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Abstract
Preconditioning reduces stress, maintains health, and adds value to feeder calves. Calf response to pasture nutritive value and supplementation was studied on 17 farms in 2002, 8 farms in 2003, and 9 farms in 2004. Calves were weaned in late August and backgrounded on pasture to mid-October. Calves were fed a commercial concentrate (0.0 to 1.5% bodyweight [BW]), hay, and on some farms haylage, ground shelled corn (*Zea mays* L.), or soybean (*Glycine max* L.) hulls. Calf average daily gain (ADG) was evaluated across farms relative to animal, pasture, and supplement characteristics using multiple regressions. Commercial supplement intake, corn intake, and pasture total digestible nutrient (TDN) or pasture neutral detergent fiber (NDF) significantly influenced calf ADG. Based on regression coefficients, 4.4 lb of commercial supplement or 4.1 lb of corn were required to produce 1 lb of additional gain. Increasing pasture TDN or decreasing pasture NDF by 10 percentage units increased ADG 0.86 or 0.48 lb/day, respectively. Regressions were tested against 2004 data. Regression-estimated gains were not significantly different from measured ADG 67% of the time. Calf performance during backgrounding can be cost effective when management ensures adequate pasture quantity and nutritive value and supplements are used judiciously relative to their cost and the value of calf gain.

Introduction
Calf preconditioning programs can add value to feeder cattle (3). Weaning systems that incorporate high-quality pastures can help reduce stress and health-related expenses that may occur later in feedlot when feeding high-concentrate diets. During weaning and backgrounding, animal performance, conversion rate of supplements to additional gain, feed cost, and marginal value of animal gain determine profitability (3,4,6). Accurate predictions of animal response to pasture nutritive value and supplements are a valuable tool for producers evaluating alternative management options. The objective of this study was to develop and test regressions for predicting calf response to pasture nutritive value and supplementation during pasture weaning and backgrounding.

Procedures for Assessing Animal Response to Pasture Nutritive Value
Calf performance was measured on 17 farms in 2002, 8 farms in 2003, and 9 farms in 2004. All farms were in northern West Virginia participating in West Virginia Beef Quality Assurance Sale marketing pools. Calves were born between January and May. Individual calf performance was measured during backgrounding by obtaining bodyweight (BW) at weaning in late August and shrunk BW (SBW) at sale in mid-October. Weaning BW was multiplied by 0.96 to estimate weaning SBW (8). At sale the animals were physically shrunk over night (off feed and water) and transported to certified scales at the marketing delivery point for weighing. Additional data collected to characterize the animals

included: weaning day body condition score, gender, birth date, breed of sire, breed of dam, supplement consumed (lb/animal/day) in each lot, and number of days backgrounded. Animal weights, ages, and condition scores were averaged by gender within year by farm. The average length of the backgrounding period was 50 days.

The experimental unit was animal group by gender. There were 15, 7, and 8 male groups and 16, 7, and 7 female groups in 2002, 2003, and 2004, respectively. Group size averaged 29, 32, and 28 steers and 22, 25, and 18 heifers in 2002, 2003, and 2004, respectively; for a total of 1,541 animals over three years. Bulls were castrated shortly after birth. Calf breeds were Angus, Angus-Limousine cross, Red Angus, Angus-Limousine-Hereford cross, Angus-Gelvieh cross, and Angus-Hereford cross.

The calves were weaned on pasture and fed supplemental hay and a commercial supplement pellet formulated from grain by-products and corn. On some farms haylage, ground shelled corn, or soybean hulls were also fed to the animals. Concentrates were fed at different rates on each farm and intake ranged from 0.0 to 8.1 lb/animal/day.

Pasture height was measured using a falling plate meter (10) and forage mass was estimated from average sward height using local clipped calibrations. In 2002 and 2003 pasture nutritive value was determined weekly using hand plucked samples (13) representing the grazed horizon. In 2004 hand-plucked samples were collected one time before animals went on pasture to represent how producers would evaluate pasture nutritive value when developing a feeding system for backgrounding.

Hay bales (averaging 1000 lb) on each farm were randomly sampled using an electric drill and core sampler. Four or five cores were taken from each bale and all cores were composited by farm. Concentrate samples were randomly collected by hand from two farms at the beginning of the backgrounding period and composited. Calf groups were fed the same commercial supplement pellet, with the majority of the farms group-purchasing from the same production lot in a given year. Corn and soybean hull samples were collected from each farm that fed these feeds. All feed and forage samples were placed in plastic bags and transported in ice-filled coolers to the lab. Feed samples were placed in forced-air ovens (150°F) for 72 h after collection, dried to a constant weight, and allowed to air equilibrate. Samples were ground in a Wiley Mill (Thomas Scientific, Swedesboro, NJ) to pass through a 1-mm screen, sub-sampled, and stored in plastic bags until sent to a commercial forage testing laboratory (Dairy One, Inc., Ithaca, NY) for analyses. Chemical composition of samples was conducted using near infrared procedures. Analysis of samples included dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), nonstructural carbohydrates (NSC), ash, lignin, sugar, crude fat, total digestible nutrients (TDN), and minerals. Results from forage analyses on a DM basis were averaged across pastures for each farm.

Animal ADG from 2002 and 2003 was evaluated using multiple regression analysis (7) to develop prediction equations for calf ADG. Independent variables for the model included mean animal group characteristics (SBW, weaning body condition score, age), pasture characteristics (forage mass, height, TDN, NDF, ADF, CP), and supplement intake (lb/day of commercial supplement, soybean hulls, and corn). Residual analysis was used to evaluate the effect of year, farm, breed, and gender on estimated ADG. To test the usefulness of the regressions for predicting animal ADG based on one estimate of pasture nutritive value at the beginning of backgrounding and a level of supplementation to be used during backgrounding, the regressions were used to predict ADG for animals in 2004. Predicted and observed ADG for each group were compared by T-test, using the within group ADG variance.

Pasture and Supplement Characteristics

There was a large range in calf weaning SBW and ADG (Table 1) due to the range in pasture nutritive value (Table 2) and supplements fed (Table 3) across farms and years. The range in pasture nutritive value is typical of West Virginia naturalized pastures (11). Forage species present in the pastures and hay were primarily orchardgrass (*Dactylis glomerata* L.), tall fescue (*Loloium arundinaceum* (Schreb.) Darbysh.), and white and red clover (*Trifolium repens* L. and *T. pratense* L.), and in less proportion Kentucky bluegrass (*Poa pratensis* L.), timothy (*Phleum pratense* L.), and alfalfa (*Medicago sativa* L.). Pasture height maintained on the farms (Table 2) provided adequate forage mass for maximum pasture intake (8, p. 92). Concentrates fed (Table 3) represents a low to moderately high percentage of the total diet, enabling the use of regression analysis to measure conversion efficiency of concentrates to ADG. Corn contained similar TDN content between years but differed in CP concentration (Table 4). Soybean hulls and commercial supplement differed in NDF and TDN between years, but were relatively constant in the other chemical components. This variability, combined with the small number of soybean hull comparisons, resulted in soybean hulls not having a statistically significant effect on calf ADG.

Table 1. Mean, standard deviation (SD), and range of animal characteristics and performance of calf groups backgrounded on pasture in 2002 and 2003.

Measure	**N**	**Mean ± SD**	**Min**	**Max**
Weaning shrunk weight (lb)	45	486 ± 44	398	594
Sale shrunk weight (lb)	45	581 ± 55	491	763
Weight gained (lb)	45	95 ± 29	11	154
ADG (lb/day)	45	1.98 ± 0.66	0.40	3.21

Table 2. Mean, standard deviation (SD), and range of pasture condition and nutritive value fed to calves backgrounded on pasture.

Year	**Measure**	**N**	**Mean ± SD**	**Min**	**Max**
2002-2003	Plate height (inches)	45	3.4 ± 0.9	1.3	4.9
	Forage mass (lb DM/ac)	45	1721 ± 467	592	2402
	ADF (% DM)	45	32 ± 4	23	37
	NDF (% DM)	45	55 ± 4	46	61
	CP (% DM)	45	18 ± 3	12	26
	TDN (% DM)	45	59 ± 3	54	65
2004	Plate height (inches)	15	4.3 ± 0.8	3.0	5.2
	Forage mass (lb DM/ac)	15	2172 ± 356	1375	2576
	ADF (% DM)	15	28 ± 3	22	32
	NDF (% DM)	15	45 ± 6	32	56
	CP (% DM)	15	21 ± 3	16	26
	TDN (% DM)	15	64 ± 2	61	67

Table 3. Mean, standard deviation (SD), and range of supplement dry matter intake (lb DM animal/day) consumed by calves backgrounded on pasture.

Year	Measure	N	Mean ± SD	Min	Max
2002-2003	Soybean hulls	4	2.5 ± 0.3	2.3	2.9
	Corn	6	1.4 ± 0.2	0.9	1.5
	Commercial supplement	43	4.8 ± 1.3	2.0	7.7
	Total supplement	45	5.1 ± 1.5	0.0	8.1
	Hay	45	2.9 ± 1.6	0.1	6.0
	Haylage	2	0.4	0.4	0.4
2004	Commercial supplement	15	5.1 ± 1.5	3.1	6.4
	Total supplement	15	5.1 ± 1.5	3.1	6.4
	Hay	13	3.5 ± 1.6	2.0	6.8

No soybean hulls, corn, or haylage were fed in 2004.

Table 4. Mean nutritive characteristics of energy supplements fed to calves backgrounded on pasture in 2002 and 2003 (percent DM basis).

Energy supplement fed	Year	CP	ADF	NDF	TDN
Soybean hulls	2002	13.1	42.9	53.3	63.0
	2003	11.1	49.5	65.9	70.4
Corn	2002	12.5	2.3	6.7	88.0
	2003	8.6	2.0	7.6	88.0
Commercial supplement	2002	17.0	29.3	38.4	75.0
	2003	17.7	28.4	48.8	76.6

Animal Response to Supplements and Pasture Nutritive Value

Regression analysis used to compare calf ADG to animal, pasture, and diet characteristics, found commercial supplement intake (CSI, lb/animal/day), corn intake (CI, lb/animal/day), pasture TDN (TDN_{past}) percent, or pasture NDF (NDF_{past}) percent to be statistically significant. When pasture TDN was used in the regression, the R^2 was 0.59 and the standard deviation about the regression (SD_{reg}) was 0.369 lb (N = 45, $P = 0.004$, $P < 0.001$, $P = 0.025$, and $P < 0.001$ for intercept, CSI, CI, and TDN_{past}, respectively).

$$ADG = -4.43 + 0.222\ CSI + 0.294\ CI + 0.0861\ TDN_{past}$$

When pasture NDF was used in the regression the R^2 was 0.54 and the SD_{reg} was 0.387 (N = 45, $P < 0.001$, $P < 0.001$, $P = 0.004$ and $P = 0.009$ for intercept, CSI, CI, and NDF_{past}, respectively).

$$ADG = 3.21 + 0.246\ CSI + 0.382\ CI - 0.0493\ NDF_{past}$$

Analysis of regression residuals indicated there were no year, gender, or farm effects on ADG. Regression with TDN in the model indicated a significant (P = 0.036) breed effect. Calves with some continental breeding (Limousine and Gelvieh) gained 0.28 lb/day more than calves of British breeding (Angus and Herford). However, when pasture NDF was used there was not a significant breed effect.

The regression run with pasture TDN and breed as a discrete variable was:

$$ADG = -5.94 + 0.229\ CSI + 0.243\ CI + 0.110\ TDN_{past} + Breed$$

where Breed = 0.00 for British and Breed = 0.28 for Continental. The R^2 was 0.64 and the SD_{reg} was 0.349 lb (N = 45, $P < 0.001$, $P < 0.001$, $P = 0.053$, $P < 0.001$, and $P = 0.028$ for intercept, CSI, CI, TDN_{past}, and Breed, respectively).

Economics of Feeding Energy Supplements on Pasture

The regression coefficients from this analysis enable livestock managers to estimate the economic benefit of supplemental feeding and improved pasture management. Using the pasture TDN with breed regression it took 4.37 lb of commercial supplement to obtain 1 lb of additional gain (4.37 = 1.0/0.229). If this supplement cost $180/ton, then 1 lb would cost $0.09 ($0.09 = $180/2000). The cost of supplement per lb of additional gain would be $0.393 ($0.393 = $0.09 × 4.37). If the marginal value of gain were $0.80/lb, then feeding this supplement would return almost two dollars for every dollar invested over the 6-week backgrounding phase. Similarly, the 0.243 lb of gain per lb of corn equates to 4.12 lb of corn for 1 lb of gain (4.12 = 1.0/0.243).

Effects of Improved Pasture Nutritive Value on Calf Gain

Increasing pasture TDN from 55 to 65% increased ADG by 1.10 lb (1.10 = 10 × 0.110). The NRC table value of ADG for similar cattle and feed intake (8, p. 212) indicates that increasing diet TDN from 50 to 60% will result in a 1.28-lb increase in ADG for a 660-lb steer. In this study, supplements accounted for about 33% of intake and pasture about 66% of intake, giving an expected increase in ADG of 0.84 lb (0.84 = 1.28 * 0.66). This is similar to the regression estimate (0.861) when breeds are not separated.

Based on the regression using pasture NDF, decreasing pasture NDF increased ADG by 0.494 lb per 10 percentage unit decrease in NDF. This decrease in forage NDF could be accomplished by establishing a good stand of legumes in a pure grass pasture (9) or by grazing younger growth.

When the 2004 data were used to test these regressions, 10 out of 15 (67%) ADG predictions were not significantly different than the measured group ADG.

Comparison to Other Research

Moore and co-workers (5) compared 444 unsupplemented controls and supplemented treatments, to describe supplement associative effects on ad libitum intake, ADG, and diet digestibility in non-lactating cattle. Levels of supplementation in this study were similar to and supplement effect on gain was within the range of Moore's data. In our study the cool-season pastures used were adequate in CP and there was a positive ADG response to supplemental energy. The commercial concentrate was higher in energy than the pastures resulting in an ADG response and the corn was higher in energy than the commercial concentrate resulting in a greater ADG response.

Sanson and Coombs (12) evaluated five levels of corn supplementation (0, 0.2, 0.4, 0.6, 0.8% BW) with Angus-Brangus cross yearling steers on a rye-ryegrass pasture. They observed that as level of supplementation increased, the ADG per unit of supplement decreased. At the 0.4% BW level of supplementation, it required 5.6 lb of ground corn for each additional lb of gain. In this study, there was no quadratic effect of supplementation level detected ($P = 0.330$). The conversion rate in this study was lower than Sanson and Coombs (4.1 vs. 5.6 lb of corn/lb of gain) most likely due to different breeds of cattle (Angus-Brangus cross vs. selected Angus and Angus cross cattle), different pasture species present, and the younger and smaller (500 vs. 700 lb) calves in this study. The calves in this study were sired by bulls with above-breed average growth as a requirement of the West Virginia Quality Assurance Program. This genetic selection and the age and size of calves would allow calves to out perform yearling steers. Also, the yearling steers were on winter-annual pasture where one would expect less response to energy supplementation.

Harvey and Burns (2) used early weaned Herford and Herford-Simental cross calves to evaluate four pasture quality treatments and two concentrate feeding levels. They obtained an ADG of 1.85 lb when using a pasture measuring 71.7% TDN with 1% BW concentrate feeding. The conversion rate in their study was 2.47 lb of ground ear corn for each additional lb of gain. In this study, the calves had similar ADG (1.83 lb) but required more supplemental feed per lb gain (4.12 ground shelled corn vs. 2.47 lb ground ear corn per lb gain). The younger age and lighter weight of the early weaned calves may explain their greater gain per unit of supplement since lighter weight cattle deposit less fat at the same ADG than do larger animals (8).

Dicker et al. (1) demonstrated that supplementing steers backgrounded on pasture generally increases post-weaning ADG (1.14 vs. 1.69 lb) and reduces the period to feedlot entry compared to steers backgrounded on pasture without supplement. Our study provided similar results since animals on higher nutritive value pasture and those fed higher levels of supplementation had an increased ADG (0.40 vs. 3.21 lb).

Conclusions

Good calf growth and profitable pasture backgrounding depends on pre-weaning health management, high nutritive value pasture, and proper supplemental feeding. Improved pasture nutritive value increased calf gain by 0.86 lb/day for each 10 percentage unit increase in pasture TDN or 0.48 lb/day for each 10 percentage unit decrease in pasture NDF. Energy supplements, fed at 0.5 to 1 % of BW, increased calf gain by approximately 1 lb for about each 4 lb of supplement fed. The development of on-farm regression predictions for calf ADG from pasture and supplement characteristic is helpful for evaluating calf performance and the economics of alternative pasture management and feeding programs during backgrounding on pasture.

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Literature Cited

1. Dicker, R. W., Ayres, J. F., McPhee, M. J., Robinson, D. L., Turner, A. D., Wolcott, M. L., Kamphorst, P. G., Harden, S., and Oddy, V. H. 2001. Post-weaning growth of cattle in northern New South Wales. 2. Growth pathways of steers. Aust. J. Exp. Agr. 41:971-979.
2. Harvey, R. W., and Burns, J. C. 1988. Forage species, concentrate feeding level and cow management system in combination with early weaning. J. Anim. Sci. 55:2722-2727.
3. Keith, A. R., Ward, E. C., and David, D. L. 2004. Market valuation of preconditioning feeder calves. J. Agric. and Appl. Econ. 36:173-183.
4. Lopez, J. W., Woods, G. T., Crandell, R. A., Prickard, J. R., and Mansfield, M. E. 1984. A preconditioning program for beef calves. AgriPractice 5:7-9, 12-13, 16-17.
5. Moore, J. E., Brant, M. H., Kunkle, W. E., and Hopkins, D. I. 1999. Effects of supplementation on voluntary forage intake, diet digestibility, and animal performance. J. Anim. Sci. 82:122-135.
6. Morter, R. L. 1983. Preconditioning programs for calves. Mod. Vet. Pract. 64:262.
7. NCSS. 2002. NCSS statistical system for windows. NCSS, 329 North 1000 East, Kaysville, Utah 84037.

8. NRC. 2000. Nutrient requirements of beef cattle, 7th rev. ed. 1996. National Research Council. Nat. Acad. Press, Washington, DC.
9. Rayburn, E. B., Hall, M. H., Murphy, W., and Vough, L. 1998. Pasture production. Pages 13-50 and 25–26 in: Pasture Management in the Northeast: Assessing Current Technologies, Research Directions and Educational Needs. NRAES-113. C. R. Krueger and H. B. Pionke, ed. Northeast Reg. Agric. Engin. Serv, Ithaca, NY.
10. Rayburn, E. B., and Rayburn, S. B. 1998. A standardized plate meter for estimating pasture mass in on-farm research trials. Agron. J. 90:238-241.
11. Rayburn, E. B., and Wallbrown, R. M. 2003. Pasture forage quality in West Virginia. Online. W. Vir. Univ. Ext. Bull., Morgantown, WV.
12. Sanson, D., and Coombs, D. 2000. Energy supplementation for yearling cattle grazing ryegrass and ryegrass/rye mixture. Rosepine Res. Sta., Louisiana Agric. Exp. Sta. 11:34-38.
13. Sollenberger, L. E., Rusland, G. A., Jones, C. S., Jr., Albrecht, K. A., and Gieger, K. L. 1989. Animal and forage responses on rotationally grazed ‘Floralta’ limpograss and ‘Pensacola’ bahiagrass pastures. Agron. J. 81:760-764.