Managing cattle feeding programs for marbling

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Abstract. Managed cattle feeding programs are integral to the achievement of maximum genetic expression of marbling. Genetics set a limit to marbling but achieving this limit depends on nutritional factors (grain versus grass; feed intake; days on feed; ionophores) and annual management factors (age; sex; background nutrition; supplementation; castration; animal health; HGP implants). This paper reviews all these factors and assesses their relative importance.

Introduction

Cattle feeding programs in Australia have more rapidly evolved to specifically address desired carcass outcomes than our companion industry in the US. However, more recently with the increased participation of US cattle feeders in Branded Beef Programs and Meat Processor driven alliances there has been accompanying emphasis on carcass quality programs.

Fundamentally, feeding cattle for extended periods to maximise genetic marbling deposition encompasses the management of dietary energy intake within a complexity of pre-feedlot entry variables, within feedlot management options and cattle marketing limitations. Moreover, in the present cattle supply climate, this is further complicated by dynamic changes in feedlot cattle youth at entry, an increase in feedlot disease challenge and high costs of feed inputs. Therefore, the need to assure cattle marbling within an extreme cost equation has been unprecedented in Australian cattle feeding history.

The following paper has been written with the purpose of briefly reviewing cattle and feedlot management factors that may potentially impact cattle marbling performance, and consequently carcass value.

Variables affecting marbling performance

While you cannot feed cattle beyond their genetic capacity to marble, there are groups of factors (or opportunities) that can be managed from the cattle feedlot perspective. These include:

Nutrition

- Grain versus grass
- Feed intake
- Days on feed
- Ionophores

Animal management factors

- Age class
- Backgrounding nutrition
- Creep feeding
- Age at castration
- Animal health
- Implants

Nutritional factors

Grain versus grass

Evaluation of grain versus grass fed beef finishing systems (Williams *et al.* 1983) identified that consumption of the grain diets increased carcass marbling scores, USDA Quality Grade and percent fat in the soft tissues. Similarly, recent results cited from Australian Cooperative Research Centre for Cattle and Beef Quality (CRC) research, identify: (a) grain-fed beef at the same carcass weight are fatter than grass-fed cattle; and, (b) feedlot cattle have higher marbling scores than pasture finished beef (Oddy 2000).

Feed intake

The proportion of fat in weight gain is related to the rate of gain as well as to body weight (NRC 1996). Berg and Butterfield (1976) described the partitioning of nutrients as a hydraulic process, whereby available nutrients were allocated first to high priority processes such as maintenance, or specific tissues (such as brain), then to lower priority tissues, with fat being lowest of all. Using this model, fat accretion will only occur following the satisfaction of priority tissue energy requirements. Evaluating diet energy density in relation to days on feed, Burson *et al.* (1980) noted that means for adjusted fat thickness and percentage kidney, pelvic and heart fat were

lowest for carcasses from cattle fed sub maintenance diets, while cattle fed a energy dense ration for 175 days had the most external fat as well as the most internal fat. More recent efforts (Hicks *et al.* 1990; Hermesmeyer *et al.* 2000; Rossi *et al.* 2001) to improve cattle feed efficiency by restricting or programming intake repeatedly have a negative impact on marbling scores, regardless of days on feed, extent of the feed limiting period in the total feeding period. Therefore, one can conclude that any form of feed intake restriction from feedlot management strategies (or their absence), and (or) environmental conditions (season) may negatively impact the capability of cattle to maximise marbling deposition.

Days on feed

The most common methodology utilised to increase carcass marbling is to increase days on feed. Regardless of cattle breed type or maturity, serial slaughter studies (Zinn *et al.* 1970; Tatum *et al.* 1980; Dolezal *et al.* 1982; Williams *et al.* 1989; Huffhines *et al.* 1992; Duckett *et al.* 1993; Van Koevering *et al.* 1995) repeatedly confirm as days on a high energy density ration is increased, so does marbling deposition in a non-linear manner.

Zinn (1970) showed with calf-feds that marbling score increased significantly up to 240 days on feed, while other researchers (Williams *et al.* 1989 and May *et al.* 1992) found that increased time on feed from 84 to 112 days increased marbling score, however, after 112 days marbling score remained relatively constant. Duckett *et al.* (1993) identified that intramuscular lipid content in the loin increased two-fold from 84 to 112 days on feed, but did not differ from days 0 to 84 and from day 112 to 196. These authors concluded that the increase in loin intramuscular lipid associated with increasing days on feed was attributable to enlargement of the adipocyte cell versus an increase in adipocyte number.

Nash *et al.* (1989) used serial real time ultrasound measurements to evaluate increases in loin lipid content as days on feed increased. Carcasses grading USDA Choice increased from 20% at day-84 to 80% at day-100 and 120 on feed.

Ionophores

Ionophores have been reported not to influence marbling deposition, despite greater quantities of propionate available for fatty acid synthesis (Duckett and Wagner 1997). However, monensin has been noted to increase odd-chain and branched-chain fatty acids in loin muscle (Marmer *et al.* 1985).

Animal management factors

Genetic and cattle biological type influences on marbling have been addressed by other authors at this conference. Therefore, I will direct attention to animal factors as affected by management immediately prior to, or during the feeding period.

Age class

Feeder cattle maturity and age can dramatically affect feedlot performance and marbling. Cattle entering the feedlot as weaners (9-months of age), yearlings (approximately one year of age) and various Bullock categories greater than 18-months of age (370 – 450 kg), require different management programs to meet specific slaughter endpoints. The days on feed required to reach incremental carcass weights and degree of fatness varies with age. Totusek (1971) noted that as initial age of feedlot cattle increased, fewer days on feed were required to reach a grade endpoint with heavier carcasses attained. Lunt *et al.* (1987) evaluated differences between weanling and yearling heifers that were slaughtered at a constant weight. While yearlings were more efficient, weanlings had carcasses that were assigned higher marbling scores and greater dressing percentages. Rib eye area was not different between the two age-classes.

Harris *et al.* (1997) utilised 18 sets of nuclear clones (selected for a propensity to marble) in two experiments to allow for the separation of animal age and feeding regimen. Clone pairs in each of the experiments were fed as calf or yearlings to either (1) constant age endpoint, or (2) a constant live weight endpoint. Not suprisingly, results of experiment 1 utilising clone pairs fed to a constant age (16-months) identified calf-feds (fed for 217 days) to be heavier, with higher dressing percentages and marbling scores than the yearlings fed for 93 days. Average daily gain was similar for both cattle groups. More interesting was the results of the second experiment in which clone pairs (calf-fed versus yearling-fed) were fed for 224 and 182 days, respectively, to a constant live-weight endpoint of 528 kg. Contrasts of carcass data identified calf-feds to still have higher dressing percentages, greater external fat thickness and similar marbling scores than yearlings. Yearlings have larger rib eye areas and less internal fat than the calf feds.

At the extreme, Zimbayashi *et al.* (1999) and Smith *et al.* (2000; Unpublished data) noted that while Angus and Charolais-crossbred cattle reach a marbling plateau at approximately 700 days of age, Japanese Black cattle continue to accumulate lipid in the loin up to nearly 1200 days of age.

Backgrounding

Two studies (Burton *et al.* 1993; Deering *et al.* 1993) determined the effect of feedlot age and background on carcass traits. Steers of Angus heritage were allocated to five treatments of either (a) early weaned directly to feedlot at 3.5 months of age; (b) normally weaned and placed into feedlot at 7.9 months; (c) backgrounded on wheat pasture for 112 days then placed in the feedlot at 11.6 months; (d) dry wintered and then grazed prior to feedlot placement at 15.4 months; (e) dry wintered and long grazed for 122 days prior to feedlot placement at 17.4 months of age. At a constant fat thickness, early weaned and normally weaned cattle resulted in lighter carcasses than backgrounded steers, but no differences were noted among age treatments for marbling score, rib eye area or USDA Yield Grade. Interestingly, Burton *et al.* (1993) did note skeletal maturity scores were not different for steers directly placed into the feedlot versus short backgrounded steers, however, the two extended-grazing treatments resulted in carcasses with more advanced skeletal ossification than

carcasses from short-grazed steers.

The implications of this later study are important for the management of smaller frame feeder steers, such that carcass weight targets at a given marbling score can be achieved. Moreover, effects of skeletal maturity have obvious impacts for cattle submitted under the Meat Standards Australia grading program.

Creep feeding

Provision of self-fed, creep supplements to beef calves can be employed as a means to increase weaning weights, and, hence profitability of breeding enterprises. Although a number of creep studies have been conducted, one of notable interest is that of Faulkner *et al.* (1994). These researchers supplemented corn and soybean hulls to suckling calves and observed creep feeding to decrease forage consumption but had no effect on milk consumption relative to unsupplemented controls. While preweaning supplementation did not impact growing or finishing performance, increased marbling scores (attributed to differences in overall fatness) were reported in the supplemented group.

Age at castration

The impact of hormones on growth can be summarised into testosterone prolongs growth of muscle and delay the onset of fattening, while oestrogen hastens physiological maturity and fat deposition. Studies conducted to evaluate the age of castration on beef carcass characteristics (Champagne *et al.* 1969) identified that castrating at 2 and 7-months of age provided fatter carcasses that were assigned higher marbling scores than carcasses from steers castrated at 9-months or non castrates.

Animal health

Bovine Respiratory Disease complex is the most important disease affecting cattle in Australian and North American feedlots (Furman 1993; MLA 2001). Moreover, results each year from the Texas A & M Ranch to Rail program (1993 – 2000) have identified a reduction in the incidence of carcasses grading USDA Choice between 12% and 17% for cattle that have been treated (McNeill 2000). Of significance to cattle producers is that only 24 to 30% of reduced income from these cattle is from medical treatments and livestock losses. The balance, (exceeding $100 per head in 1999/2000) was attributable to reductions in liveweight performance and marbling. Gardner *et al.* (1999) reported from an investigation of finishing steer health on carcass traits that hot carcass weight, average daily gain, fat thickness and marbling score were negatively affected by respiratory disease treatment. Moreover, these same researchers identified that the presence of a respiratory tract lesion at slaughter (both inactive or active) depressed carcass marbling scores. Similar results for cattle treatments have been reported by Roeber *et al.* (2000) in for the entire feeding period, and Stovall *et al.* (2000) when respiratory disease was confined to the initial receiving period. However, in the study of Roeber *et al.* (2000), morbidity rates were significantly lower for cattle that underwent a preconditioning program prior to feedlot entry.

Implants

Although this is being addressed specifically by another author, some brief comments can be made.

Anabolic steroids alter the mature body size of beef steers (Preston 1978). Furthermore, oestrogenic and androgenic implants increase the percentage of muscle and decrease the percentage of fat in the carcass. Implants increase hot carcass weight, loin muscle area and lean tissue yield (Combs and Hinman 1985; Preston 1978). Duckett *et al.* (1999) reported a decrease in marbling score when cattle were implanted with oestradiol benzoate and trenbolone acetate compared to controls, however, the absolute quantity of fat present in a loin section was similar in implanted and non-implanted steers. Hence the decrease in marbling score was a result of increased muscling and *longissimus* muscle area rather than a direct decrease in intramuscular fat. More recently, a study (Platter *et al.* 2001) examining the impact of sequential implant administration throughout the production life of steers identified reductions in marbling score as the number implants progressively increased from one to four.

Conclusion

While one cannot feed or manage marbling beyond the genetic limitations of a feeder animal, nutrition and animal management systems can have a dramatic impact on the realisation of this genetic merit. An understanding of the science and physiological concepts is instrumental for effective management of cattle to appropriate slaughter endpoints.

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