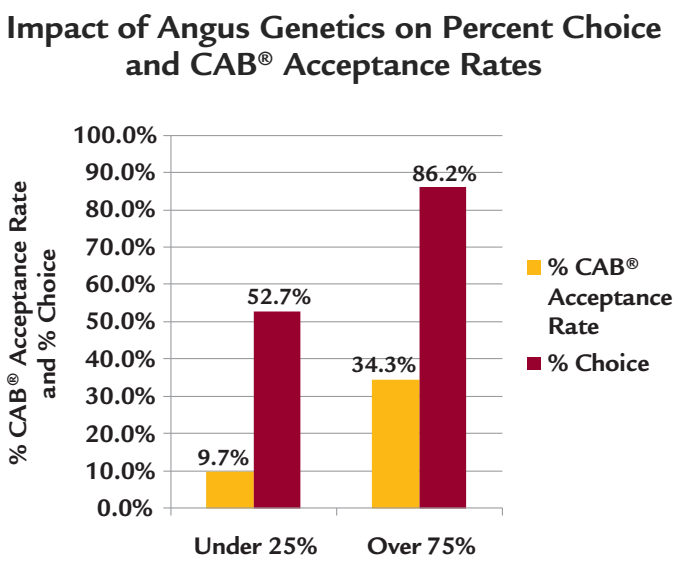
## An increase in the percentage of heifers on feed

Heifers traditionally out-grade steers by 9 to 10 ppt Choice or higher (Figure 14). With the cowherd liquidation occurring in the beef industry, heifers have constituted a higher proportion of the fed cattle mix, 37.4% vs. the traditional 34% to 35%. Calculating the impact this had on the overall increase in percentage Choice is an estimate, but likely in the .3- to .5-ppt range.

**Bottom Line**

The increase in heifers in the feeding mix has had a positive, possibly as much as half a percentage-point, impact on the Choice proportion of the mix.

Figure 12




Source: Busby, 2004, Iowa Tri-County Steer Carcass Futurity data

Figure 13

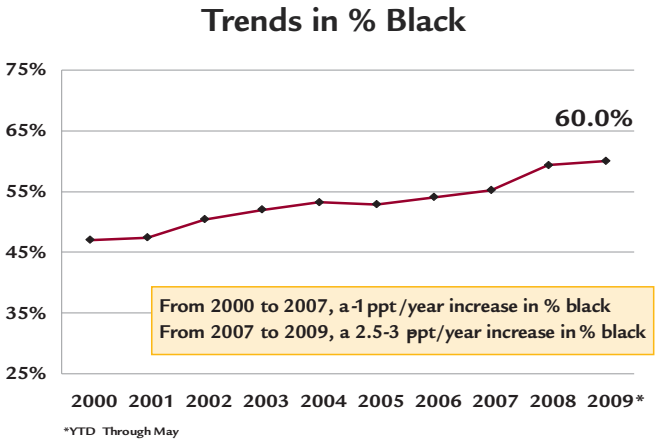



Table 5

### Quality Grade by Hide Color

| Factor | Non-black | Black |
|---|---|---|
| Prime | .046 | 1.31 |
| Premium Choice | 7.73 | 19.70 |
| Choice | 48.08 | 53.15 |
| Select | 38.82 | 24.08 |
| Standard | 4.91 | 1.76 |

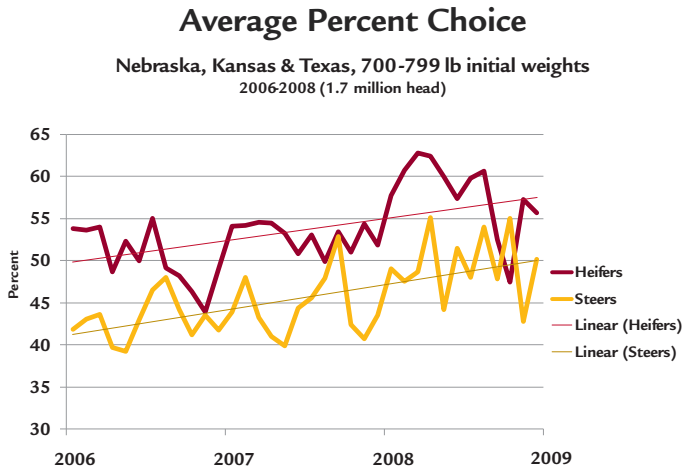
The total of 28,350 calves used in these analyses included 7,450 non-black calves and 20,900 black calves from 2002 to 2007.

Source: Busby, 2007, Iowa Tri-County Steer Carcass Futurity

## A possible change in the USDA Choice grading line

Many cattle feeders and industry professionals suggest much of the change in percentage Choice relates to a USDA grading change in the marbling levels needed for the Choice grade. Camera-grading data collected by packers would strongly refute that being a factor in the 2008-2009 quality grade increase trend. Hard to explain, how ever, was the dramatic increase (9.6 ppt) in Choice grading cattle that occurred in Kansas-harvested cattle in the first half of 2008, which was triple the increase occurring in any other region. It is difficult to determine whether that phenomenon was in any way related to the USDA grading system.

Figure 14




Source: Elanco Animal Health

### Bottom Line

Although many equate the increase in quality grade to a change in the USDA grade line, definitive supporting data does not exist. As instrument grading is implemented, we will have greater knowledge of potential effects, if any.

## Changes in the compositional end point of the fed cattle mix

### a. Previous research has shown that the compositional end point (backfat) is a key influencer of quality grade

As the fed cattle compositional end point moves from .4 inches of fat cover to .6 inches fat cover, there is a corresponding increase in the population share of Prime and Choice grades amounting to 13.5 ppt (Figure 15). Historically, the average fat thickness at harvest has been .50 to .55 inches. When fat thickness shifts from .5 inches to .7 inches, the incidence of YG 4 and 5 carcasses increases from 2% to 18.8%, with a corresponding increase of 6.2 ppt in Prime and Choice grading cattle. But a population analysis does not necessarily establish cause and effect.

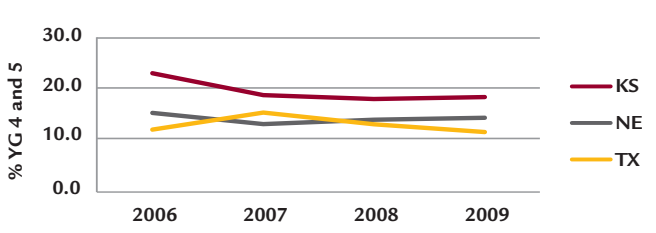
Figure 15 **Impact of 12th Rib Fat Thickness on Quality Grade**

| | Fat Thickness (in.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | .1 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | .9 |
| Marbling Score | 368 | 392 | 409 | 430 | 450 | 460 | 470 | 478 | 477 |
| 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 | 9.0 | 13.2 | 17.7 | 22.0 | 21.4 | 17.4 | 12.7 |
| Yield Grade, % 4 and 5's | 0.7 | 0.2 | 0.3 | 0.7 | 2.0 | 5.6 | 18.8 | 35.2 | 56.1 |
| | 23.7% | | | 52.7% | | | 23.6% | | |
| % Choice | 44.5 | | | 66.8 | | | 78.3 | | |
| % Premium Choice and Prime | 10.1 | | | 21.7 | | | 27.1 | | |

Source: 2005 Certified Angus Beef LLC Packing Consist Study

**b. Compositional changes have occurred, but the quality grade impact is unclear**
With the trend toward higher quality grades, a logical question to ask is, "Are the cattle being marketed with more fat cover, especially in 2009?" Most packers are reporting the answer is yes. In theory, YG 4 and 5 data should provide that information. Yet, in the time period of the drastic quality grade increase (2006 to 2008), the percent of cattle grading YG 4 and 5 actually decreased in Nebraska and Texas (Tables 6 and 7). Analyzing data collected in the CAB® Feedlot Licensing Program, similar trends appear (Figure 16).

Figure 16




Source: 2005 Certified Angus Beef LLC Packing Consist Study

However, from 2008 to 2009, the largest quality grade increase (7.3 ppt) occurred in Nebraska, providing an opportunity to test the theoretical link to higher YG. Using Nebraska-harvested cattle as an example (Table 6), we have seen an increase in percentage YG 4 and 5 in cattle (3.5 ppt). Texas-harvested cattle provide another test: since the percentage of Choice grading cattle in Texas was lower, there should be less change in % YG 4s and 5s. That is the case (Table 7), as there was only a 0.7-ppt increase in YG 4 and 5 cattle.

Table 6

**Yield Grade 4 & 5 Levels in Nebraska-harvested Cattle**

| | Nebraska | | National Avg. | | National Avg. (minus NE) | |
|---|---|---|---|---|---|---|
| | HCW | %4-5 | HCW | %4-5 | HCW | %4-5 |
| FY-06 | 806 | 15.4 | 795 | 9.6 | 794 | 9.2 |
| FY-07 | 801 | 12.6 | 791 | 8.8 | 790 | 8.5 |
| FY-08 | 806 | 11.9 | 809 | 8.4 | 810 | 8.1 |
| FYTD-09 | 812 | 15.4 | 811 | 9.4 | 811 | 8.9 |

Source: Elanco Animal Health

Table 7

**Yield Grade 4 & 5 Levels in Texas-harvested Cattle**

| | Texas | | National Avg. | | National Avg. (minus TX) | |
|---|---|---|---|---|---|---|
| | HCW | %4-5 | HCW | %4-5 | HCW | |
| FY-06 | 794 | 7.4 | 795 | 9.6 | 795 | 11.3 |
| FY-07 | 794 | 7.3 | 791 | 8.8 | 788 | 10.2 |
| FY-08 | 810 | 6.8 | 8.09 | 8.4 | 809 | 9.9 |
| FYTD-09 | 508 | 7.5 | 811 | 9.4 | 815 | 10.9 |

Source: Elanco Animal Health

**Bottom Line**

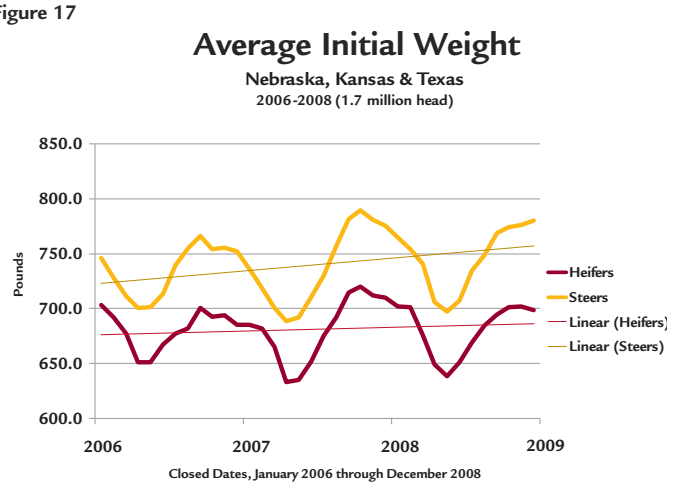
Cattle entering the packing plants are heavier. Heavier placement weights, ideal feeding conditions, market conditions and feedlot economics have contributed to the increase in weight. One theory would be that these heavier cattle have reached a higher percentage of their mature weight potential and therefore have deposited more marbling. Others would suggest that the fed cattle population is comprised of more Angus and British cattle and those cattle are simply fatter. While logical, USDA yield grade data does not support this theory. Cattle are certainly heavier, but the compositional changes and the resulting effect on quality grade are unclear.

## Factor likely not important

**The increased in-weight of feedlot cattle has been neutral on quality grade**

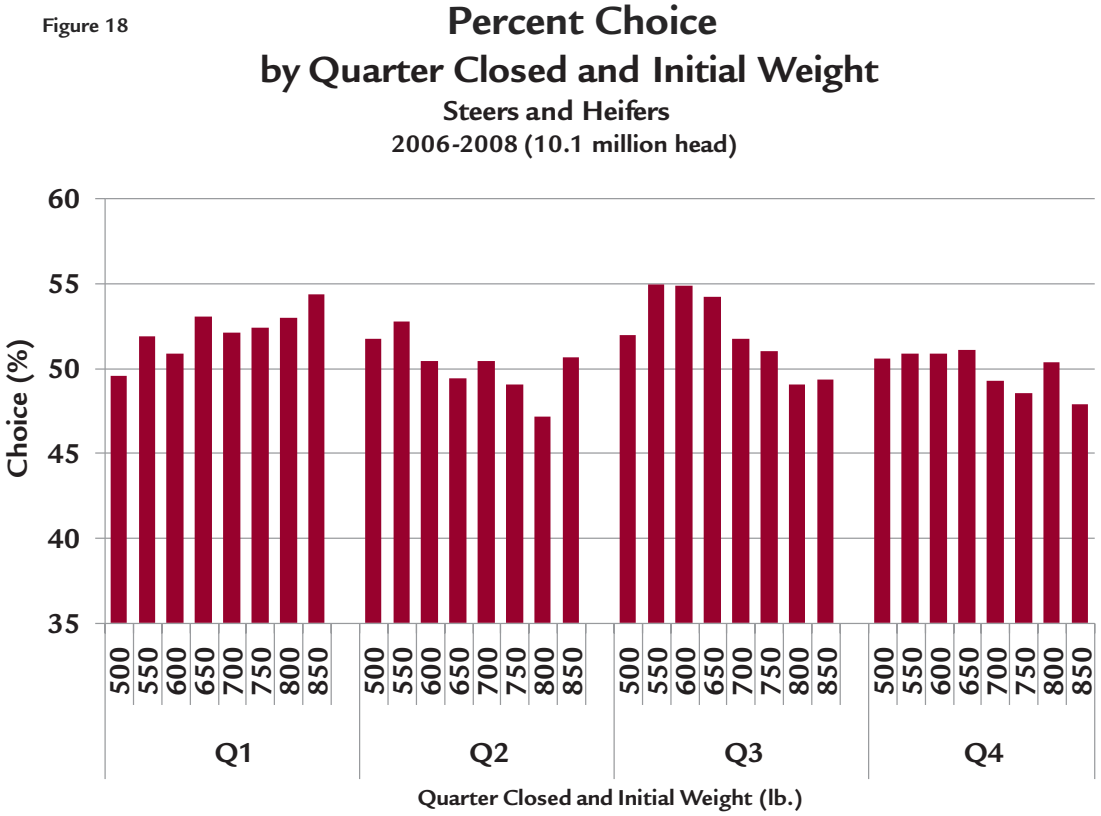
As corn price escalated, numerous theories persisted about shorter days on feed and heavier placement weights likely having a negative impact on quality grade. In contrast, placement weights did increase (Figure 17), but days on feed stayed constant, resulting in little or no effect on quality grade (Figure 18).

Figure 17




Source: Elanco Animal Health

Figure 18




Source: Elanco Animal Health

## So what does the future hold for quality grade?

This question was posed to eight meat scientists who contributed ideas to the paper, and their responses included the following:

- **The current levels of Choice and Prime will likely decline**
- **The factors driving grade today will likely keep the percentage above 2006 levels**

### The Positives

There are a number of reasons cattle will continue to grade well.

- Genetics – All indications are that Angus will continue as the favored breed, and bull turn out data would suggest 70% black-hided cattle is a likely share by 2015.
- Knowledge of early marbling differentiation is just beginning to open new windows. Recent research by meat scientists is starting to create an understanding of how early marbling deposition occurs and how we can change that process. Companies are even talking about developing products that will enhance marbling deposition.
- The extensive use of distiller's grains will likely continue and, when fed at moderate levels (under 40%), they appear supportive to quality grade.
- At least short term, corn prices will likely favor a continuation of current feeding programs. Long term is anybody's guess.

### The Negatives

- Corn prices long term may pose a challenge.
- Percentage heifers in the mix will decline.
- Positive feeding conditions may not persist.
- Flat economic premiums for quality cattle do not encourage a focus on marbling.
- Continued aggressive use of growth technologies may sidetrack genetic potential.

### The Unknown

- Instrument grading may have an impact on percentages of quality grades in the consist.

### Best Guess

Grading levels likely will hold for 2009 and into 2010. If quality grades do not decline after that, it could mean that the infusion of higher-marbling genetics has had a lasting effect. Coupled with the smaller cattle number, consumer demand in a recovering economy will likely drive the Choice-Select spread to higher levels.

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## Works Cited


American Angus Association®. 2009. Sire Evaluation Report.

Beef Improvement Federation (Smith et. al.) 2006 Proceedings.

Busby, W.D., D. Strohbehn, P. Beedle and L.R. Corah. 2004.
Effect of postweaning calf health on feedlot gain and quality grade.
J. Anim. Sci. (Suppl. 2): 83. (Abstr.)

Calkins, C.R., A.S. deMello, Jr. and L.S. Senaratne. 2009.
Effect of distillers grains on beef carcass quality and palatability.
J. Anim. Sci. (Suppl. 2): 87. (Abstr.)

Cattle-Fax weekly report. Sept. 2005.
Where have all the Choice cattle gone?

Certified Angus Beef LLC Packing Industry Consist Report. 2004-05.

Corah, L.R. and M.A. McCully. 2006.
Declining quality grades: A review of factors reducing marbling deposition in cattle.
Certified Angus Beef LLC white paper.

Drovers-Certified Angus Beef LLC survey details Angus influence.
Drovers Journal. Nov 13, 2008.

Hocquette, Jean-Francois. 2009.
Markers for intramuscular fat. Reciprocal Meat Conference proceedings.

Huls, T.J., N.R. Meyer, G.E. Erickson, T.J. Klopfenstein and R.A. Stock. 2009.
The effects on ruminal pH, feed intake and digestibility when using wet corn gluten feed to adapt cattle to finishing diets. U. of Nebr. Beef Research Report MP92.
Pages 56-58.

Johnson, B.J. 2009.
Bovine satellite cells as precursors of intramuscular adipocytes.
Reciprocal Meat Conference proceedings.

Tatum, J.D. 2009.
Growth technologies: Performance benefits and quality considerations.
J. Anim. Sci. (Suppl. 2): 87. (Abstr.)

USDA beef grading reports. AMS Section 2009.

Vasconcelos, J.T. and M.L. Galyean. 2007.
Nutritional recommendations of feedlot consulting nutritionists:
The 2007 Texas Tech University survey. J. Anim. Sci. 85: 2772-2781.

Weaber, R.L. and R.M. Enns. 2009.
Managing genetic antagonisms between economically important beef production traits and marbling. J. Anim. Sci. (Suppl. 2): 87. (Abstr.)