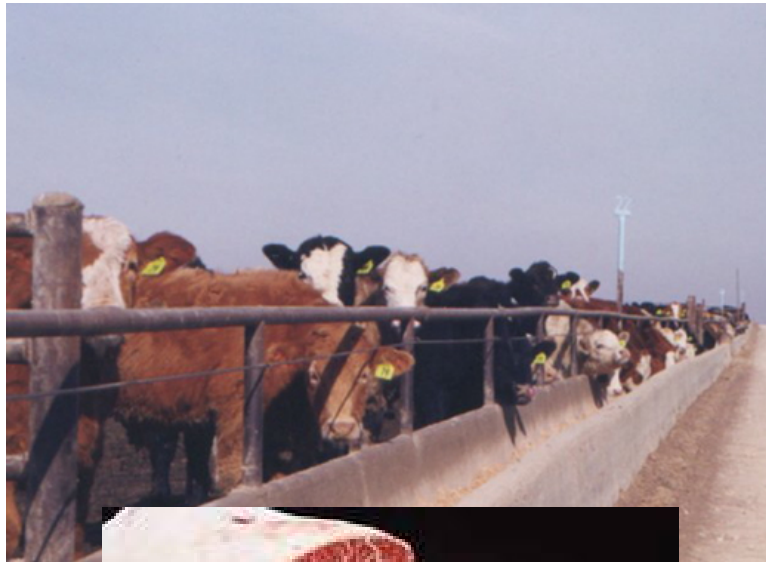




NUTRIFAX

Nutrition News and Information Update



MANAGING AND FEEDING FOR MARBLING AND CARCASS QUALITY IN BEEF CATTLE

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Producing a product that meets consumers' needs is an important part of the beef industry. Consumers want beef that is consistently tender and palatable. There are many on-farm nutritional and management strategies that can improve beef quality. Everything from feeding programs, implant strategies, animal health and management can impact marbling and carcass quality. Improving these will ultimately increase consumer satisfaction and demand for beef.

Carcass Grading Systems (Canada and America):

Grading carcasses is intended to classify meat into uniform groups of similar quality. Carcasses are graded by such characteristics as:

- Maturity
- Muscling
- Fat (colour, texture and cover)
- Meat (colour, texture and marbling)

The marbling content of meat is a key component in determining quality grade (the table below displays the Canadian grading system along with the American system). The more marbling present results in a higher graded carcass.

Canadian and American beef quality grades for carcasses

Standards Used for Quality Grade Determination

GRADE	MARBLING*	MATURITY**	MEAT COLOUR	FAT COLOUR	MUSCLING	MEAT TEXTURE*
CANADA***						
Prime	Slightly abundant	Youthful	Bright red only	No yellow fat permitted	Good muscling or better	Firm only
AAA	Small	Youthful	Bright red only	No yellow fat permitted	Good muscling or better	Firm only
AA	Slight	Youthful	Bright red only	No yellow fat permitted	Good muscling or better	Firm only
A	Trace	Youthful	Bright red only	No yellow fat permitted	Good muscling or better	Firm only
UNITED STATES***						
Prime	Slightly abundant	Maturity class A & B	Light red	Yellow fat permitted	No minimum requirement	Moderately firm
Choice	Small	Maturity class A & B	Dark cutters permitted	Yellow fat permitted	No minimum requirement	Slightly soft
Select	Slight	Maturity class A	Dark cutters permitted	Yellow fat permitted	No minimum requirement	Moderately soft
Standard	Practically devoid	Maturity class A & B	Dark cutters permitted	Yellow fat permitted	No minimum requirement	Soft

* Minimum marbling and meat texture permitted for quality grade class.

** Maturity categories reflect domestic requirements.

*** Standards as of June 2006.

Prime is the highest grade meat as it contains the most marbling. When a carcass grades at Canada A or higher, lean yield is also determined. Lean yield is an estimation of the red meat content of the carcass. It is calculated based on muscle score and fat grade. Lean yield is not the dressing percentage of the carcass. Yield categories are as follows:

Yield grade grid for Canadian beef carcasses

Yield Grade	Estimated Yield (%)
Canada 1 (Y1)	59 or more
Canada 2 (Y2)	54 to 58
Canada 3 (Y3)	53 or less

The Canadian Beef Grading Agency

Yield grade in the US is based on a 1-5 scale (with 1 being the highest and 5 the lowest yielding carcass). It is calculated based on the amount of external fat, % of fat in the kidney, pelvic and heart areas (KPH), ribeye size and carcass weight. External fat is the biggest contributor to determining yield grade in the US system.

When cattle are sold based on grid premiums, discounts are applied based on quality and yield grade. Carcasses with more marbling and higher yield grades qualify for higher prices. Carcasses with lower yields, less marbling, cattle over 30 months of age, over and under weight carcasses (due to genetics and over and underfeeding cattle) receive discounts. The Canadian packing industry will generally discount Canada 3 (Y3) carcasses. In the American system carcasses in the 4-5 scale are generally discounted (equivalent to Canada Y3 yield grade).

The quality grade of beef is directly related to consumer satisfaction with meat containing more marbling preferred.

Sensory panel tenderness rating for beef based on quality^a

	Certified Angus Beef (CAB)	USDA Choice	USDA Select
Strip Loin	5.93 ^b	5.69 ^c	5.47 ^d
Shoulder clod	5.14 ^e	5.16 ^e	4.87 ^{fg}
Knuckle	4.86 ^{fg}	5.05 ^{ef}	4.70 ^{gh}
Inside round	4.54 ^{hi}	4.32 ^j	4.47 ^{ij}
Round Flat	4.09 ^k	4.02 ^k	3.94 ^k
Top sirloin butt	4.62 ^{hi}	4.49 ^{ij}	4.44 ^{ij}

Angus Journal, 1999

^a Sensory panel tenderness: 8 = extremely tender, 1 = extremely tough

Means in the same row with a common subscript are not different

Declining Marbling in Beef

When looking at the historical pattern for graded carcasses there has been a downward trend in marbling. Fewer carcasses are grading choice or better.

Historical USDA Grading Scores for Beef Carcasses

	1986	1996	2005
% Prime	3.3	2.4	3.1
% Choice	93.6	60.4	57.2

Robinson, Western Livestock Journal, 2006

Biology of Marbling in Beef Cattle

Marbling (intramuscular fat) is the fat within the actual muscle of the animal. It is different to subcutaneous fat, which is external fat. Marbling is deposited more slowly and continuously throughout the life of an animal. Subcutaneous fat is deposited more quickly and in greater amounts as the animal ages. Historically, it was believed that marbling fat was developed later during the finishing stage. However, more recent research has shown that marbling is an earlier developing tissue.

Manipulating the by-products of rumen fermentation can alter fat deposition in cattle. The rumen bacteria create fermentation by-products called volatile fatty acids (VFA's) from their feed. The 3 main VFA's produced are acetate, proprionate and butyrate. Fiber-utilizing bacteria produce more acetate as a by-product whereas starch-utilizing bacteria produce more proprionate. As a result, forage-based diets will result in more acetate production while grain-based diets will result in more proprionate. Research has shown that acetate is the preferred substrate for the deposition of external carcass fat. Proprionate is used by the liver of cattle for glucose production and glucose is the preferred substrate for intramuscular fat (i.e. marbling). Consequently, more marbling tends to occur in cattle fed grain-based diets. The site of digestion of the grain may also play a role in marbling. Grain that bypasses rumen fermentation is digested and absorbed in the intestinal tract of the animal. The starch absorbed from the intestine is thought to increase marbling content more efficiently compared to proprionate from rumen fermentation.

Dietary protein level may also impact marbling. Increasing the protein content of the diet may increase starch digestion and absorption in the intestinal tract. Research at the University of Illinois suggests that increasing the protein level in diets of young calves to as high as 16% increases marbling. The combination of higher grain and protein in diets will lead to more marbling.

Nutritional Strategies to Increase Carcass Marbling

There are many feeding strategies to increase the marbling content of beef. Some of these include:

Creep Feeding & Early Weaning

Marbling fat develops at a young age in beef cattle. Feeding higher energy feeds to young calves will help increase the amount of marbling. Creep feeding is the easiest way to do this as shown by research from the University of Georgia.

Marbling scores of creep vs. non-creep fed calves

	Non creep-fed	Creep-fed
Marbling Score	318	348

200 = select; 300 = choice; 400 = average choice; and 500 = high choice
University of Georgia, Creep Feeding Calves Article

The type of creep feed can also impact marbling. Research at the University of Illinois showed that calves fed corn and grain-based creep feed resulted in higher marbling scores compared to calves fed fiber-based creep feed. This is due to the higher starch content of grains. Therefore, to increase marbling creep-fed calves should be fed a high energy diet after weaning. Feeding animals for low daily gains after weaning will not enhance marbling.

Early weaning has also been shown to improve marbling. Research from the University of Illinois showed calves weaned at a younger age (5-6 months of age) and put directly onto a finishing diet had higher marbling scores compared to older weaned calves (7-8 months) that were creep-fed. The early use of grain in the diet of early weaned calves is key to increased marbling. As with previous studies non-creep fed calves had less marbling.

Carcass grade of early weaned, normal weaned calves with creep and non-creep fed calves

	Early Weaned	Normal Weaned (with creep)	Normal Weaned (no creep)
Marbling score	1198	1144	1,120
≥ Avg. Choice, %	93	68	68
≥ Prime, %	15	11	0

Myers et al., 1999

Grain Processing

Grain processing can also impact marbling. Feeding steam flaked corn has been shown to improve average daily gains (ADG) and feed efficiency in cattle. However, in a summary of 552 studies done by Owens and Gardner (1999) feeding steam flaked corn reduced marbling.

Steam flaked vs dry corn on carcass characteristics

	Whole Corn	Dry Rolled Corn	Steam Flaked Corn
ADG, lb./day	3.15 ^a	3.12 ^b	3.48 ^b
Feed/gain	6.37	6.37	5.43
Marbling Score	512 ^{a, b}	524 ^a	482 ^b
Yield Grade	2.75 ^{a, b}	2.69 ^b	2.85 ^a

Differing superscript in same row (P<.05)

400 = slight marbling, 500 = small marbling

This is due to a shift in starch digestion. Steam flaked corn contains more rumen available starch. This starch is available to the rumen bacteria for fermentation (resulting in more proportionate production). Dry and whole corn has less available rumen starch. More starch bypasses the rumen and is digested and absorbed in the intestinal tract, resulting in more marbling cattle fed rations using dry and rolled corn. Another possible reason is there is a dilution effect of marbling when feeding steam flaked corn. With a higher ADG marbling fat is more diluted in the carcass due to the extra growth.

By-Product Feeds

With an increase in the amount of corn being used for ethanol production more distillers grains are now available for cattle feeding. In a summary of 13 studies conducted at Kansas State University they showed that when the amount of distillers grains was increased in the diet the result was reduced marbling.

The effect of level of distillers grains in the diet on carcass characteristics

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
Over 29%	5.35 ^b	3.06 ^b

Dr. Chris Reinhardt, Kansas State University

^{a, b} Differing superscript in the same column(P<.05)

Distillers grains are a high energy feed. However, the energy comes from fat and digestible fiber. The starch from corn is removed to make ethanol during the distilling process. Feed efficiency and ADG may not be reduced but marbling can be impacted. The reason for the decline in marbling may be due to less starch in the diet.

Feed Additives

Optaflexx® (beta antagonist ractopamine) is a new medication that can be fed to cattle for 28-42 days prior to slaughter to increase lean muscle yield and is approved to be fed at 10-30 mg/kg in the diet. Other beta antagonists have been shown to affect carcass quality. However, research by Elanco has shown that Optaflexx® has no impact on marbling.

Performance expectations for steers fed ractopamine for 28 days

Ractopamine (mg/head/day)	Dressing %	Marbling	Rib eye are Sq. in.	Yield Grade
100	No change	No change	+0.3	No change
200	+0.3	No change	+0.4	-0.1
300	+0.4	No change	+0.5	-0.14

Elanco Animal Health Optaflexx Core Data Sheet

Feeding Optaflexx® increases dressing % and rib eye area without affecting marbling. Yield grades are also improved. In another summary it was noted that when feeding a higher level of ractopamine (300 mg/h/d) steak tenderness may be negatively affected based on a shear force and panel taste test.

Effect of ractopamine on steak tenderness

	Ractopamine, mg/head/day			
	0	100	200	300
Initial tenderness	111.7	110.7	111.5	106.0*
Sustained tenderness	101.8	100.5	100.3	95.2*

Feedstuffs 2003, * P<0.05 compared to controls

Tenderness evaluation: 0 = not tender, 150 = tender

Other feed additives such as Rumensin, Bovatec, Posistac, MGA and Tylan do not impact marbling.

Management Strategies to Improve Marbling in Beef

Along with nutrition, on-farm cattle management can significantly impact marbling. Some key on-farm strategies to increase marbling include:

Cattle Health

Cattle health in the feedlot can have a dramatic impact on marbling. Research has shown that marbling is reduced the more frequently an animal becomes sick.

Marbling and carcass grade for sick vs. healthy cattle

	Number of Antibiotic Treatments		
	Never Treated	Treated once	Treated more than once
Marbling Score*	288 ^a	266 ^b	249 ^b
% Choice Grade	66.2	59.4	41.1
Yield Grade	2.53	2.43	2.36

Stovell et al. 2001

*300 = choice

Another study from Iowa State University showed that calves treated two or more times for BRD had a 44% and 33% reduction in prime and choice grades respectively. Cattle that become sick often go off feed and use more energy to fight off their illness. This results in less energy available for growth and marbling. Keeping cattle healthy is critical to increase marbling.

Implant Programs

Implanting cattle will improve ADG and feed efficiency by up to 20 and 15%, respectively (depending on the implant used). Using implants will improve the overall bottom line for beef producers. However, if implant programs are not managed properly marbling can be impacted. Trenbolone acetate (TBA) implants have been implicated in reduced marbling. A summary of 325 published implant studies for heifers and steers was compared to a negative control. Both ADG and % choice carcasses were analyzed with the results as follows:

Change in ADG and % Choice+ based on steers and heifers for implants

	ADG (% improvement compared to negative control)	Choice + (% decrease compare to negative control)
All steers and heifers (TBA implant)	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

Vetlife Research Database, 2007

Some key findings were:

- TBA implants had a minimal effect on quality grade for heifers. Heifers can be aggressively implanted for performance with limited effect on marbling.
- Implanting steers with lower strength TBA products will have a minimal effect on marbling. More potent TBA implants in steers can reduce marbling.

Some other research suggests that implants have no effect on marbling as long as cattle are fed to a common level of external fat cover. This would mean that if cattle are fed to a common carcass weight larger framed animal could have less marbling content. Delayed implanting is another management strategy to reduce their potential impact on carcass quality. A number of research studies suggest that delaying implanting cattle by 30-50 days will help improve marbling. This would minimize ADG and feed efficiency losses in cattle.

Implant potency should be matched to the ADG the animal can achieve. Cattle being fed for low daily gains (under 1.5 lbs/h/d) would not benefit from implants. Animals fed on a more conservative finishing program are best suited for moderate strength implants. Cattle on a more aggressive finishing ration are most suited for higher strength implants.

Research has shown that using a less aggressive implanting program can result in improved carcass grade.

The effect of implant potency on Certified Angus Beef (CAB) acceptance rates

CAB Acceptance Rate	Total Implant Potency Score*
0	5.25 ^a
0.1 to 19.9%	4.16 ^a
20-29.9%	4.17 ^a
Over 30%	2.53 ^b

Anderson and Gleghorn, Vetlife Technical Services

Differing superscripts are different at P<0.05, * is the number of times an animal is implanted, multiplied by the mean implant potency score

Low (1) Ralgro, Synovex C, Component EC, Compudose

Medium (2) Synovex S&H, Component ES, EH

Medium High (3) Synovex Choice, Component TE-IS

High (4) Revalor S, H, Component TE-S and TE-H

Aggressive (5) Synovex Plus, Revalor 200

Genetics and Sex Type of Cattle

Marbling is a moderately heritable trait in cattle. This means that genetic progress can be achieved by selecting for marbling within a breed. Breed of cattle can have an impact on grade quality. British breeds (Angus etc.) have been associated with more marbling than continental breeds. Managing type of cattle fed is another option to improve marbling.

Carcass grade based on % Angus breed in cattle

	Less than 25%	26-75%	Above 75%
% 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	0.8
Yield Grade % 4&5	1.0	1.5	3.0

Iowa Tri-County Steer Carcass Futurity, 2005

There is also carcass and marbling differences between sexes. In general, heifers have more marbling than steers. The results of comparing over 20 million carcasses since 2000 showed heifers produce more premium and choice grade quality (GW) carcasses.

Carcass quality based on sex of cattle

	Steers	Heifers	Difference
Dressing %	64.1	64.2	0.1%
Premium GQ, %	4.8	8.1	3.3%
Choice or Higher %	42.8	54.0	11.2%
Penalty GQ, %	6.3	4.6	1.7%
Heavy, % carcasses	3.8	0.5	3.3%

Anderson & Gleghorn, Vetlife Technical Services

Timing of castration of bull calves can also impact marbling. Male calves left intact for a longer period of time will have more lean growth. Castrated males deposit fat sooner thus increasing marbling. Also, intact males have a more aggressive disposition which has been shown to reduce marbling.

Effect of castration weight on marbling score

Castration Weight	Marbling Score*
154 lbs	5.0
506 lbs	5.4
704 lbs	4.2
902 lbs	4.0

Worrell et al., * marbling score: 3-3.9 = trace, 4-4.9 = slight, 5-5.9 = small

Animal Disposition/Temperament

Often overlooked is the impact of animal disposition on carcass grade. Research at Iowa State showed that cattle displaying more aggressive behaviour had reduced quality grades compared to more docile cattle. Housing and managing cattle in a more animal friendly manner can help improve carcass grades.

Effect of animal disposition on quality grade

	Docile	Restless	Aggressive
% CAB Accepted	29.1	22.8	14.3
% Select & Standard	19.8	25.1	37

Busby et al. 2006

Calves vs. Yearlings

There is a widely held industry belief that yearling cattle grade better than calves. However, recent research has shown this is not the case. Adipocyte (fat cells) develops at an early age in cattle. Feeding cattle a higher energy diet at a younger age will increase marbling in cattle.

Comparison of 500 vs. 900 lb cattle entering the feedlot on carcass grade

	Placement weight of Steers	
	500-599 lb	800-899 lb
Choice or higher, %	46.2	42.1
Penalty grades, %	6.1	6.5
Yield grade 4 or 5, %	5.0	5.5

Anderson & Gleghorn, Vetlife Technical Services

Other Factors Affecting Carcass Quality

Carcass Yield and Fat Cover

Marbling is a key component to carcass quality. However, feeding cattle for optimal carcass yield is also critical. Underfed cattle will have less marbling. As cattle get heavier they will have more marbling. Unfortunately, as cattle get fed for heavier weights they will also deposit more external fat, resulting in a lower yield grade for the carcass. Carcasses that are sold based on a grid could get discounts if they are too light or heavy.

Level of external carcass fat cover (inches) on carcass characteristics

	.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	13.2	17.7	22	21.4	17.4	12.7
Yield Grade, % 4 & 5	.7	.2	.3	.7	2	5.6	18.8	35.2	56.1

CAB Feedlot Licensing Program (FLP) database

Producers should also know the market conditions and buyer requirements for selling cattle to ensure discounts are not applied to over-fed cattle. Discounts can also be applied to cattle over thirty months of age (OTM).

There have been numerous reports that sorting cattle during the feedlot period can help improve marbling; however, no solid research is available. A summary of data from over 32,000 cattle suggests that sorting cattle has limited value in improving marbling. However, yield grade may benefit from sorting by reducing the number of over-fed cattle going to market.

Sorting cattle and its effect on carcass grade and quality

	Sort Number		
	0	1	2 or more
% 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
Yield Grade % 5	1.4	1.3	0.8

CAB Feedlot Licensing Program (FLP) database

Vitamin E

Feeding higher levels of vitamin E has been shown to improve shelf life of meat. Vitamin E decreases the incidence of rancidity and extends the red colour retention of meat. 500 IU/head/day of vitamin E for the final 100 days before slaughter is generally recommended.

There are many factors that influence marbling and carcass yield. Key on farm management and nutritional strategies to improve carcass quality includes:

- Feeding high energy, grain based diets
- Creep feeding calves
- Managing the amount of by-product ingredients fed to cattle
- Keeping cattle healthy
- Managing implant programs to minimize its effect on marbling
- Managing the genetics, age, disposition and sex of cattle fed on farm

The result will be improved meat quality for the consumer and the potential for greater returns for the beef producer.