MATCHING CATTLE TYPE AND FEEDLOT PERFORMANCE **Issue 8**
August 1990

Pete Anderson
Extension Beef Cattle Specialist

Introduction

Correct projection of breakeven prices is essential to profitable cattle feeding. In order to calculate breakevens correctly, feedlot performance must be predicted accurately. Average daily feed intake (ADFI), average daily gain (ADG), feed conversion (F/G), days on feed, carcass characteristics, morbidity and mortality can vary greatly from one group of cattle to another. This paper will review the factors that are known to affect feedlot performance in order to allow feeders to improve their skills of matching cattle type and feedlot performance. Factors that will be described include: starting weight or age, frame size, muscling, breed, sex, implant status, condition or previous nutrition, previous management and environment.

Starting Age or Weight. Feed intake is the only performance characteristic that is routinely measured in commercial feedyards on a daily basis and is highly related to both gain and efficiency (Table 1). Under most circumstances, average daily gain can be predicted from feed intake. Obtaining maximum, consistent feed intake is a goal of cattle feeders. Both age (calves vs. yearlings) and starting weight have dramatic, predictable effects on dry matter intake of feedlot cattle.
Most predictions of feed intake are based on equations that anticipate a curvilinear increase in feed intake as weight increases. That is, as cattle get heavier, feed intake increases, but intake as a percent of body weight decreases. Age is not considered in some intake projections. It is difficult to separate the effects of age from the effects of weight but they are not identical.

Researchers at Oklahoma State University (Hicks et al., 1990 a,b; Figures 1-3 are from these references, see also FEEDSTUFFS, March 19, 1990) analyzed records compiled by a large commercial feedlot in Oklahoma. As shown in Figure 1, cattle exhibited a predictable pattern of feed intake which was closely related to their starting weight. In general, feed intake of all groups of cattle increased rapidly just after the beginning of the feeding period, as the cattle adapted to feed. Intake then increased slowly or plateaued as weight increased until the end of the feeding period, when intake declined. A similar pattern was observed in all cattle, regardless of starting weight; however, intake was higher at all points for cattle that were heavier when placed on feed. This would suggest that predictions of ADG, based on estimated feed intake, that do not consider initial weight, may overestimate performance of heavy cattle.

Figure 2 describes the differing feed intake patterns of calves and yearlings, compared at the same number of days on feed. While calves will differ in weight from yearlings in most cases, the difference in weight does not explain all of the difference in feed intake. Yearling cattle exhibit a predictable feed intake pattern, which includes a linear increase for the first 40-50 days on feed, a 40 day plateau, followed by declining feed intake until slaughter. Calves, on the other hand, increase intake at a more gradual pace for approximately 70 days, then plateau.

Frame size. Few variables are as well understood, or have been as thoroughly discussed, as the effects of frame size on beef cattle performance. Although the general shape of the growth curve is not different regardless of frame size, cattle of similar age or weight will not be at similar points on the growth curve, if they differ in frame size. Independent of breed effects, increased frame size results in increased rate of growth, increased time required to reach choice quality, decreased fat thickness and marbling at equal weight, and increased weight at equal fat thickness. Since large framed cattle are actually less mature than small framed cattle at equal weight or age, their gains during any period are more efficient. This is because the large framed cattle are gaining more muscle, which contains mostly water, and less fat, which contains a great deal of energy. However, when fed to equal carcass composition, large and small framed cattle are usually similar in efficiency.

The effect of frame size on growth rate and profitability, as reported by researchers at Kansas State University, is shown in Table 3. Rate of gain increased with frame size but profit plateaued when yearling height reached 47". In this study, the most profitable cattle were those that combined ability to grow rapidly and reach the choice quality grade.

While frame size can be useful in predicting the weight at which cattle will grade choice (Table 2), it is important to realize that frame size is only a marginal predictor of performance. A recent study at Michigan State University points that out clearly. As part of a larger experiment, two groups of cattle with similar frame scores were fed. One group was an unselected line, the other group was from a herd that selected heavily for growth, but not frame size, for several generations. Over a 221 day feeding period, the selected cattle out-gained the unselected cattle 3.1 lb per day to 2.4 lb per day. This 29% advantage in rate of gain produced 155 more pounds of gain per head in the selected group although frame size was similar. Cattle feeders should strive to obtain cattle from herds that have selected for performance, rather than assuming that frame size will assure rate of gain.

An important aspect to consider is the interaction between frame size and dietary energy content. Prior et al. (1977) fed diets with low, medium or high energy content to small framed (Angus x Hereford crosses) or large framed (Charolais and Chianina crosses), during feeding periods of various lengths. Data are shown in Table 4, low energy data are omitted since these diets would be impractical for an entire feeding period. Increasing the energy density of the diet increased ADG and improved feed conversion in both types of cattle and increased all measures of fatness in small framed, but not large framed cattle. The authors concluded that high energy diets promote weight gain in both large and small framed cattle, but that the added weight gain in small framed cattle was fat, while added gain in large cattle was muscle. Other studies have resulted in similar conclusions; however, they must be considered with some skepticism. In the study of Prior et al. (1977), small framed cattle were slaughtered at an average yield grade of 4.2, large framed cattle, 3.0. Using regression analysis, the authors estimated that dietary energy required for deposition of a pound of lean was equal across dietary treatments and frame sizes.

Muscling. Muscle has become a buzzword in the industry in the past few years. From packers to show ring judges, nearly everyone is extolling the virtues of muscular cattle as if they had just discovered the first ones. In reality, the industry should be reprimanded for having produced too many light muscled cattle in recent decades. Whether premiums will be paid for muscular carcasses remains to be seen but it is clear that deep discounts will be assigned to light muscled carcasses. The goal of the industry should be to produce carcasses with 2.0 square inches of ribeye area per 100 lb of carcass weight. Carcasses with less than 1.6 square inches of rib eye area per 100 lb carcass weight will be penalized severely, those with less than 1.8 may also be discounted. Since current industry average is approximately 1.8, it is clear that crossbreeding systems and within-breed bull and female selection must change.

Researchers at Colorado State University have examined the performance and cutout differences in cattle varying in muscularity. Feeder calves representing the three USDA feeder calf muscle scores (1-3, 1 is most muscular) and frame sizes (large, medium and small) were fed to slaughter. Frame size had expected effects on performance and slaughter weight, but muscling did not affect feedlot growth rate, although muscular calves were much heavier entering the feedlot. Change in live weight is a poor variable to describe performance of cattle that differ in muscling. In this study, muscular cattle had higher dressing percentages and greater muscle yield, despite no difference in growth rate or live weight. This indicates that the rate of muscle weight gain was greater in muscular cattle. If future carcass or live cattle pricing structures are based on muscle or lean content of the carcass, rather than simply based on weight, advantages of muscular cattle will be obvious. Widespread use of hot fat trimming would enhance the value of muscular carcasses.

Breed. The physical descriptive factors described above account for most, but not all of the variation in feed intake observed between groups of cattle. There are clearly other, breed-related factors that are involved. Taylor et al. (1986) compared cattle of 25 different beef and dairy breeds has described that weight accounts for 88% of the variation in feed intake within a given breed, but only 14-33% of the variation observed from one breed to another. These researchers stated that for young, growing cattle, feed intake, within a breed, is not proportional to body weight, or metabolic body weight. Thus, cattle feeders that have experience with a particular breed or cross can be reasonably confident that another group of the same breed would have similar feed intake, which could be predicted based on their weight. However, cattle of another breed could be considerably different, even at the same weight.

These researchers further observed that genetically larger breeds consumed relatively more feed at young ages, compared to later ages. This could partly explain the effect of starting weight on feed intake, as shown in Figure 1 since the cattle with higher starting weights likely had a higher concentration of the larger breeds. This speculation is supported by the data of Pamp (1981) who observed low, non-significant correlations between initial weight and subsequent rate of gain in within-breed comparisons of data from various research studies conducted at the University of Minnesota.

It is likely that breeds differ in maintenance requirement also. Ferrell and Jenkins (1984) have shown that the energy required to maintain weight of cows differs by as much as 30% between breeds, even when the cows are non-growing, non-pregnant and non-lactating. If maintenance requirement of non-producing cows can differ, it is reasonable to assume that steers could differ as well. Work in cows has shown that maintenance requirements, expressed per unit of weight or metabolic body weight, are highly related to potential milk production, even when cows are dry. This is due to the larger vital organ mass of the high milk breeds and to the fact that maintaining vital organs, such as liver, intestine and kidney, is quite energy expensive. Liver size is related to within-breed performance of growing steers (Anderson et al., 1988), and could be expected to differ between breeds as well. If so, steers of two breeds that consume similar quantities of feed could differ in ADG and F/G due to differing maintenance requirements. A difference of 15% in maintenance requirement between two breed types would result in approximately 9% difference in feed required to support similar ADG. Furthermore, differences in composition of gain could induce differences in efficiency of gain, with no difference in rate of weight gain.

Dairy breed steers are thought to have maintenance requirements approximately 12% greater than beef breed steers. Steers from higher milking beef breeds probably have higher maintenance requirements as well. Dairy breed steers can be managed to gain as much as, or slightly less than beef breed steers; however, they will consume approximately 8% more feed, and thus convert feed less efficiently than colored steers.

Sex. Describing the sex of feedlot cattle is more complicated than simply classifying them as male or female. Feedlot cattle can be classified into four sex groups: bulls, steers, heifers, and ovariectomized heifers. The situation gets even more cloudy since each of these four groups can be implanted with androgenic or estrogenic hormones, which will be discussed later. Implanted steers and heifers comprise the vast majority of all feedlot cattle.

At equal carcass composition, heifers will weigh 20% less than their steer mates (Table 2). However, because of their earlier maturity, heifers will reach a given endpoint sooner than steers, thus the difference in feedlot ADG is less than 20%, most estimates range from 8 to 15%. For the most part, these differences are similar when both groups are implanted.

Bulls would be expected to weigh 10 to 15% more than implanted steers at similar composition. Anderson et al. (1988) compared bull to steers slaughtered at the same age as bulls (Steers I) or at the same slaughter weight as the bulls (Steers II). These cattle were purebred or high percentage Simmental, frame score 6.0, were not implanted and were placed on feed at 8 months of age. As expected, performance of the bulls was superior to both groups of steers (ADG and F/G = 4.05. 3.44 and 3.24; 4.57, 5.24 and 5.94 for bulls, Steers I, and Steers II, respectively), even though performance of the steers was exceptional. Daily carcass fat gain of bulls (.96 lb) was similar to steers (1.04 and 1.03 lb for Steers I and Steers II, respectively). Thus, the advantage in carcass leanness of the bulls is due to greater lean gain per day, rather than less fat gain.

Steers have higher quality grades than bulls and most of the performance advantages are minimized if bulls are fed until they grade choice. However, there are numerous reports which indicate that bulls that are less than 16 months old, if fed a high energy diet for at least 150 days, will produce highly palatable beef, despite low quality grades. There are numerous reasons why very few bulls are fed for beef in this country (most slaughter cattle in Europe are bulls) but resistance is diminishing and bull beef may have a future in the U.S.

Growth-promoting Implants. The effects of growth-promoting implants on feedlot performance and carcass characteristics are well known. Since virtually all cattle in large feedyards are implanted, these effects will not be discussed in detail. However, effects of implants are dramatic and should be considered in performance projections. Steers implanted with traditional estrogen(E)-containing products (Synovex, Ralgro, Compudose, Steer-oid) can be expected to gain 8-10% faster, consume more feed, convert feed more efficiently, and be leaner at any weight endpoint than their non-implanted counterparts. Heifers also respond to implants specifically designed for females, but the heifer response is somewhat lower than that of steers.

Use of trenbolone acetate (TBA), a synthetic androgen (product name, Finaplix), was approved in 1987. By itself, this product enhances performance in a manner similar to, or slightly less than, estrogen-containing implants. However, TBA used in combination with estrogen-containing implants, is a very potent growth stimulator. The TBA+E combination has resulted in increased gains of 15-30% in most trials, with an average increase in gain of approximately 20%, and a similar improvement in feed conversion. Because of its dramatic muscle-enhancing effects (ribeye area is often increased 1-2 square inches), some cattle feeders have reported poorer quality grades in cattle implanted with this combination. An unresolved question is whether TBA+E actually reduces marbling, or whether the cattle must simply be marketed at much heavier weights than if they had been implanted with E-containing products alone. Results from a definitive experiment to answer this question has not yet been reported; however, many researchers believe that cattle implanted with TBA+E will grade adequately, if fed to 75 or 100 lb heavier weight than if not implanted. The added performance, and increased slaughter weight requirement must be taken into consideration when projecting performance and slaughter weights of cattle implanted with TBA+E.

Condition or Previous Nutrition. Cattle feeders have long profited "from someone else's mistakes", by purchasing feeder cattle in thin condition in order to take advantage of compensatory gain. Table 6 includes data from a Kansas survey of prices paid for feeder calves, based on condition at time of purchase. It is clear that fat calves are discriminated against at time of sale.

Most reports indicate that cattle subject to restricted dietary energy, such as might occur in a pasture or backgrounding system, will compensate when fed high energy diets. Typically, this compensation will include increased feed intake (5-10%), increased ADG (10-30%) and improved feed conversion (15-40%) for periods of up to 42 days. Diet formulation for cattle with potential for compensatory growth does not differ greatly from formulation of diets for non-compensating cattle, but projected performance does. In general, as condition increases, energy required for maintenance increases, while the energy content of the diet that is available for gain decreases. Adjustment factors (Table 7) could be used when formulating diets, or projecting gains of feedlot cattle, based on condition at the beginning of the feeding period.

The data of Ridenour et al. (1982, Table 8) suggest caution in purchasing calves for the purpose of exploiting compensatory gain. In this study, cattle fed 50% concentrate diets, or grazed on irrigated wheat pasture until they reached 550 lb, exhibited typical compensatory responses when placed on full feed. However, cattle that received either of these treatments until 800 lb compensated very little. Reasons for this difference are unclear; however, it may be that beyond a certain age (or more likely a certain weight), cattle have reduced ability to compensate.

Previous Management. Weaning, castration, dehorning, and vaccination are management practices that place considerable stress on calves. Feedlot operators and cow-calf producers have long debated the ideal time to perform these practices in relation to weaning weight (or sale weight) and feedlot performance. Research at Iowa State University has examined the effects of timing of these practices, together or separately, on feedlot performance (Table 9).

Environment. The effects of cold, wind, snow, and rain on beef cattle performance are of particular interest to cattle feeders in the Upper Midwest. Effects of heat and humidity must be considered as well. While weather conditions cannot be predicted, use of proper adjustment factors will allow cattle feeders to adjust projections based on observed weather.

Bourdon et al. (1984) reported that maintenance requirements increase by more than 24% during cold stress and metabolic acclimatization in commercial Colorado feedlot cattle. In fact, an increase of 37% was noted during November, December and January. Typically, gains were depressed by approximately .5 lb per day, with little change in intake, resulting in an increase of approximately 1 unit of feed required per unit of gain. If cattle are acclimated, cold weather can increase intake, to meet the greater resting metabolism needs. Plegge (1987), in a summary of 14,199 cattle, reported that intake averaged 8% higher in winter months in Minnesota, compared to summer months. Figure 3, from Hicks et al. (1990b) shows that ADFI peaks in late fall and in May and June, with lowest intake in late winter and July and August.

Muddy pens also affect performance. Bond et al. (1970) observed 25 to 37% reductions in daily gain and 20 to 33% decreases in efficiency due to muddy feedlot pens. Rayburn and Fox (1990) have developed prediction equations based on 15 years of Holstein steer data in Minnesota, Wisconsin and New York. Tables 10 and 11 contain descriptions of the effects of weather and mud.

FIGURE 1. THE EFFECT OF STARTING WEIGHT ON FEED INTAKE, Oklahoma

FIGURE 2. COMPARISON OF FEED INTAKE PATTERN OF CALVES AND YEARLINGS, Oklahoma

FIGURE 3. EFFECTS OF MONTH AND WEIGHT ON FEED INTAKE, Oklahoma

TABLE 1. EFFECT OF FEED INTAKE AND RATE OF GAIN ON FEED EFFICIENCY

Ma

Weight, lb	ADFI, lb	feed	ADG, lb	conversion
600	12.0	6.08	1.83	6.57
600	14.0	6.08	2.38	5.89
600	16.0	6.08	2.90	5.52
600	18.0	6.08	3.40	5.30
600	20.0	6.08	3.88	5.16

Source: Wagner, 1972.

TABLE 2. WEIGHT OF STEERS AND HEIFERS OF AT LOW CHOICE QUALITY GRADE, BY FRAME SIZE

Frame	Yearling hip height, in		Weight at low choice, lb	
score	Steers	Heifers	Steers	Heifers
1	41	39	751-850	600-680
2	43	41	851-950	681-760
3	45	43	951-1050	761-840
4	47	45	1051-1150	841-920
5	49	47	1151-1250	921-1000
6	51	49	1251-1350	1001-1080
7	53	51	1351+	1080+

TABLE 3. GAIN, CARCASS TRAITS AND NET RETURN OF KANSAS FUTURITY STEERS BY FRAME SIZE

Yearling ht, in.	ADG, lb	Carcass wt, lb	Quality grade	Yield grade	Net profit, $

37-39	2.58	571	ChE	2.5	53
39-41	2.75	604	ChE	2.6	61
41-43	2.84	634	Ch-	2.6	61
43-45	3.08	672	Ch-	2.5	65
45-47	3.24	716	Ch-	2.4	76
47-49	3.37	757	Ch-	2.4	83
49-51	3.43	777	Se+	2.2	86
51-53	3.50	801	Se+	2.2	85

Lambert, 1984. J.A.S. 59(1):89.

TABLE 4. THE EFFECTS OF FRAME SIZE AND DIETARY ENERGY DENSITY ON FEEDLOT PERFORMANCE OF STEERS, Nebraska

	Small frame		Large frame	
	ME	HE	ME	HE
Weight, lb				
Initial	571	567	605	605
232 days	1145	1189	1278	1297
308 days	----	----	1456	1489
ADG, lb				
0-63 days	2.38	2.67	2.53	2.64
0-232 days	2.58	2.75	2.91	2.97
0-308 days	----	----	2.82	2.93
ADFI, lb				
0-232 days	18.5	18.5	19.6	18.5
0-308 days	----	----	20.9	19.8
F/G				
0-232 days	7.2	6.7	6.7	6.2
0-308 days	---	---	7.4	6.7

Prior et al., 1977. JAS 45:132.

TABLE 5. THE EFFECT OF FRAME SIZE AND MUSCLING ON FEEDLOT PERFORMANCE, Colorado

	Weights, lb			
	Initial	Final	ADG	Days on feed
Frame size				
Large	605	1368	1.70	450
Medium	523	1152	1.56	402
Small	440	937	1.37	364
Muscle score				
Thick (USDA #1)	578	1146	1.52	374
Average (USDA #2)	543	1143	1.54	389
Thin (USDA #3)	447	1157	1.56	454

Tatum et al., 1988. JAS 66:1942.

TABLE 6. EFFECT OF CONDITION ON SALE PRICE OF STEER CALVES, Kansas

Condition	Average price, $/cwt
Very thin	55.11
Thin	64.26
Average	64.07
Fleshy	62.48
Fat	57.50

Lambert et al., 1983.

TABLE 7. ADJUSTMENT FACTORS FOR FEEDLOT NUTRIENT REQUIREMENTS BASED ON CONDITION ENTERING THE FEEDLOT, New York

	Condition code				
	1	3	5	7	9
Adjustment					
NEm required/d	.955	.980	1.00	1.02	1.045
NEg value of feed	1.10	1.05	1.00	.95	.90
ADG of a 1000 lb steer fed for 3.0 lb/d	3.34	3.19	3.00	2.83	2.64

1 = very thin; 9 = very fleshy

Fox et al., 1988. JAS 66:1475.

TABLE 8. COMPARISON OF GROWING-FINISHING SYSTEMS, New Mexico

Phase	Treatment	Days	ADG, lb	F/G
Growing	Full feed	66	2.86	5.6
	50% conc-550 lb	79	2.03	9.1
	50% conc-800 lb	173	2.17	10.2
	Wheat past-550 lb	133	1.48	
	Wheat past-800 lb	201	1.85	
Finishing	Full feed	163	2.62	7.8
	50% conc-550 lb	160	2.78	7.7
	50% conc-800 lb	111	2.42	9.2
	Wheat past-550 lb	156	2.86	8.0
	Wheat past-800 lb	101	2.42	9.6
Total	Full feed	229	2.69	7.3
	50% conc-550 lb	239	2.53	8.0
	50% conc-800 lb	284	2.27	9.6
	Wheat past-550 lb	289	2.22	
	Wheat past-800 lb	302	2.07	

Ridenour et al., 1982. JAS 54:1115.

TABLE 9. EFFECT OF MANAGEMENT PRACTICES PRIOR TO SALE ON FEEDLOT PERFORMANCE, Iowa

Practice	Effect on feedlot ADG, lb
Creep fed	+.04
Weaned before sale	+.15
Creep fed, weaned	-.07
Horned calf	-.07
Dehorned and castrated before weaning	-.02
Vaccinated and grub treated before weaning	-.04
Weaned, dehorned, castrated	-.11
Dehorn, castrate, vaccinate before weaning	+.13
Medium frame	+.13
Large frame	+.22

Age of calf	-.035/day
Weight of calf	+.029/lb

Peterson et al., 1989. JAS 67:1678.

Table 10. DESCRIPTION OF CRITICAL TEMPERATURE, AND EFFECTS ON MAINTENANCE, OF CATTLE WITH DIFFERENT SEASONAL HAIR COATS, Kansas

Coat description	Critical temp, F	Increase in maintenance per degree of coldness, %
Summer coat or wet	59	2.0
Fall coat	45	1.3
Winter coat	32	1.0
Heavy winter coat	18	.7

Table 11. EFFECTS OF MUD ON PERFORMANCE OF HOLSTEIN STEERS, New York

Mud depth, in	ADFI, kg	ADG, kg	F/G
0.0	15.1	3.02	5.02
1.6	12.8	2.38	5.41
3.1	11.7	2.05	5.73
4.7	10.6	1.70	6.22

Literature Cited

Anderson et al. 1988. Anim. Prod. 47:493.
Bourdon. 1984. Colorado St. Univ. Beef Report
Ferrell and Jenkins. 1984. J. Anim. Sci. 58:234.
Fox et al. 1988. J. Anim. Sci. 66:1475.
Hicks et al. 1990a. J. Anim. Sci. 68:245.
Hicks et al. 1990b. J. Anim. Sci. 68:254.
Lambert. 1984. J. Anim. Sci. 59(1):89.
Pamp. 1981. Ph.D. Thesis, University of Minnesota.
Peterson et al. 1989. J. Anim. Sci. 67:1678.
Plegge. 1987. Proc. Int. Feed Intake Symp., Okla. St. Univ.
Prior et al. 1977. J. Anim. Sci. 45:132
Rayburn and Fox. 1990. J. Anim. Sci. 68:788
Ridenour et al. 1982. J. Anim. Sci. 54:1115.
Tatum et al. 1988. J. Anim. Sci. 66:1942
Taylor et al. 1986. Anim. Prod. 42:11.