

**Strategies for Managing Marbling in Beef Cattle**  
**Harlan Ritchie**  
**Distinguished Professor of Animal Science**  
**Michigan State University**  
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The objective of this paper is to review strategies that are known to enhance the level of marbling in beef. Research has demonstrated that marbling contributes significantly to beef's eating quality—primarily to flavor and juiciness—but also to tenderness. Furthermore, a recent study showed that consumers are willing to pay 50% more for well-marbled USDA Prime grade steaks than for lesser-marbled USDA Select grade steaks (\$3.66 vs. \$2.44/lb). At the production level, feedyards are paying significant premiums for feeder cattle that are known to have a propensity to marble and produce carcasses capable of grading Mid-Choice or higher (Modest degree of marbling or higher). Packers are likewise providing premiums for cattle of this type. It is estimated that the demand for highly-marbled beef for upscale restaurants and retail stores accounts for approximately 30% of the U.S. beef market. All of this begs the question, “What can cattle producers do to hit this high-quality market target?” The following sections will attempt to address this question.

### **Breed/Biological Type**

The scientific literature indicates that British breeds have a greater ability to marble than Continental and Brahman-influenced breeds. Among British breeds, Angus, Red Angus, and Shorthorn have a greater propensity to marble than most other breeds that originated in the British Isles. The only breed excelling these breeds in marbling is the Japanese Wagyu, which fits a limited but important niche market in the U.S.

Recent research revealed that as the percentage of Angus breeding increased from 0-25% up to 76-100%, the percentage of cattle qualifying for Mid-Choice or higher increased markedly from 11.4% to 37.1%. This in turn resulted in an increase in carcass quality grade premiums of \$37.29 per head. Similar results would be expected with Red Angus or Shorthorn breeding.

Extremes in biological type are difficult to fit into the high-quality beef market. Extremely large-framed, late-maturing biotypes are apt to produce overweight carcasses by the time they reach a Modest degree of marbling, resulting in severe price discounts. Conversely, extremely small-framed, early-maturing biotypes are at risk of producing underweight, overfat carcasses that will likewise experience severe price discounts. In either case, profitability will be jeopardized.

### **Genetic Selection**

Marbling is a moderately to highly heritable trait (about .40) which means that significant progress can be made by selecting for it within a breed. Most breeds now provide Expected Progeny Differences (EPDs) for marbling in their genetic evaluation programs. By selecting sires having marbling EPDs that are well above breed average, a reasonable increase in a herd's marbling potential can be made in a couple of generations of selection. Progress can be especially rapid if one uses highly proven A.I. sires with high marbling EPDs.

When selecting for a specific trait such as marbling, it is important to be aware of any economically important traits that may be antagonistically correlated with it. The scientific literature indicates that in general there are no major antagonisms between marbling and growth

traits. In fact, some studies have shown a positive correlation between marbling and growth. On the carcass side, increased marbling tends to be correlated with increased subcutaneous (external) fat and a higher numeric yield grade, which would be considered an antagonism. On the other hand, it also suggests that marbling may be related to “easier-keeping” cows which would be especially advantageous in those environments where feed resources are limited.

In summary, genetic antagonisms between marbling and other economically important traits do not appear to be a major problem. However, a word of caution is in order. There is evidence to suggest that extreme single-trait selection for marbling could eventually result in cattle that are lighter muscled, fatter, and have a lower percentage of retail product. This can be avoided by the judicious balancing of marbling with other economically important traits. In other words, the strategic use of EPDs.

### **Calf Health**

Iowa State Univ. researchers recently reported the effect of calf health and postweaning disease on feedyard performance and carcass traits. Calf health was classified as no treatment (NT), single treatment (1T), or two or more treatments (2T). Mortality rates were 0.05, 3.07, and 9.95%, respectively. Average daily gains (ADG) were 3.20, 3.02, and 2.93 lb/day, respectively. Percent of carcasses grading Low Choice or higher were 74.3, 64.6, and 57.5%, respectively. Percent of carcasses grading Standard were 2.2, 4.9, and 9.3%, respectively. Percent of carcasses yield grading 1 or 2 were 57.0, 67.7, and 73.1%, respectively. Because 1T and 2T calves yield graded lower, they returned \$2.90 and \$4.59 more per head than NT calves. However, lower quality grades for both groups decreased return per head by \$10.39 and \$19.41, respectively. In addition, there were more dark cutting carcasses in the 1T and 2T groups. Given the cumulative effects of disease, net return on non-treated calves was significantly higher than on 1T and 2T calves (\$85.02 and \$201.16, respectively). These results illustrate how calf disease can dramatically impact performance, carcass quality, and net return.

### **Disposition/Temperament**

A recent Iowa State Univ. study involving a total of 13,315 calves fed in eight Iowa feedyards evaluated the effects of disposition on performance and carcass characteristics. On arrival, calves were classified for disposition as docile, restless, or aggressive. Calves with ill-tempered, aggressive dispositions were lighter weight upon arrival at the feedyard, gained less, had higher mortality rates and higher treatment costs, reduced quality grades, and reduced Certified Angus Beef® (CAB) acceptance rates compared to docile and restless calves. When considering the effect of disposition on all of these factors, docile calves returned \$13.13 and \$62.19 more per head than restless and aggressive calves, respectively. Only 59% of aggressive calves graded Low Choice or higher compared to 74% for docile calves.

### **Early Weaning**

Research in recent years has demonstrated that weaning calves early (2½ to 5 mos. of age) and placing them on a high-energy, high-starch, grain-based diet can increase marbling levels compared to calves weaned at conventional ages (6 to 8 mos.). Early weaned (EW) calves are more susceptible to diseases such as diarrhea and respiratory problems than conventionally weaned (CW) calves. Consequently, they must be closely observed and promptly treated if symptoms are detected. If EW calves are fed a high-energy diet until the age at which they would normally be conventionally weaned, their body wt. will be equal to or greater than that of

CW calves. Feedlot avg. daily gain and carcass wt. tend to be slightly lower, yield grade is similar, and percent of carcasses grading Mid-Choice or higher is greater for EW compared to CW cattle.

An Illinois study showed that calves weaned early at 142 days of age and harvested at 16½ mos. were 20% more efficient in feed conversion at any marbling endpoint than CW calves harvested as long yearlings at 29 mos. The costs of EW are often greater than that of CW, but these tend to be offset by reduced cow feed costs. When the stress of lactation is eliminated by EW, cows gain body wt. and condition. If EW calves are weaned prior to the start of breeding season, pregnancy rates of their dams can be increased.

Whole shelled corn works well in EW diets along with commercial supplements of the type that are used in calf-fed Holstein programs. The initial diet should contain about 16% protein until the calves weigh 600 lb. It can then be reduced to 12.5%. The supplement should contain an ionophore to reduce the risk of acidosis and bloat. EW calves can be implanted with growth stimulants without jeopardizing marbling as long as the proper implants are given at the proper times. The calves can be implanted twice about 100 days apart with low-dose estrogenic implants (e.g., Ralgro® or Synovex-C®). For the last 120 days, a combination estrogen-androgen implant can be used (e.g., Revalor® or Synovex-S®).

### **Creep Feeding**

Extensive studies at the Univ. of Illinois have shown that getting nursing calves to consume a high-energy creep diet as early as possible will enhance marbling deposition. To achieve the increase in marbling, calves need to be on creep feed for at least 80 days. The diet should be based on corn or other high-energy grains, rather than high-fiber feedstuffs such as soyhulls, to maximize the initiation of marbling. As in the case of early-weaned calves, shelled corn can work well in these diets. In one trial, percentages of calves grading Mid-Choice or higher were as follows: corn-based creep, 55%; soyhull-based creep, 34%; Control, 28%. Calves on the corn-based creep also had significantly greater carcass weights.

A word of caution is in order. Heifer calves destined to be retained as replacements should not be creep-fed. It has been demonstrated that future milk production will be reduced by an average of 25%. This holds true for Continental as well as British heifers.

### **Age at Harvest**

For many years, it was believed that cattle fed and harvested as yearlings have more marbling and graded higher than calf-feds. Recently, a number of studies have shown this does not hold true. In these studies, calf-feds have had marbling scores and USDA quality grades that were equal or superior to those of yearlings.

### **Season of Year**

The effects of season of the year when cattle are harvested on percentage grading Choice are well documented. In general, the percentage that grade Low Choice or higher increases in the spring and peaks around April. From there, it gradually declines to a low point in October, and then the cycle is repeated. Research has indicated that this trend is related to the diets that cattle are fed for 4-6 months prior to harvest. Cattle harvested in the fall often enter the feedlot in late spring or early summer after coming off lush growing grasses or wheat pasture that have extremely high concentrations of vitamin A. It is known that high vitamin A levels in the blood

plasma can slow down marbling deposition. In contrast, cattle entering the feedlot after consuming dry forage diets do not experience this decrease in rate of marbling deposition.

### **High Oil Corn**

Corn has been developed that contains twice the oil content of conventional corn. In a Univ. of Georgia study, it was found that feeding dry rolled high oil corn in finishing diets for 93 days increased marbling score and the percentage of cattle grading Choice from 42 to 72%. Furthermore, the percentage of carcasses that qualified for Certified Angus Beef® was greater for high oil corn than conventional corn (32% vs. 16%). Iowa State Univ. researchers also observed an increase in the percentage of carcasses grading Choice when whole shelled high oil corn was fed (57% vs. 43%). Whether there is adequate incentive for corn growers to produce high oil corn remains to be seen.

### **Restricted Growth**

A period of slowed growth after weaning for an extended period of time has been shown to reduce eventual marbling and quality grade in the carcass. Research has not yet precisely determined the minimum ADG below which marbling is at risk of being lowered. Some have suggested that the minimum ADG required would be roughly equivalent to that needed for a weaned heifer calf to reach puberty on schedule in order to conceive at 14-15 mos. of age. For a British heifer, the bare minimum would be about 1.0 lb/day, and for a Continental heifer, it would be about 1.25 lb/day.

### **Growth Promotants**

#### **Implants**

Growth promotants given to cattle as implants are powerful tools that increase the efficiency of beef production. These products may improve ADG by as much as 20%, improve feed efficiency by 10%, and increase carcass wt. substantially when harvested at a constant age or days on feed. When cattle are harvested at a constant body wt., carcasses from implanted cattle will have a greater lean-to-fat-ratio than carcasses from nonimplanted cattle. However, there can be a down side to these products. If the appropriate implants are not administered at the appropriate times, there can be a reduction in marbling. But when used properly, this problem can be averted.

Contrary to previous thinking, recent studies have shown that marbling deposition begins early in life. This means that implanting should be delayed until such a time that the animal is consuming enough energy above that required for maintenance and maximum muscle growth in order to accommodate marbling deposition. It also means that the initial implant should not consist of an aggressive, high-potency product. A partial list of low-, moderate-, and high-potency implants is presented in Table 1.

Based upon an extensive amount of research, South Dakota State Univ. scientists have developed the following guidelines for implanting cattle destined to be sold on a high quality marketing grid.

**Backgrounding Programs:** Programs where ADG is 1.75 lb or less should probably not include an implant. If ADG is targeted at 1.75 to 2.25 lb, use a low-potency implant with a payout window of 50 to 80 days. If ADG is greater than 2.5 lb, use a moderate-potency implant

with a window of 80 to 110 days. If the cattle are large-framed steers, increase these ADG targets by 0.25 lb.

**Previously Weaned 575-lb Calves to be Fed for 200 Days.** This program would allow a low-potency implant with a 60- to 70-day window followed by a high-potency implant.

**Backgrounded 650-lb Steers to be Fed for 150 to 160 Days.** In lower energy finishing programs (less than .58 Mcal NEg/lb), you can use two moderate-potency implants, with at least 75 days between the two implants. For lower conditioned cattle, a low-potency implant (50 days) followed by a high-potency implant can work well. For cattle in good condition, you could use a moderate-potency implant followed by a high-potency implant.

**Young 750-lb Cattle to be Fed Less than 140 Days.** If these cattle have been well-fed throughout their life, the implant strategy can be relatively aggressive in order to increase carcass wt. A low (50 days) – high strategy works well. If cattle are of good flesh, a single high-potency implant could be used.

**Older Cattle Weighing 750 lb or More and Fed for Less than 130 days.** If these cattle are capable of substantial compensatory growth, they may not be suited for a high quality program. Implanting should be delayed until cattle are clearly on full feed. With limited days remaining, a moderate-potency implant seems appropriate.

Organic and Natural beef production programs do not permit the use of implants. When considering whether to be engaged in such programs, one must weigh the potential premiums to be garnered against the additional costs involved, including the cost of not implanting. According to a Colorado State Univ. analysis, the reduction in returns from not using implants ranges from \$25 to \$80 per head .

### **Ionophores**

Feeding an ionophore (e.g., Rumensin®, Bovatec®, Cattlyst®) is an economical means of improving ADG and feed efficiency as well as reducing the risk of acidosis and bloat. The cost of feeding an ionophore is only a few cents per head per day. Supplementation with an ionophore has been shown to improve ADG by 3 to 5% and feed efficiency by an average of 8%. When used in combination with an implant, those benefits are on top of those received from the implant alone. There is no evidence in the scientific literature to suggest that ionophores have a negative effect on marbling deposition.

### **Melengestrol Acetate (MGA®)**

The feed additive, MGA, is approved for use in feedlot heifers to suppress heat and improve performance. On average, it will increase ADG by 3 to 5% and feed efficiency by 4 to 8%. MGA has no influence on marbling deposition.

### **Ractopamine (Optaflexx®)**

The feed additive, Optaflexx, is approved for feeding during the last 28 to 42 days of the finishing period at a level of 100 to 300 mg/head/day. When fed at the recommended level of 200 mg, research shows that it has the following effects: live wt. and carcass wt. are increased

by an average of 17 and 14 lb, respectively, with no increase in feed intake, resulting in about a 15% improvement in feed efficiency; ribeye area is increased by 0.4 sq. in.; fat thickness is not affected; and numeric yield grade is slightly lower (-0.1). Marbling is not affected, nor is tenderness as measured by either shear force or human taste panel. At the 300 mg level, performance and carcass muscling are further enhanced. However, meat tenderness is reduced significantly. Consequently, the 300 mg level is not generally recommended.

**Table 1. Partial List of Growth Implants Classified by Relative Potency<sup>a</sup>**

<b>Potency Level<sup>b</sup></b>	<b>Animal application</b>	<b>Days</b>	<b>Physiological Effect</b>
<b>Low Potency</b>			
Ralgro	steers, heifers, calves	50-75	estrogenic
Synovex-C	calves	50-75	estrogenic
Component E-C	calves	50-75	estrogenic
<b>Moderate Potency</b>			
Compudose	steers, heifers, steer calves	150-120	estrogenic
Encore	steers, heifers, steer calves	400	estrogenic
Component E-S	steers	80-120	estrogenic
Synovex-S	steers	80-120	estrogenic
Component E-H	heifers	80-120	estrogenic & androgenic
Synovex-H	heifers	80-120	estrogenic & androgenic
Magnum	steers	80-120	estrogenic
Revalor-G	pasture steers & heifers	60-80	estrogenic & androgenic
Finaplix-H	heifers	60-100	androgenic
Component T-H	heifers	60-100	androgenic
Component T-S	steers	60-100	androgenic
<b>High Potency</b>			
Component TE-S	steers	80-120	estrogenic & androgenic
Revalor-S	steers	80-120	estrogenic & androgenic
Synovex-Plus	steers, heifers	100-140	estrogenic & androgenic
Revalor-H	heifers	80-120	estrogenic & androgenic

<sup>a</sup>Adapted from Pritchard (2005).

<sup>b</sup>Relative classification based primarily on dosage.

<sup>c</sup>Intended as a reference point when formulating implant strategies for cattle intended for harvest.