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M. L. Galyean
New Mexico State University

G. C. Duff
New Mexico State University

K. J. Malcom-Callis
New Mexico State University

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MANAGEMENT FACTORS TO DECREASE HEALTH PROBLEMS IN WEANED CALVES

M. L. Galyean, G. C. Duff, and K. J. Malcolm-Callis
Clayton Livestock Research Center
Department of Animal and Range Sciences
New Mexico State University

INTRODUCTION

Economic losses caused by morbidity and mortality from bovine respiratory disease (BRD) in newly weaned/received cattle are one of the most significant problems facing the beef cattle industry. In small feedlots (100 to 1,000 animals marketed annually) throughout the United States (USDA-APHIS, 1994), death losses ranged from 1.5 to 2.7 per 100 animals marketed, with greater losses in western than in central regions of the US. Two-thirds to three-quarters of these deaths were attributed to respiratory disease (USDA-APHIS, 1994).

Two factors contribute to the high incidence of BRD in newly received, lightweight (e.g., < 400 to 500 lb) cattle. First, stresses associated with weaning and transportation negatively impact the immune system (Blecha et al., 1984) at a time when the animal is often exposed to a variety of infectious agents as a result of marketing procedures. Second, feed intake by stressed calves is typically low (Cole, 1995), averaging approximately 1.5% of BW during the first 2 wk after arrival of lightweight feeder cattle (Galyean and Hubbert, 1995). This low feed, and thereby nutrient, intake may further impair immune function (Cole, 1995). Older (e.g., yearling) cattle typically have greater intake than lightweight cattle subjected to shipping stress, although outbreaks of BRD can still be a problem in older cattle. Practices that have been used to offset these negative factors that impact the health of newly received cattle include preconditioning (Cole, 1993), on-ranch vaccination programs (Parker et al., 1993), nutritional management, and prophylactic medication. This review will emphasize nutritional and prophylactic medication approaches and their effects on performance and health of newly weaned/received beef cattle.

DIETARY MANAGEMENT

Dietary Energy Concentration. Stressed calves have an altered eating pattern (Lofgreen, 1983b) in two ways. First, as noted above, they have low feed intake, and second, they tend to prefer, and will consume greater quantities of, a high-concentrate than a high-roughage diet. When given a choice among feed mixtures varying in concentrate level, stressed calves selected diets with 72% concentrate during the 1st wk after arrival (Lofgreen, 1983b). Because of this preference, performance by newly received calves is typically optimized with higher concentrate (in excess of 60%) diets. Recovery of pay weight is typically faster and cost of gain less with higher than lower concentrate diets, but one negative aspect of higher concentrate receiving diets is that severity of morbidity (days of medical treatment per calf purchased) tends to increase as dietary concentrate level increases. Lofgreen (1988) reported that feeding alfalfa or good-quality grass hays in addition to a 75% concentrate diet during the 1st wk of the receiving period could decrease the negative effect of higher concentrate receiving diets on morbidity. Grass hay was more effective in decreasing morbidity than alfalfa hay, and gains were comparable to those noted with a 75% concentrate diet alone. Our current receiving program at the Clayton Livestock Research Center includes a 70% concentrate diet (steam-flaked milo or steam-flaked corn as the grain), with hay (sudangrass, millet, or wheat hay) provided either free-choice or in limited quantities (approximately 2 lb/animal daily) during the 1st wk of the receiving period. In a recent review article, Cole (1995) made similar recommendations. If feed milling capabilities are limited, feeding good-quality hay plus protein supplement has worked well in some cases (Cole, 1995), but weight gains are typically low with such programs, and calves may not fully compensate for lower gains during the receiving period (Lofgreen, 1988).

Dietary Protein Concentration and Source. The NRC (1984) factorial equations can be used to calculate the quantity of protein required by beef cattle. Such requirements are a function of body weight (BW) and feed (specifically net energy) intake. Galyean et al. (1993c) modeled the protein requirements of newly received calves (approximately 400 lb) using the NRC (1984) protein requirement calculations. Based on previous research, feed intake was assumed to be 1.45% of BW from arrival to d 14. For subsequent 14-d periods, dry matter (DM) intake was predicted from equations suggested by Galyean et al. (1993b). This model approach assumed that a 65% concentrate was fed for the first 28 d, followed by 14 d on a 75% concentrate diet, 14 d on an 85% concentrate diet, and a 90% concentrate diet thereafter. Bacterial crude protein (CP) synthesis in the rumen was calculated from equations of NRC (1985). Results of this modeling approach indicated that percentage of dietary CP needed to provide the required protein with the assumed feed intakes varied from approximately 17% during the second 14-d period to approximately 12% after cattle were consuming the 90% concentrate diet. Further, the model indicated that newly weaned/received calves have a low capacity for protein deposition during the first 2 wk after arrival because of low feed intake relative to subsequent periods when feed intake is normal. Percentage of CP required during the 1st 2-wk period was approximately 12.5% with an intake of 1.45% of BW. Needs for ruminal escape protein would be greatest for lightweight cattle, but for cattle that weigh more than 450 lb, escape protein needs decrease because bacterial CP synthesis increases with increasing intake of a high-concentrate diet. The model indicated that supplemental protein sources that provide 35 to 40% ruminal escape protein would most likely meet the needs of such cattle, provided that total dietary CP requirement was met (Galyean et al., 1993c).

Results of experiments dealing with the protein nutrition of newly received/weaned cattle have typically agreed with the modeling approach used by Galyean et al. (1993c). Readers are referred to Cole et al. (1984), Eck et al. (1988), Cole and Hutcheson (1990), Van Koevering et al. (1991; 1992), Gunter et al. (1993), Malcolm-Callis et al. (1994), and Fluharty and Loerch (1995) for additional information on protein source and level for newly received calves and yearlings. Generally supplemental source of protein does not seem to be a major factor in receiving diets, as long as a natural source is used. One exception may be corn silage-based receiving diets, which would likely supply a fairly large amount of ruminally degraded nitrogen from corn silage. For example, Fluharty and Loerch (1995) noted improved gain and gain efficiency when blood meal was the source of supplemental protein in corn silage-based receiving diets compared with soybean meal. Positive effects of ruminal escape protein sources in some diets also may be relatively short-term in nature (Eck et al., 1988).

In an experiment conducted at the Clayton Livestock Research Center (Galyean et al., 1993a; Table 1), calves shipped from Tennessee to the Research Center (19.5 h in transit, 6.8% shrink from pay weight) were assigned randomly to one of three diets with CP concentrations of 12, 14, or 16% for a 42-d receiving period. Daily gain ($P < .05$) and DM intake ($P < .10$) increased linearly with increasing CP concentration for the overall 42-d period. Percentage of calves treated for symptoms of BRD was 35.8% overall, with more ($P < .03$) calves requiring treatment on the 16% CP (47.5%) than on the 14% CP diet (22.5%) and intermediate morbidity for calves fed the 12% CP diet (37.5%). After the 42-d receiving period, all calves were stepped up to a common 14% CP, 85% concentrate diet. Those fed the 12% CP diet during the receiving period compensated for decreased gain during the subsequent 42-d period, such that dietary CP concentration fed during the receiving period did not affect performance for the 84-d period.

Mineral and Vitamin Fortification. With the exception of potassium, Cole (1993) indicated that the mineral requirements of stressed calves do not seem to differ greatly from those of non-stressed calves. Because of low feed intake, however, concentrations of most minerals need to be increased in receiving diets. Among the trace minerals, Zn, Cu, and Se have been evaluated in receiving diets because of potential effects on immune function. In model systems, results with Zn (Chirase et al., 1991), Se (Reffett Stabel et al., 1989), and Cu (Stabel et al., 1993) have generally been positive, and field studies have indicated some benefit of added Zn and Cu in receiving diets on decreasing morbidity from BRD (Galyean et al., 1995c). Galyean et al. (1995a) recently reviewed potential effects of Zn and Cu supplementation on performance and health of beef cattle. Studies with supplemental organic Cr for calves fed silage-based diets (Chang and Mowat, 1992; Moonsie-Shageer and Mowat, 1993) have been positive, suggesting that, under some conditions, supplemental Cr decreases morbidity and increases performance during the receiving period.

Experiments with B-vitamin supplementation to newly weaned/received cattle have yielded variable results, with some studies suggesting decreased morbidity and increased performance, whereas other studies have shown little or no response (Cole, 1993; 1995). There seems to be little economic justification for B-vitamin supplementation of nutritionally balanced receiving diets. Vitamin E is known to have effects on the immune system. It seems to stimulate the immune response when given before an infectious challenge, but have little or no effect when given after the challenge (Cole, 1993). Because of possible injection-site reactions, injections of vitamin E with some commercial preparations may be less desirable than dietary supplements or drenches (Galyean et al., 1991). Further studies with vitamin E supplementation are needed, but feeding 400 to 800 IU/animal daily has increased performance and decreased morbidity in some field studies (Hays et al., 1987).

Table 1. Influence of protein concentration on performance by calves during a 42-d receiving period - Galyean et al. (1993a)

Item	Dietary CP concentration, % 12	14	16	Contrast[a]	SE[b]
Receiving period performance					
No. of calves	40	40	40	-	-
Initial BW, lb	412.4	409.2	403.3	-	2.6
d 42 BW, lb	520.1	536.6	537.2	-	5.5
Daily gain, lb					
d 0 to 21	1.50	1.85	1.97	NS	.34
d 21 to 42	3.52	4.23	4.40	L*	.21
d 0 to 42	2.51	3.04	3.19	L*	.11
Daily DMI, lb/steer					
d 0 to 21					
Hay	1.34	1.36	1.34	NS	.05
Concentrate	5.84	6.36	6.67	NS	.34
Hay + Concentrate	7.17	7.72	8.01	NS	.35
d 21 to 42	12.55	12.40	13.30	NS	.39
d 0 to 42	9.86	10.06	10.65	L†	.27
Feed:gain					
d 0 to 21	5.64	4.72	4.35	NS	.94
d 21 to 42	3.61	2.95	3.04	L*	.17
d 0 to 42	3.95	3.32	3.35	Q*	.08
Calves treated for BRD, %[c]	37.5	22.5	47.5	-	-
Mortality, no.	2	1	0	-	-
Post-receiving performance					
Daily gain, lb	3.49	3.40	3.21	NS	.18
Daily DMI, lb/steer	15.37	15.76	15.49	NS	.47
Feed:gain	4.44	4.66	4.83	NS	.16
Overall performance					
Daily gain, lb	3.00	3.22	3.20	NS	.12
Daily DMI, lb/steer	12.62	12.91	13.07	NS	.33
Feed:gain	4.23	4.01	4.09	NS	.09

[a]Orthogonal contrasts: L = linear, Q = quadratic effect of protein concentration.
[b]Standard error of means, n = four pens per treatment.
†P<.10; *P<.05.
[c]Distribution differs; for 12 vs 14% CP, P<.15; for 14 vs 16% CP, P<.03.

Other Dietary Considerations. Several dietary factors need special attention in receiving diets. For example, 4% added fat in receiving diets did not greatly affect daily gain and efficiency but increased mortality compared with no added fat (Cole, 1995). Similarly, Cole (1995) recommended that urea levels in receiving diets be restricted to limit total urea intake to less than 30 g/d, which equates to approximately .5 to .75% of DM with intakes usually observed for newly received, lightweight cattle.

Ionophores are typically added receiving diets, often as a means of controlling coccidiosis. As a general rule, any factor that decreases feed intake should be avoided in receiving diets. Based on results with finishing cattle, one would expect lasalocid to have lesser effects on feed intake than monensin, but effects of monensin on feed intake vary with its concentration in the diet. Duff et al. (1995) evaluated effects of ionophore type and level on performance by newly received beef cattle. Two hundred fifty calves (initial BW = 391 lb) purchased from auction barns in southern Arkansas were shipped to the Clayton Livestock Research Center and fed one of four 70% concentrate diets: 1) Control - no ionophore; 2) lasalocid at 30 g/ton; 3) monensin at 20 g/ton; and 4) monensin at 30 g/ton of the dietary DM. Data from this trial are shown in Table 2. Ionophores decreased ($P < .08$) feed intake compared with the Control diet for the 28-d trial, but daily gain and feed efficiency were not significantly altered by treatments. Numerically, monensin at 30 g/ton resulted in a lower intake than lasalocid at 30 g/ton. All three ionophore treatments decreased the presence of coccidial oocysts (data not shown). Ionophores seem to have negative effects on intake of receiving diets, but these effects can be minimized by choice of ionophore or, with monensin, by decreasing its dietary concentration.

PROPHYLACTIC MEDICATION OF NEWLY RECEIVED BEEF CATTLE

Antibiotics are often added to feed or water of newly received cattle as a means of decreasing morbidity. In a survey that included approximately 86% of the US cattle-on-feed inventory (USDA-APHIS, 1995), approximately 58% of cattle in feedlots with greater than 1,000-head capacity received antibiotics in the feed for varying lengths of time. Most commonly used antibiotics for this purpose are chlortetracycline and oxytetracycline (USDA-APHIS, 1995).

Treatment of individual animals with antibiotics on a prophylactic or preventive basis is another approach that has been successful in decreasing the incidence of BRD in newly received cattle. Animals are typically mass medicated at or near the time of arrival in the feedlot. "High-risk" cattle that undergo extensive stress and shrink during marketing and transport, or cattle from locations with a history of health problems, are the most likely candidates for such programs. Lofgreen et al. (1980) reported that oxytetracycline injections to newly received calves for three consecutive days decreased mortality and morbidity from BRD; however, calves that became sick after mass medication with oxytetracycline required more treatments than control calves. Subsequently, Lofgreen (1983a) used a combination of long-acting oxytetracycline and sustained-release sulfadimethoxine as a mass-medication treatment for newly received, stressed calves. Morbidity from BRD decreased from 63.3% in control calves to 7.1% in mass-medicated calves, and treatment days did not differ among morbid control and mass-medicated calves.

Table 2. Effects of ionophore and ionophore level in the receiving diet on performance by beef steers - Duff et al. (1995).

	Treatment					Contrast[b]		
Item	Control	Monensin 20 g/ton	Monensin 30 g/ton	Lasalocid 30 g/ton	SE[a]	1	2	3
No. of calves	62	62	62	64	-	-	-	-
Initial BW, lb	388.7	391.8	391.0	393.2	3.06	-	-	-
d 28 BW, lb	486.6	477.1	481.1	485.7	8.89	-	-	-
Daily gain, lb								
d 0 to 14	2.46	2.17	2.22	2.43	.227	NS	NS	NS
d 15 to 28	4.53	3.93	4.21	4.18	.336	NS	NS	NS
d 0 to 28	3.50	3.05	3.22	3.31	.235	NS	NS	NS
Daily DMI, lb/steer								
d 0 to 14								
Hay	.98	.96	.99	.94	.032	NS	NS	NS
Concentrate	8.87	8.39	7.34	8.19	.304	.04	.05	NS
Total	9.84	9.34	8.32	9.13	.279	.03	.04	NS
d 15 to 28	14.03	13.15	12.67	13.67	.503	NS	NS	NS
d 0 to 28	11.94	11.25	10.50	11.40	.375	.08	NS	NS
Feed:gain								
d 0 to 14	4.01	4.62	3.75	3.83	.429	NS	NS	NS
d 15 to 28	3.14	3.51	3.07	3.29	.257	NS	NS	NS
d 0 to 28	3.42	3.77	3.29	3.47	.207	NS	NS	NS

[a]Pooled standard error of treatment means, n = four pens per treatment.

[b]Observed significance level of contrasts: 1 = Control vs ionophores; 2 = Monensin at 20 g/ton vs Monensin at 30 g/ton; 3 = Lasalocid vs the average of Monensin at 20 and 30 g/ton. NS = P>.10. Tylosin was added at a rate of 10 g/ton to Monensin diets, and oxytetracycline was added at a rate of 8 g/ton to the Lasalocid diet.

Tilmicosin phosphate (Micotil® 300, Elanco Animal Health), a recently introduced prescription drug, seems to have considerable potential as a prophylactic treatment for newly received cattle. It is a highly effective therapeutic treatment for *Pastuerella* pneumonia, the dose is small, and effective blood levels are maintained for 72 to 96 h (Elanco, 1992). Galyean et al. (1995b) conducted three trials in which tilmicosin phosphate was given at the time of arrival processing to newly received, lightweight calves. In two of the trials (Galyean et al., 1995b), tilmicosin phosphate was given as a mass-medication treatment (10 mg of tilmicosin phosphate/kg of BW) to calves at the time of arrival processing, whereas control calves received no prophylactic medication. Calves in the first trial were housed in feedlot pens after processing and fed a 65% concentrate receiving diet, and those in the second trial were allowed to freely graze irrigated winter wheat pasture. Mass medication with tilmicosin phosphate did not affect daily gain or feed intake in the first trial, but the percentage of calves treated for BRD was decreased from 46.4 to 0%. Similarly, with calves on wheat pasture, mass medication with tilmicosin phosphate did not affect daily gain, but decreased the percentage of calves treated for BRD from 32.8 to 12.1%. In a third trial, calves were received in the feedlot and fed a 65% concentrate diet. Treatments included no arrival medication (Control), mass medication with tilmicosin phosphate at 10 mg/kg of BW, or medication with tilmicosin phosphate if the rectal temperature at arrival processing was ≥ 103.5° F. Results of this experiment are shown in Table 3 (Galyean et al., 1995b). Treatment of calves with tilmicosin phosphate, either by mass medication or based on arrival rectal temperature, increased daily gain and DM intake during a 28-d receiving period and subsequent 28-d feeding period. Percentage of calves treated for BRD was decreased from 43.6% in Control calves to 11.9% in mass-treated calves, and 12.9% in calves treated on the basis of arrival temperature. Because temperature-based treatment can greatly decrease the use of tilmicosin phosphate (42% of calves in the temperature-based treatment group received tilmicosin phosphate), this approach should be the most cost-effective in practice. When using a rectal temperature-based approach, consideration should be given to environmental and cattle working conditions that can artificially inflate rectal temperature (Galyean et al., 1995b).

SUMMARY AND CONCLUSIONS

Performance by newly weaned/received cattle is optimized when the receiving diet contains 60% or more concentrate. Increasing morbidity from bovine respiratory disease with increasing concentrate level can be offset by providing good-quality hay free-choice, in addition to the concentrate diet, during the first 1 to 2 wk after arrival. For newly weaned/received calves, performance seems to increase as CP concentration increases from 12 to 14 % or more of the diet. The optimum protein source could vary with other dietary ingredients, possibly being greater with silage or other high-soluble nitrogen diets, but until definitive results are available, the natural protein source in receiving diets should be selected on the basis of cost per unit of protein. Further research is needed on possible nutritional modifiers of the immune system (e.g., vitamin E, zinc, copper, and selenium). Prophylactic antibiotic treatment of newly received calves decreases the incidence of respiratory disease, and may be most useful with cattle that are likely to experience high morbidity rates because of marketing and transportation stress. Tilmicosin phosphate, a prescription drug, when administered en masse or on the basis of rectal temperature at the time of arrival processing has markedly decreased respiratory disease in lightweight calves.

Table 3. Performance and health of newly received beef calves as influenced by arrival medication with tilmicosin phosphate - Galyean et al. (1995b)

	Treatment[a]				Contrast[c]	
Item	Control	Mass	Temp	SE[b]	Mass	Med
No. of calves	62	59	62	-	-	-
Body wt, lb						
Initial	517.6	508.3	506.5	3.0	-	-
d 28	601.5	610.5	610.7	3.9	-	-
d 56	693.6	702.2	698.8	5.2	-	-
Daily gain, lb						
d 0 to 28	3.00	3.66	3.71	.03	.01	.33
d 29 to 56	3.29	3.28	3.15	.11	.63	.50
d 0 to 56	3.14	3.47	3.43	.07	.07	.72
Daily DMI, lb/steer						
d 0 to 28	9.75	10.54	10.49	.19	.09	.85
d 29 to 56	14.32	14.26	14.39	.31	.99	.80
d 0 to 56	12.03	12.40	12.44	.07	.05	.76
Feed:gain						
d 0 to 28	3.29	2.92	2.87	.06	.03	.57
d 29 to 56	4.40	4.48	4.67	.13	.37	.40
d 0 to 56	3.87	3.63	3.69	.03	.03	.27
Calves treated for BRD, %[d]	43.6	11.9	12.9	-	.01	.43

[a]Control = no mass medication; Mass = medication at arrival processing with Micotil (tilmicosin phosphate); Temp = medication at arrival processing with Micotil if the rectal temperature was $\geq$103.5° F.

[b]Pooled standard error of treatment means, n = four pens/treatment.

[c]Observed significance level of contrasts: Mass = Control vs Mass and Temp; Med = Mass vs Temp.

[d]BRD = bovine respiratory disease.

LITERATURE CITED

Blecha, F., S. L. Boyles, and J. G. Riley. 1984. Shipping suppresses lymphocyte blastogenic responses in Angus and Brahman x Angus feeder calves. J. Anim. Sci. 59:576.

Chang, X., and D. N. Mowat. 1992. Supplemental chromium for stressed and growing feeder calves. J. Anim. Sci. 70:559.

Chirase, N. K., D. P. Hutcheson, and G. B. Thompson. 1991. Feed intake, rectal temperature, and serum mineral concentrations of feedlot cattle fed zinc oxide or zinc methionine and challenged with infectious bovine rhinotracheitis virus. J. Anim. Sci. 69:4137.

Cole, N. A. 1993. Nutritional strategies for stressed feeder calves. In: Proc. of the Southwest Nutrition and Management Conference. pp 1-9. University of Arizona, Tucson.

Cole, N. A. 1995. Review of bovine respiratory disease: Nutrition and disease interactions. In: R. Smith (Ed.) Schering-Plough Animal Health - Review of Bovine Respiratory Disease. Veterinary Learning Systems, Trenton, NJ (In Press).

Cole, N. A., and D. P. Hutcheson. 1990. Influence of dietary protein concentrations on performance and nitrogen repletion in stressed calves. J. Anim. Sci. 68:3488.

Cole, N. A., D. P. Hutcheson, J. B. McLaren, and W. A. Phillips. 1984. Influence of pretransit zeranol implant and receiving diet protein and urea levels on performance of yearling steers. J. Anim. Sci. 58:527.

Duff, G. C., M. L. Galyean, K. J. Malcolm-Callis, and D. R. Garcia. 1995. Effects of ionophore type and level in the receiving diet on performance by newly received beef calves. Clayton Livestock Res. Ctr. Prog. Rep. No. 96, New Mexico Agric. Exp. Sta., Las Cruces.

Eck, T. P., S. J. Bartle, R. L. Preston, R. T. Brandt, Jr., and C. R. Richardson. 1988. Protein source and level for incoming feedlot cattle. J. Anim. Sci. 66:1871.

Elanco. 1992. Micotil® 300 - Veterinarian Reference Guide. Elanco Anim. Health, A Division of Eli Lilly and Co., Indianapolis, IN.

Fluharty, F. L., and S. C. Loerch. 1995. Effects of protein concentration and protein source on performance of newly arrived feedlot steers. J. Anim. Sci. 73:1585.

Galyean, M. L., G. C. Duff, K. J. Malcolm, and D. R. Garcia. 1991. Effects of *Pasteurella haemolytica* vaccine and injectable vitamin E on the performance and health of newly received calves. Clayton Livestock Res. Ctr. Prog. Rep. No. 70, New Mexico Agric. Exp. Sta., Las Cruces.

Galyean, M. L., G. C. Duff, and A. B. Johnson. 1995a. Potential effects of zinc and copper on performance and health of beef cattle. In: Proc. of the Southwest Nutrition and Management Conference. pp 1-16. University of Arizona, Tucson.

Galyean, M. L., S. A. Gunter, and K. J. Malcolm-Callis. 1995b. Effects of arrival medication with tilmicosin phosphate on health and performance of newly received beef cattle. J. Anim. Sci. 73:1219.

Galyean, M. L., S. A. Gunter, K. J. Malcolm-Callis, and D. R. Garcia. 1993a. Effects of crude protein concentration in the receiving diet on performance and health of newly received beef calves. Clayton Livestock Res. Ctr. Prog. Rep. No. 88, New Mexico Agric. Exp. Sta., Las Cruces.

Galyean, M. L., and M. E. Hubbert. 1995. Effects of season, health, and management on feed intake by beef cattle. In: F. N. Owens (Ed.) Intake by Feedlot Cattle. Oklahoma Agric. Exp. Sta., P-942, pp 226-234..

Galyean, M. L., M. E. Hubbert, and S. A. Gunter. 1993b. Reevaluation of empirical approaches to predict feed intake by beef cattle. J. Anim. Sci. 71(Suppl. 1):286 (Abstr.).
Galyean, M. L., K. J. Malcolm-Callis, and S. A. Gunter. 1993c. Nutritional strategies for newly received cattle. In: Proc. of the 23rd Annual AFIA Liquid Feed Symposium. pp 147-170. September 13-15, Denver, CO. American Feed Industry Association, Arlington, VA.
Galyean, M. L., K. J. Malcolm-Callis, S. A Gunter, and R. A. Berrie. 1995c. Effect of zinc source and level and added copper lysine in the receiving diet on performance by growing and finishing steers. Prof. Anim. Sci. 11:139.
Gunter, S. A., M. L. Galyean, K. J. Malcolm-Callis, and D. R. Garcia. 1993. Effects of origin of cattle and supplemental protein source on the performance by newly received feeder cattle. Clayton Livestock Res. Ctr. Prog. Rep. No. 85, New Mexico Agric. Exp. Sta., Las Cruces.
Hays, V. S., D. R. Gill, R. A. Smith, and R. L. Ball. 1987. The effect of vitamin E supplementation on performance of newly received stocker cattle. Oklahoma Agric. Exp. Sta., MP-119, pp 198-201.
Lofgreen, G. P. 1983a. Mass medication in reducing shipping fever-bovine respiratory disease complex in highly stressed calves. J. Anim. Sci. 56:529.
Lofgreen, G. P. 1983b. Nutrition and management of stressed beef calves. In: Veterinary Clinics of North America: Large Animal Practice. pp 87-101. Vol. 5, No. 1, March, 1983.
Lofgreen, G. P. 1988. Nutrition and management of stressed beef calves - an update. In: Veterinary Clinics of North America: Food Animal Practice. pp 509-522. Vol. 4, No. 3, November, 1988.
Lofgreen, G. P., L. H. Stinocher, and H. E. Kiesling. 1980. Effects of dietary energy, free choice alfalfa hay and mass medication on calves subjected to marketing and shipping stresses. J. Anim. Sci. 50:590.
Malcolm-Callis, K. J., M. L. Galyean, and G. C. Duff. 1994. Effects of dietary supplemental protein source and a *Pasteurella haemolytica* toxoid on performance and health of newly received calves. Agri-Practice. 15:22.
Moonsie-Shageer, S., and D. N. Mowat. 1993. Effect of level of supplemental chromium on performance, serum constituents, and immune status of stressed feeder calves. J. Anim. Sci. 71:232.
NRC. 1984. Nutrient Requirements of Beef Cattle (6th Ed.). National Academy Press, Washington, DC.
NRC. 1985. Ruminant Nitrogen Usage. National Academy Press, Washington, DC.
Parker, W. R., J. A. Winder, M. L. Galyean, and R. L. Cravens. 1993. Effects of vaccination at branding on serum antibody titers to viral agents of bovine respiratory disease (BRD) in newly weaned New Mexico calves. J. Anim. Sci. 71(Suppl. 1):121 (Abstr.).
Reffett Stabel, J., J. W. Spears, T. T. Brown, Jr., and J. Brake. 1989. Selenium effect on glutathione peroxidase and the immune response of stressed calves challenged with *Pasteurella hemolytica*. J. Anim. Sci. 67:557.
Stabel, J. R., J. W. Spears, and T. T. Brown, Jr. 1993. Effect of copper deficiency on tissue, blood characteristics, and immune function of calves challenged with infectious bovine rhinotracheitis virus and *Pasteurella hemolytica*. J. Anim. Sci. 71:1247.
USDA-APHIS. 1994. Cattle death rates in small feedlots. Report N134.594. USDA-APHIS, Fort Collins, CO.
USDA-APHIS. 1995. Cattle on feed evaluation. Part II: Feedlot health and management

report. USDA, APHIS, Fort Collins, CO.
Van Koevering, M. T., D. R. Gill, F. N. Owens, and R. L. Ball. 1992. The effects of types and quality of protein on health and performance of shipping-stressed calves. Oklahoma Agric. Exp. Sta., MP-136, pp 326-332.
Van Koevering, M. T., D. R. Gill, F. N. Owens, F. T. McCollum, and R. L. Ball. 1991. The effects of escape protein on health and performance of shipping stressed calves. Oklahoma Agric. Exp. Sta., MP-134, pp 156-162.