OPTIMUM FORAGE USE IN BEEF CATTLE GROWING AND FINISHING DIETS

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INTRODUCTION

Forage is included in beef cattle growing or finishing diets for several reasons. Nutritionally, forage provides protein, vitamins and minerals. When included as a minor component of high grain finishing diets, forage may increase feed intake and reduce nutritional disorders due to increased salivation, rumination and passage rate. Manipulating dietary moisture content through inclusion of dry or wet forages can improve palatability. In comparison to limit feeding high concentrate diets, deliberate reduction in dietary energy content through inclusion of forage is usually preferred in growing systems. From a management standpoint, feeding to beef cattle facilitates use of stored forage. Production of forage for feed may be most efficacious use of marginal land, or better land in marginal climates. Production and use of forage, whether grazed or harvested, should disperse the labor load and spread risk on individual farms.

Historically, forage has been considered a low cost source of nutrients and grain has been considered expensive. As a result, forage use often was maximized to reduce feed cost. Under current market conditions, the cost of energy in forage often exceeds that of grain, especially in southern Minnesota. Diet formulation and choice of feedstuffs should be re-evaluated as prices change. Production of forage, and inclusion of forage in beef cattle diets, are enterprise decisions. Whole farm profit should be the prime consideration.

Beef cattle feeding can be considered in two phases: backgrounding (growing) and finishing. Backgrounding involves feeding (or grazing) cattle to grow at moderate rates (1-2.5 lb/d) for several months, prior to finishing. The most appropriate use of large quantities of forage in diets for beef cattle other than cows, is in the backgrounding stage.

FORAGE USE IN GROWING/BACKGROUNDING SYSTEMS

Cattle are backgrounded for several reasons; to utilize a particular feedstuff, to take advantage of transient grazing opportunities, to delay finishing in order to target a market, or to promote skeletal growth of small frame cattle for the purpose of increasing their slaughter weight. Producers should consider cost and availability of feedstuffs, cattle type, markets, interest cost, labor and facilities when deciding whether cattle should be backgrounded or placed directly on high energy finishing diets.

Researchers and cattle feeders alike have long debated the merits (or lack thereof) of backgrounding cattle. Researchers in Kansas utilized small (Angus x Hereford; A x H) and large framed (3/8 Simmental, 1/4 Chianina, 3/8 British breeds; S x C) steers in a study to investigate this question. One-half of each breed group was placed directly in the feedlot at 8 months of age and fed a high energy diet for 140 days (A x H) or 180 days (S x C). This is termed an accelerated production system. The remaining half of each breed group was fed in a conventional system which included a backgrounding phase and a finishing phase. Within each breed group, the accelerated program produced faster, more efficient gains and lighter, leaner carcasses with lower yield grades but smaller rib eyes (Table 1). While the quality grades of the accelerated program steers were lower, palatability of the accelerated program carcasses was equal to or greater than the conventional program steers.

Given the prices listed in the footnote, accelerated S x C cattle were the only profitable group. Their advantage was greatest when a premium was paid for carcasses leaner than yield grade 3.5. In this particular study, the conventional program A x H cattle, a system designed to mimic typical U.S. beef production, were yield grade 4.0 with only select^{+} quality grade. This is an unusual yield/quality grade relationship and accounts in part for the poor economic showing of that group. Nevertheless, some conclusions can be drawn from this study. First, the accelerated system produced beef more efficiently than the conventional system. Second, if cattle are slaughtered when they grade select, large framed, crossbred cattle will likely be more profitable than A x H cattle. Third, the conventional system does not produce more palatable beef than the accelerated system, despite higher quality grades. Finally, premiums and discounts based on weight, yield or quality grade may affect large framed crossbred cattle more than British breed cattle.

Nonetheless, backgrounding cattle is an appropriate choice in many operations. If the decision is made to background a group of cattle, medium or high quality forage sources can comprise all or most of the diet for cattle growing at moderate rates. If ADG higher than 2.5 lb/d is desired, hay must comprise less than 50% of the diet. Corn silage alone can support ADG of up to 2.2 lb/d in most cases. Two questions are vital to consideration of forage use in backgrounding systems:

How much forage should be included?
How long should the backgrounding phase last?

Researchers at Cornell University have addressed the first of these questions. In their study, Holstein steer calves (initial weight, 350 lb) were fed 50, 30 or 10% alfalfa haylage diets for 98 days, followed by finishing on high energy diets. While increased forage slowed growth during the growing phase, compensatory growth during the finishing phase resulted in all treatments being equal in terms of rate

and efficiency of growth (for the combined grower and finisher phases), carcass traits and boxed beef yield (Table 2). In comparison to other studies, these cattle were allowed to grow relatively rapidly (2.5 lb/d) during the growing phase. Slower rates of growth may have produced different conclusions. If high quality forage is used, the grower phase is the most appropriate time.

The data of Ridenour et al. (1982, Table 3) suggest that a backgrounding phase can last too long. 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 afterward. 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.

Taken together, the data in Tables 1-3 illustrate several points. Inclusion of a low energy backgrounding period will increase ownership cost and feed required for gain. Feeding moderate energy diets which include high quality forage for periods of two to three months may not reduce efficiency for the combined growing and finishing phases. If forage is cheap, backgrounding small to medium framed cattle may be a good choice. If grain is cheap, backgrounding may make little sense. Large framed beef breed steers are inappropriate for backgrounding programs.

Holstein steers are somewhat different than large framed beef breed steers. University of Minnesota research has shown that Holstein calves started on high grain diets can be switched to high forage diets at 2-400 lb and will gain 2-2.5 lb/day with feed conversion of 4-5:1 on corn silage or 50% haylage/50% concentrate diets up to 6-700 lb. Feeding high forage diets up to 6-700 lb does not reduce carcass quality grades as long as calves are switched to high grain diets and gain at least 3 lb/day in the finishing period.

Forage does not have to be harvested to be used in growing systems. Cattle grazing improved pastures can gain 3-3.5 lb/d for brief (20-40 d) periods and gains of 1.8-2 lb/d should be expected for season-long grazing at 4-7 AUM/acre. Many producers are content with slower rates of gain but economic efficiency favors those cattle that grow at 2 lb/d. Supplementation of energy (grain) to cattle of pasture is not recommended, but protein supplementation may prove beneficial, especially if pasture is not fertilized. If forage quality is good, the grazing season can last up to 150 days. Grazing duration of backgrounded steers on medium quality forage should be limited to 90 days or less.

Placing weaned calves directly into feedlot for finishing on high energy diets is **always** more biologically efficient (energy used/energy deposited) than including a backgrounding phase. However, improved biological efficiency does not always result in improved economic efficiency. Specific economic advantages must exist for backgrounding to make sense. Forage quality is a critical consideration in backgrounding systems. Growing cattle are a poor choice for utilization of low quality forage.

FORAGE USE IN FINISHING SYSTEMS

Considerations of forage use in finishing systems are quite different than in growing or backgrounding

systems. Although many feeders and researchers have tried to prove otherwise, moderate energy finishing simply will not work (Tables 4, 5) in most situations. In Minnesota, many feeders utilize large quantities of silage as a reflex, rather than after considering alternatives. This is seldom appropriate.

Maximizing energy intake, and thus performance, due to dilution of maintenance cost (Table 6) is a goal of cattle feeders. However, maximizing energy intake does not exclude forage use and should not be confused with maximizing energy content of the diet. A slight reduction in energy content of the diet due to inclusion of forage may induce a greater increase in consumption of the total diet, resulting in greater energy intake. In addition, the improvement in rumen health and consistent feed consumption observed in finishing cattle that consume some roughage are significant. Inclusion of 5-15% forage in the diet should reduce the incidence of subacute and acute acidosis, bloat, founder and sudden death. These considerations are especially critical for feeders of Holstein steers.

The quantity of forage in the diet is another consideration. In Kansas research (Table 7) inclusion of 5 or 10% forage produced the greatest energy intake, the most rapid gains, and the most efficient feed conversion. While the calculated energy content of the diet diminished as forage content increased, the realized energy content was greatest with 5 or 10% forage in the diet.

The positive associative effects in this study were expected since steam rolled wheat, a rapidly fermentable energy source, was used. The greatest improvements in performance and rumen health will be observed when rapidly fermentable feeds, such as barley, wheat, high moisture corn or finely ground dry corn are fed.

For maximum performance, finishing diets should contain approximately 10% forage. In University of Minnesota research trials, a common diet would be 80% rolled corn (DM basis) and 20% corn silage. Inclusion of supplement at a constant rate, usually 1 lb/hd/d, lowers forage content of the total diet to approximately 9%. In other trials, corn silage intake is held constant (6-8 lb/hd/d, as fed) and corn is offered to appetite. Reducing the forage content would increase the risk of nutritional disorders and inconsistent feed intake. Increasing the forage content would likely diminish performance slightly, but this observed decrease may be offset by the opportunity to use a low cost feedstuff.

Type of forage in finishing diets can make a slight difference. The author prefers corn silage, corn cobs, or grass-legume hay, chopped to 1-2" in length. Research at the University of Nebraska has shown that when dry corn is used as the energy source, corn silage is preferred to alfalfa (hay or haylage). In diets containing high moisture corn, there seems to be no clear preference. When alfalfa hay is used, medium quality is adequate.

PRACTICAL CONSIDERATIONS OF FORAGE USE

STARTING CATTLE ON FEED. Forage, in particular long hay, is vital to most starting on feed programs. Cattle will not do well if high grain diets are presented to them upon receipt in the feedlot. Cattle feeders routinely start cattle on long hay and gradually convert them to other diets. Non-fermented forages, typically hay or ground corn cobs, are preferred over silage for starting cattle due to more rapid acceptance, especially by young, newly weaned calves.

BUNK SPACE. Bunk space requirements vary with type of facility, cattle and diet, as well as season and feeding frequency. Inclusion of substantial quantities of forage will increase the bunk space requirement. If calves with no horns are fed a low moisture, high grain diet two or three times per day, 6 to 8" of bunk space per head is adequate. If yearlings with horns are fed silage diets once daily, 15 to 18" may be more appropriate. For typical situations, 9 to 12" is adequate. If bunk space is limited, timid cattle will be unable to eat when feed is presented. Intake and performance of these cattle will suffer and uniformity of the group will become poorer.

BUNK MANAGEMENT. Proper bunk management, which really means intake management, is critical to cattle feeding success. Inclusion of substantial quantities of forage in diets affects bunk management recommendations. The importance of ingredient quality and consistency cannot be overstated. If identical diet composition could be guaranteed from one day to the next, other aspects of intake management would become much easier, cattle would remain on feed better, grow faster and have reduced nutritional disorders. Daily variations in dry matter, contaminant and nutrient content of feedstuffs, as well as variation in processing or mixing, contribute to dietary changes that can affect intake. While daily analysis of feed is impractical, and variation is unavoidable, some steps can be taken to minimize variation.

Forage feeds are more variable than grain. Much of the variation can be avoided by harvesting and storing corn silage, hay or haylage at the proper stage. There is no substitute for quality forage preparation. While finishing cattle do not benefit from consuming the highest quality forage, avoiding problems such as mold and heating, which will affect intake, are essential. Forages should be tested routinely.

Forage must be properly processed and mixed. Chopping or grinding hay too fine will defeat the purpose of adding it to the diet and can contribute to bloat problems. Although diets containing 1 to 3" hay are more difficult to feed than those with shorter cuts, this length provides optimal rumen stimulation and digestibility with minimal sorting.

All forage should be included in the feedbunk. Some Minnesota cattle feeders place round bale feeders in feedlot pens, away from the bunk, with no forage placed in the bunk. This allows timid cattle or those not interested in grain to consume hay away from the bunk. However, there is no way to know if all cattle are consuming forage, or how much any of them are consuming. Leaving forage out of the bunk promotes digestive disorders because forage intake will not be consistent, some cattle will consume little or no hay under this system. Also, some cattle will consume little of the grain component of the diet and their performance will be poor. Roughage is not included as a nutrient in feedlot diets, rather it is used for rumen stimulation and health. It is important that all cattle consume the proper amount of forage and including it in the bunk, mixed in the total diet, is the only way to guarantee this.

If by-products such as sweet corn silage, carrot tops, etc. are used, variation is unavoidable. The keys to making these feedstuffs work are fine tuning diets daily so that variation is minimized, and including them in the diet at a rate low enough that expected variation will not throw cattle completely off feed.

These feedstuffs are more suited to growing or backgrounding diets than to finishing diets.

Proper diet mixing is essential. All too often the time allotted for mixing is based on the time required to drive to the bunk. Mixing should be complete, so that every mouthful of feed is as uniform as possible. Mixing for too long, in some types of mixers, can result in finer particles sifting to the bottom, and hay sorting to the top. The most expensive components of the diet (medication, ionophores, vitamins, etc.) will have the smallest particle size.

SELF FEEDERS. Self feeding systems are common in Minnesota, especially among feeders of dairy breed steers. Use of a self feeder does not diminish the importance of bunk management. In fact, managing intake properly is more important when self feeders are used than in other situations. It is also more difficult. To manage intake with a self feeder, feed consumption must be estimated on a daily basis and measures must be taken to ensure that all cattle are eating every day. If these steps are not taken, fluctuations in intake cannot be prevented and will not be observed. Proper management is possible with a self feeder, but a self feeder is not a substitute for proper management.

Use of a self feeder limits the types of diets that can be fed. Bulky, high moisture or high roughage diets will not work well. All concentrate diets with pelleted supplements are most suited to self feeder use. Exclusion of forage in these diets increases the chance of nutritional disorders. The importance of proper intake management is magnified when all concentrate diets are used.

Forage should be mixed in feedlot diets and included in the bunk. It is common in Minnesota to feed grain in a feedbunk and offer hay in a round bale feeder elsewhere in the pen. Allowing cattle to choose forage or grain in separate feeders will result in inconsistent and unpredictable forage consumption. If 200 lb of hay disappears each day, from a round bale feeder in a pen of 100 cattle, that does not mean that each steer consumed 2 lb/d. Some steers may have eaten 8-10 lb, others none at all. This will result in inconsistent performance within the pen. Forage is included in finishing diets to improve rumen health and increase consumption, <u>not</u> to provide nutrients. Thus, if the decision is made to use forage, and that is usually the best choice, all cattle should consume the desired quantity.

IMPLANTS AND IONOPHORES. Use of growth promoting implants and inclusion of ionophores in diets should be automatic for cattle feeders unless they are received a significant premium for carcasses or cattle in which these technologies were not used. Cattle will exhibit 5-15% increases in growth rate when implanted. Ionophores will increase growth of cattle on high forage diets and will improve feed conversion regardless of diet type.

TABLE 1. PERFORMANCE, CARCASS DATA AND ECONOMIC ANALYSIS OF DIFFERENT MANAGEMENT SYSTEMS

	Accelerated		Conventional	
Item	A x H	S x C	A x H	A x C

Backgrounding, d			140	183
Finishing, d	140	180	116	122
Total days	140	180	256	305
Slaughter wt, lb	946	1116	1170	1300
Total ADG, lb	2.62	2.06	2.36	2.40
ME/lb of gain, Mcal	8.9	8.1	10.6	11.1
Carcass wt, lb	578	662	700	784
Fat thickness, in.	.51	28	.60	35
Rib eye area, $in.^2$	10.2	12.2	10.5	13.4
Yield grade	3.3	2.3	4.0	2.7
Quality grade	Se-	Se-	Se+	Se+
Tenderness	6.6	6.8	6.3	6.1
Juiciness	6.2	6.4	6.3	6.2
Flavor	6.6	6.6	6.5	6.3
Profit [loss][a]	[$14.55]	$68.03	[$56.69]	[$11.76]
Profit [loss][b]	[$29.12]	$ 9.99	[$58.89]	[$62.22]

[a]Choice = $100/cwt, Select = $96/cwt, Standard = $92/cwt; " $9/cwt per yield grade above or below 3.5.

[b]Same prices with $8/cwt discount for Y.G. 4 or 5, $2/cwt premium for Y.G. 1 or 2, $2/cwt discount if not between 600 and 850 lb.

Source: Dikeman et al., 1985, JAS 61:137.

TABLE 2. USE OF ALFALFA HAYLAGE DURING THE GROWER PHASE

Item 50	% haylage during grower phase 30	10	
Grower phase			
End wt, lb	592	614	639
ADG, lb	2.52	2.77	3.05
Feed/gain	5.09	4.72	4.45
Grower and finisher phase			
End wt, lb	1143	1134	1155
ADG, lb	2.75	2.79	2.80
Feed/gain	6.22	5.87	6.02

Initial wt = 344 lb

TABLE 3. 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 lb133		1.48		
Wheat past-800 lb201		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 lb156		2.86	8.0	
Wheat past-800 lb101		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 lb289		2.22		
Wheat past-800 lb302		2.07		

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

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 DIETS WITH VARYING ENERGY DENSITY ON FINISHING HOLSTEIN STEERS

	Percentage of corn silage in diet			
Item 90	60	25	5	
ADG, lb	2.47	2.91	3.26	3.50
Days on feed	244	206	184	171
Feed/gain	7.96	6.68	5.80	5.17
Costs, $/cwt of gain				
Feed 35.98	32.56	32.87	30.66	
Nonfeed	16.27	13.73	12.27	11.33
Total	52.25	46.29	45.14	41.99

Steers fed from 500 lb to 1100 lb.
Plegge and Chester-Jones.

TABLE 6. EFFECT OF FEED INTAKE AND RATE OF GAIN ON FEED EFFICIENCY

Weight, lb	ADFI, lb	Maintenance feed	ADG, lb	Feed 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 7. EFFECT OF ROUGHAGE LEVEL ON PERFORMANCE OF STEERS

	Roughage, %			
	0	5	10	15
ADG, lb	2.95	3.35	3.46	3.37
ADFI, lb	18.9	19.8	20.1	20.4
F/G 6.4	5.9	5.8	6.1	
	---------- Dietary NE, Mcal/lb ----------			
Maintenance				
Calculated	.96	.94	.92	.90
Observed	.86	.90	.91	.88
Percentage	90	96	99	97
Gain				
Calculated	.66	.64	.62	.60
Observed	.59	.61	.61	.59
Percentage	90	95	99	98

Crossbred steers (736 lb) fed 120 days.
Steam-rolled wheat diets.
Roughage source was 50% corn silage, 50% alfalfa hay.
Kreikmeier et al., 1990, JAS 68:2130.