Carcass Value as a Consequence of the Growth Curve

Robbi H. Pritchard
South Dakota State University, Brookings

Introduction

The general overview of growth is that the accumulation of mass over time follows a sigmoidal curve (Fig. 1). During this growth, the priority of fuel use for tissues is highest for skeleton, followed by muscle and eventually adipose (Hammond, 1932). Within adipose the priority (high to low) was originally reported (Andrews, 1958) and is generally perceived to be internal, intermuscular, subcutaneous, and intramuscular.

Today, we use the NRC model in which the mature size is associated with the apex of the sigmoidal growth curve and the Choice grade is set at 28% empty body fat (EBF). These reference points are powerful tools that permit significant progress in managing and/or predicting cattle production. Still, we feed cattle that fail to fit the targets. The intention here is to discuss where those deviations occur to increase our ability to exploit them for commercial purposes.

Manipulating the Growth Curve

Place a medium framed steer calf in the feedlot, and provide a grower diet for two years, and he will become an 1800 lb, Yield Grade 3 steer. His contemporaries, fed more energy dense diets, were Choice, Yield Grade 3 steers one year earlier at 1300 lb. We can change the growth curve. We should recognize that the truly normal growth curve resulted in the 1800 lb steer. Our perverted version of normal produces the 1300 lb steer. Both steers are probably 28% EBF at these referenced points. The degree of marbling expected in each steer is the point of debate.

To better understand how marbling progresses during growth, Bruns et al. (2004) conducted a serial slaughter experiment. Marbling and ribfat were evaluated relative to increasing carcass weight (Fig. 2). In steers fed sufficient energy to exceed bone and muscle demands for fuel, intramuscular fat accumulated at a constant rate of carcass growth. This occurred as body weight increased from 776 to 1294 lb. In contrast, ribfat increased quadratically over this same body weight range. The relationship between these two lines suggests that increases in Quality Grade at given Yield Grade actually occur quite early in the feeding period.

There is other evidence that growth rate in early life can alter the relationship between intramuscular and subcutaneous fat. Suess et al. (1969) reported that early growth restriction (from high to moderate energy) resulted in lowered intramuscular fat at harvest. Conversely, Meyers et al. (1999) indicated that increasing early growth by early weaning (age 117 d) caused relative increases in marbling at harvest as compared to a more typical production system (weaning age 413 d). Time windows (age or weight) and effective levels of growth restriction have not been defined. More research into the allometry of intramuscular adipose development is needed.

Implants alter the growth curve, effectively increasing the frame size of cattle (Loy et al.1988). Rather than altering diet, their influence would be to alter fuel requirements. In 9 mo old steer calves, Bruns (et al 2004) observed that exposure to 24 mg estradiol + 120 mg TBA at 681 lb depressed intramuscular fat accumulation in the subsequent 56 d and that no compensatory recovery of intramuscular fat was achieved. In contrast, the same implant administered to contemporary steers after they reached 890 lb had little effect on intramuscular fat accumulation. The influence of the implant on marbling was presumed to be sensitive to the stage of growth and caloric intake of the steers.

We have an example of this interaction in average or thin-fleshed yearling steers. Implant treatments included: 1) non-implanted control; 2) Synovex Plus, d_1; 3) Revalor-S, d_1; and, 4) Ralgro, d_1 + Revalor-S, d_56. There were 50 steers in each Flesh x Implant cell. The percentage Choice or better carcasses are shown in Table 1. Steers with little condition at feedlot arrival may have had their growth curve distorted sufficiently to depress normal muscle and adipose accumulations for their body weight-age. Exposing those steers to a strong anabolic resulted in a dramatic depression in Quality Grades persistent after 140 d on feed. Using a less powerful anabolic during early compensatory growth (Treatment 4) greatly reduced this effect. While similar patterns exist in the moderate flesh cattle, the magnitude of the responses was quenched, which greatly improved carcass value at harvest.

Carcass Value

The single, greatest driver of carcass value is weight. Manipulation of the growth curve by using implants or by lowering energy intake to achieve deferred growth is to a large extent driven by the outcome of heavier final body weight (and carcass weight) of the animal. With growing concerns over carcass marbling, it is important to keep relative values in perspective. Table 2 shows value changes for 800 or 820 lb carcass at 50% or 60% Choice with Choice-Select spreads at $5 or $20/cwt. With a $5 spread, a 10% point improvement in Choice adds $4/head in value, while a 20 lb increase in carcass weight added $24/head. Using a $20 spread, the grade improvement was worth $16/head, only 66% of the value of 20 lb of carcass weight ($120/cwt base carcass price).

Genetics play an important role in all of this. Carcass weight, cutability, and marbling are highly heritable. We can impose manipulations of the growth curve by diet or anabolics to change the genetic setpoint for carcass weight and cutability in either direction. I am not aware of evidence that we can stimulate marbling; only that we can depress marbling. If a given set of cattle do not grade, we are challenged to discern whether this outcome was due to genetics or management. As an industry, we must be cognizant of the potential cost of management done to protect Quality Grade in cattle that were genetically predisposed to not grade.

Interpretation of carcass data is important. A great example is associated with YG 4 carcasses. Did these come about because the cattle were on feed too long, because there were too many smaller framed cattle in the lot, because there was a group of cattle within the lot with greater growth rate or efficiency that was achieved without increasing frame size, or was implanting technique inadequate leaving those individuals with less anabolic stimulus?

Another example of caution interpreting carcass data is the relationship between fatness and Quality Grade. There is very little correlation between individual ribfat thickness and marbling. However, as we increase days on feed and fatness, the percentage Choice cattle increase. To better understand this phenomenon, I pooled ribfat and marbling scores on nearly 3,000 carcass records. I then calculated the percentage Choice among all carcasses at any given fat thickness over a range of 0.1 to 1.1 in. in 0.05 in. increments. Results of this analysis (Fig. 3) showed that the frequency of Choice carcasses did not improve after cattle achieved 0.4 in. ribfat. Differences in percentage of Choice carcasses between lots of cattle were expressed two ways. One outcome was for the plateau to be higher or lower for any given lot. This may have been rooted in genetics or in errors made while manipulating growth. The other outcome was that higher or lower grading was driven by the proportion of carcasses within the lot that had achieved 0.4 in. ribfat. With more days on feed cattle are fatter. The grade improvement occurs in part because the median fat thickness has moved further to the right of the 0.4 in threshold. There were no indications in this dataset that high quality cattle reached the inflection point at a lower fat thickness, but further research should be done to confirm that observation.

Summary

We can defer growth to affect mature size. While this makes cattle older, it does not enhance their ability to grade Choice. The development of marbling apparently begins relatively early in life. This can be suppressed by nutrition or implants. The fact that marbling may be lower months after the insult has occurred suggests that there is no compensatory growth at this tissue bed.

An important area of research in coming years will be to determine how to minimize depression of intramuscular adipose growth and still achieve current targets for carcass weight and production costs.

Literature Cited

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Table 1. Implant Treatment Cattle Interactions for Carcasses Grading Choice or Better

	Treatment				
	1	2	3	4	$\bar{x}$
	Control	Synovex Plus	Revalor-S	Ralgro Revalor-S	
Initial body condition			≥Choice, %		
Moderate	67.4	54.0	58.0	59.2	59.6
Thin	69.4	32.0	44.0	60.0	51.3

Table 2. Relative Carcass Value Responses to Grade and Weight[a]

		Spread			
		$5/cwt		$20/cwt	
Carcass weight	Choice/Select	$/cwt	$/hd	$/cwt	$/hd
800	50/50	117.50	940	110.00	880
800	60/40	118.00	944	112.00	896
820	50/50	117.50	963.50	110.00	902
820	60/40	118.00	967	112.00	918.40
Advantage, $/hd					
Grade improvement		+4.00		+16.00	
Pounds improvement		+23.50		+22.00	

[a]Base: $120/cwt 800 lb carcass

Figure 1. Normal postnatal growth curves of bone, muscle, and fat.

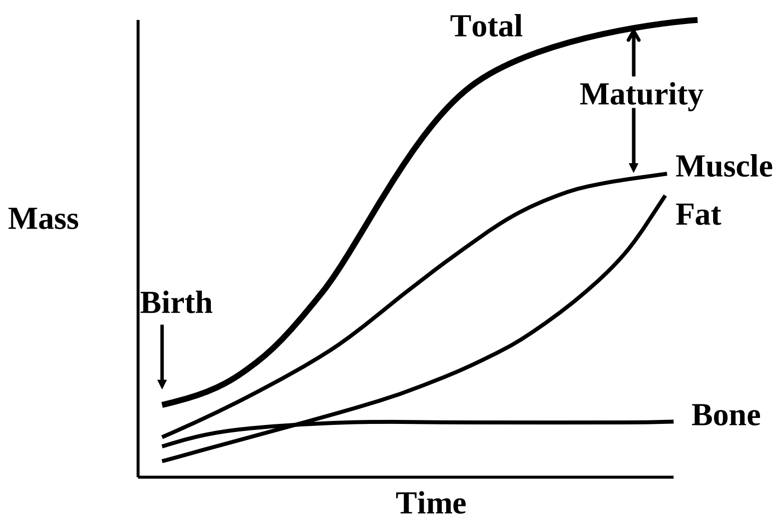

Figure 2. Backfat and marbling regressed against hot carcass weight (HCW).

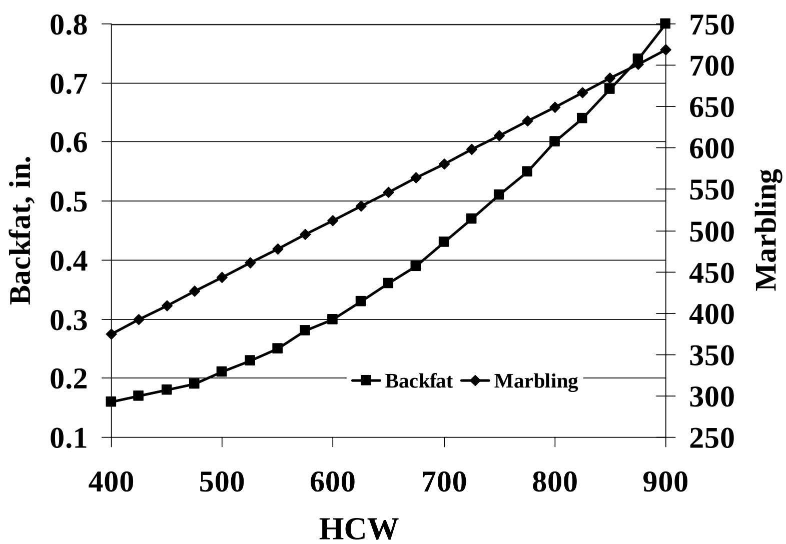

Figure 3. Choice or better grade frequency across ribfat distributions.