

Effects of Stocking Rate and Level of Supplement on Stocker Cattle Grazing Rye-Ryegrass Pastures and Subsequent Feedlot Performance and Carcass Characteristics

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Abstract

Small grains with or without annual ryegrass (*Lolium multiflorum* Lam.) pastures are used to background fall-weaned calves in the southeastern US. Bermudagrass [*Cynodon dactylon* (L.) Pers] pastures were sod-seeded with ‘Maton’ rye (*Secale cereale* L.) and “TAM-90” annual ryegrass and stocked from December 20 to May 17 with 250 kg fall-weaned steers and heifers at three fixed stocking rates of 3.7 (LO), 5.2 (ME), or 7.4 (HI) hd/ha. Stockers were fed a cracked corn ration at 0, 0.4%, or 0.8% body weight (BW) daily. Stocker ADG was different ($P < 0.001$) at each stocking rate with gains of 1.39, 1.24, and 0.78 kg/d, respectively, for LO, ME, and HI. Stocker ADG was also different ($P < 0.001$) at each level of supplement with gains of 0.93, 1.20, and 1.30 kg/d, respectively, for 0, 0.4%, and 0.8% BW. Maximum gain per area of about 1250 kg/ha ($P < 0.002$) occurred with stockers receiving supplement at 0.4% or 0.8%. Feedlot ADG was greatest ($P < 0.03$) for HI cattle at 1.96 kg/d. Level of supplement did not affect ($P = 0.23$) feedlot ADG. Hot carcass weight and dressing percentage were greatest ($P < 0.05$) at 419 kg and 62%, respectively, for HI cattle. Dressing percentage was affected by supplementation, with cattle that received 0.8% having a DP value of 61%. All other carcass traits were not affected by stocking rate nor supplementation level.

Keywords

Rye-Ryegrass Pasture, Stocking Rate, Supplementation, Feedlot, Carcass Traits

1. Introduction

Stocker and feedlot phases are invaluable segments of beef production. A majority of stockers in southeastern states in the US are from winter-born, fall-weaned calves. Management strategies for fall-weaned stockers include backgrounding on stockpiled warm-season perennial grasses and/or hay and supplement until cool-season annual grass is available for grazing. In many southeastern states, small grain plus annual ryegrass is sod-seeded on warm-season perennial grass pastures, primarily bermudagrasses [*Cynodon dactylon* (L.) Pers]. Cereal grain rye and wheat (*Triticum aestivum* L.) are the primary cool-season annual grasses selected due to adaptation and productivity [1]. During cold temperatures, cereal grain rye has greater growth and accumulation than other small grain forages [2].

Publications from 1995 through 2024 on management practices and concepts related to stocker calf performance and subsequent feedlot performance were investigated by Reference [3]. They found the most notable management practices included pre-weaning, weaning, and post-weaning strategies related to forages, pastures, supplementation, and genotype-phenotype influences. They concluded that there exist significant knowledge gaps related to management strategies for stockers and relationships to carry-over effects into finishing. A specific knowledge gap noted was the lack of reported experiments that included both stocking rate and supplementation effects on stockers grazing cool-season annual grass pastures. They encouraged additional research evaluating small grain-ryegrass mixtures to be conducted as a whole-systems approach by following calves from birth to feedlot to harvest, thus documenting management strategies affecting the beef production life cycle. Reference [4] summarized that animal performance research has been segmented, similar to the beef industry, in cow-calf, stocker, and feedlot phases. They suggested multi-location and multi-discipline efforts to concentrate on long-term systems research that affects stocker and feedlot productivity. Reference [5] created a relational database, BeefSys, for archiving beef production experiments from birth to harvest, which was used by Reference [6] to evaluate the effect of stocking rate on perinatal cows and the performance of their calves from birth to carcass over a 30-year period.

The objectives of this experiment were to evaluate the effects of three stocking rates and three levels of supplementation on gain per animal and per unit land area for steers and heifers grazing rye-annual ryegrass pastures and the effects of these grazing treatments on subsequent feedlot performance and carcass characteristics.

2. Methods and Materials

2.1. Pastures and Cattle

All protocols and procedures for this experiment were approved by the Agriculture Animal Care and Use Committee of Texas A&M AgriLife, Use of Animals in Research Protocol (AUP 2005-202). The experiment was conducted at the Texas A&M AgriLife Research and Extension Center at Overton (32.29° N, 94.98° W) from 2004 to 2005.

Treatments were the factorial arrangement of three fixed stocking rates (1 stocker = 250 kg) of 3.7, 5.2, and 7.4 hd/ha and three daily levels of a cracked corn ration of 0, 0.4%, and 0.8% BW distributed in a randomized complete block design with two replicates of each stocking rate and supplementation combination (18 pastures, experimental units). Simmental-sired steers and heifers, three of each sex, were assigned as testers to each pasture (6 hd per replicate). Grazer stockers from the same herd of Simmental-sired cattle were added to these pastures to create the desired stocking rates [7] [8].

Bermudagrass pastures were sod-seeded with cereal grain “Maton” rye and “TAM-90” annual ryegrass. A conventional grain drill (John Deere end wheel grain drill, model BD1110) with 18 cm spacings was used to direct-drill 112 kg/ha rye and 38 kg/ha ryegrass in early October. Initial fertilization of 280 kg/ha of 21-8-17 (N-P₂O₅-K₂) was applied in early November, and 168 kg/ha of 34-0-0 (N-P₂O₅-K₂O) was applied at each of three times in early December, mid-February, and late March. Thus, a total of 230 kg/ha N was applied to provide adequate forage accumulation for the stocking rates used during this 148-d stocking period. Each pasture was sampled monthly for forage mass estimation by hand-clipping four 0.093 m² quadrants to ground level.

Rye-ryegrass pastures were stocked from 20 December to 17 May with Simmental x [Angus x Brahman (dam)] steers and heifers with initial BW of 250 kg. Stockers were from a cow-calf experiment and were weaned at Overton on 30 September at approximately 235 days of age with weaning weights of 240 kg for heifers and 245 kg for steers. All stockers received a pour-on Cydectin (cydectin-moxidectin solution, Elanco Animal Health) on 20 December and again on 1 March. All cattle received a growth-promoting ear implant of Revalor-G (trenbolone acetate and estradiol implant, Merck Animal Health) on 20 December.

The corn-based supplement consisted of 95.6% cracked corn, 2.5% dried molasses, 1.25% salt, and 0.65% dicalcium phosphate, with Rumensin 80 added at 0.0625% for 0.4% BW level and at 0.031% for 0.8% BW level to supply monensin at 150 mg/hd/d. The supplement ration was hand-fed daily in cattle troughs, allowing all animals in a pasture to have ad libitum access. Troughs were visually inspected daily to ensure all supplement was consumed without orts. Stocker cattle were weighed unshrunk initially and at 28-day intervals. After each weighing, the amount of supplement was adjusted for total BW per pasture. Body condition score [9] was visually assessed for each animal at initiation and at termination of the stocking period.

2.2. Feedlot and Carcass

At termination of stocking on rye-ryegrass pastures, cattle were transported 840 km to a commercial feedlot in Hereford, TX. Due to differences in final BW off pasture, cattle were sorted by BW into four pens of 28 to 30 hd each on 19 May. Allocation of feeders into pens by arrival BW allowed for anticipated uniformity in final backfat of a pen for sales to the abattoir. Initial BW of the four feedlot pens averaged 483 kg, 431 kg, 374 kg, and 332 kg respectively, for pens 1 - 4. Days on feed for each pen were determined by visual estimate of 1.27 cm backfat and were 100, 133, 145, and 169 days for pens 1 - 4, respectively. Gain to feed was 0.1462, 0.1527, 0.1403, and 0.1560, respectively, for pens 1 - 4. Composition and nutritive value of our finishing ration are shown in **Table 1**. The primary source of energy was flaked milo [*Sorghum bicolor* (L.) Moench]. The proportions of flaked milo:cottonseed hulls in the four periods of ration adjustments were 47:38, 63:24, 77:12, and 82:6, respectively, for initial to final rations.

Table 1. Composition and nutritive value of commercial finishing ration for feedlot in Hereford, TX.

Item	As Fed	Dry
<i>Ingredients</i>		
Flaked milo (%)	82	
Cottonseed hulls (%)	6	
Fat (%)	3	
Finisher supplement (%)	9	
Monensin (g/t)	28.1	
<i>Nutritive value</i>		
NE m (Mcal/kg)		2.16
NE g (Mcal/kg)		1.46
Crude protein (%)		13.0
NPN protein (%)		3.3
Potassium (%)		0.5
Phosphorus (%)		0.4
Calcium (%)		0.4
Magnesium (%)		0.1
Sulfur (%)		0.3

At termination of the feed period for each pen, cattle were transported less than 100 km for harvest at a commercial abattoir (Tyson) in the Texas High Plains. Hot carcass weight (HCW) was recorded for each animal at the time of harvest. After a 48-h chill, an experienced evaluator from the Cattlemen's Carcass Data Service and West Texas A & M University at Canyon, TX ribbed carcasses at the 12th and 13th rib interface for USDA quality traits. Each carcass was graded for USDA quality and

yield, adjusted backfat thickness, LM area, marbling score, and KPH percent.

2.3. Statistical Analysis

Data were analyzed using SAS 9.4 [10]. Animal performance data on pasture were analyzed with PROC GLIMMIX using fixed effects of stocking rate, supplement level, sex, and their interactions. Orthogonal polynomial contrasts were tested for linear and quadratic effects of stocking rate and supplementation. Pasture replication was used as a random effect. Monthly pasture forage mass was analyzed with PROC MIXED. Fixed effects included stocking rate, supplement level, month of the year, and their interactions. Month was included as a repeated effect, with pasture as the experimental unit. Feedlot performance was analyzed with PROC GLIMMIX using stocking rate, supplement level, and sex of feeder as fixed effects and pasture replication as a random effect. Carcass traits were analyzed with PROC GLIMMIX using stocking rate, supplement level, sex, and days on feed as fixed effects and pasture replication as a random effect.

3. Results and Discussion

3.1. Forage Mass

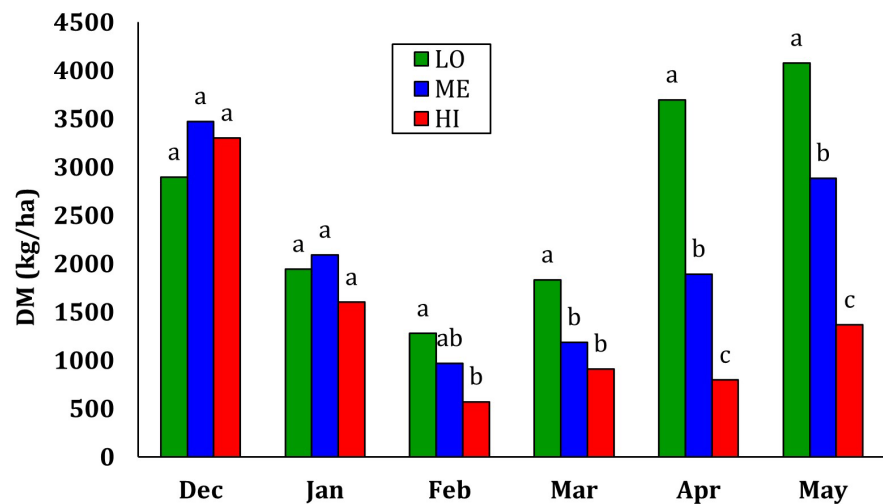


Figure 1. Stocking rates x month effects on forage mass of rye-annual ryegrass pastures. Within a month, bars labeled with different letters differ at $P < 0.01$.

Monthly measurements of forage mass demonstrated the classic bimodal forage production of cool-season forages under grazing (Figure 1), with the most ($P < 0.05$) forage mass appearing in December and May, and the least forage mass appearing during the colder months of January to early March [11]. There was an interaction ($P < 0.001$) between month and stocking rate, with the most forage mass occurring in May for LO pastures and the least forage mass occurring in February for HI pastures. Level of supplement did not affect forage mass ($P = 0.625$). Forage accumulation of cool-season annual grasses is often reduced on acidic soils due to aluminum toxicity that affects root length of growth [12]. Cereal

grain rye has been shown to have greater tolerance to aluminum concentration in the soil compared with wheat or triticale (*Triticosecale* Wittm.) [13].

3.2. Stocker Performance

As there were no significant interactions between stocking rate and supplementation level for any measured stocker performance attribute, effects of these treatments will be discussed separately.

3.2.1. Stocking Rate

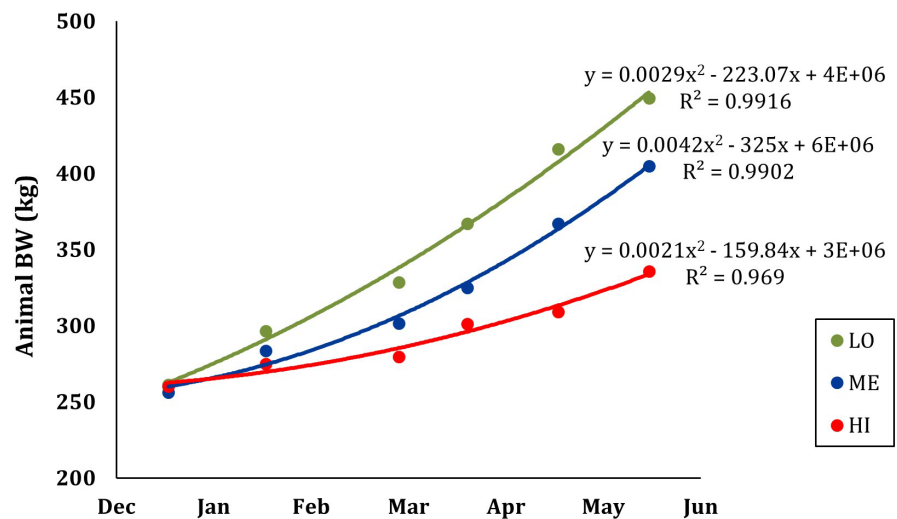


Figure 2. Effect of three stocking rates, each including three levels of supplement (0, 0.4%, 0.8%), on stocker growth on rye-ryegrass pastures.

There was a quadratic trend ($P = 0.061$) of increased animal growth with decreased stocking rate (Figure 2). Across the three levels of supplementation, ADG averaged 1.39, 1.24, and 0.78 kg/d for the LO, ME, and HI stocking rates, respectively, and differed among each stocking rate ($P < 0.0001$; Table 2). Steers gained weight faster than heifers ($P < 0.001$) at each fixed stocking rate. For grazing experiments using a range of fixed stocking rates, Reference [14] reported that higher ADG would result from low stocking rates. At low stocking rates, animals have opportunities for ad libitum intake of selected leaf components [15]. Final BCS in our experiment was different ($P < 0.001$) between stocking rates, with LO stockers having the highest score and HI stockers having the lowest score, as expected. The ME group with 5.2 hd/ha tended to have the greatest gain per area at 1259 kg/ha ($P < 0.054$). For the entire stocking period, average forage allowance (forage DM:animal BW) was 2.03 (LO), 1.28 (ME), and 0.70 (HI) and was different ($P < 0.0001$) between stocking rates. Forage allowance was calculated on a monthly basis and was reflective of the bimodal forage growth pattern typical of cool-season forages. Forage allowance at stocking initiation was about 3.4 (DM:BW). With fixed stocking rates in place, forage allowance declined to 1.12 (LO), 0.63 (ME), and 0.21 (HI) in February. By May, forage accumulation had

increased, and final forage allowance was 2.7 (LO), 1.5 (ME), and 0.6 (HI). Reference [16] reported that using forage allowance showed the relationship of forage mass per unit of animal BW which better defines stocking rate and ADG. Reference [17] summarized that knowing the forage allowance of a pasture may aid in management decisions for setting initial grazing intensity and provide opportunities to modify stocking strategies to achieve optimum ADG or gain per ha.

Table 2. Effects of three stocking rates, each including three levels of supplement (0, 0.4%, 0.8%), on average daily gain (ADG), final body condition score (BCS), and gain per area.

Performance	Stocking Rate ¹ , hd/ha			SEM
	3.7 (LO)	5.2 (ME)	7.4 (HI)	
ADG, kg/d	1.39 ^a	1.24 ^b	0.78 ^c	0.031
Male ADG, kg/d	1.48 ^a	1.33 ^b	0.85 ^c	0.036
Female ADG, kg/d	1.30 ^a	1.14 ^b	0.71 ^c	0.047
Final BCS	6.3 ^a	5.9 ^b	4.8 ^c	0.112
Gain, kg/ha	1030	1259	1050	61.0

Note: ¹ One stocker = 250 kg BW. ^{a-c} Within a row, means with different superscripts differ between treatment at $P < 0.0001$.

Reference [18] reported a seven-year study with stockers on “TAM 90” annual ryegrass at three fixed stocking rates of 4.9 (low), 6.4 (medium), and 9.6 hd/ha (high) with 250 kg BW = 1 hd, under continuous and rotational stocking methods. Stocking rates resulted in different ($P < 0.01$) ADG of 1.24, 1.04, and 0.74 kg/d, respectively, for low, medium, and high stocking rates. Medium stocked pastures produced the most gain/ha at 953 kg/ha, but were not significantly different ($P = 0.3451$) from low (929 kg/ha) or high (631 kg/ha) stocked pastures. The join point for maximum ADG was 1850 kg/ha of rye-annual ryegrass forage mass, which was achieved with low stocked pastures. At this level of forage mass, any additional forage available for consumption would not increase ADG; thus the join point for maximum ADG for forage allowance was 1.0 kg DM/kg BW. For our stocking rate x supplementation grazing experiment, the join point of forage mass would have met or exceeded 1850 kg/ha on LO pastures during Dec, Jan, Mar, Apr, and May (Figure 1).

Reference [19] cited experiments by Reference [20] and Reference [21] for a combined 117 records of stockers grazing small grain pastures in Arkansas from 2003 to 2009. These data showed a maximum ADG of 1.24 kg/d during fall and winter with a forage allowance of 3.5 kg DM/kg BW. They emphasized the relationship of ADG and stocking rate by showing ADG of about 0.9 kg/d at a forage allowance of 1.8 kg DM/kg BW. In our rye-ryegrass stocking study, we showed 1.27 kg/d gain on non-supplemented LO stocked pastures with an average forage allowance of 3.4 at initiation of stocking. In a three-year study, Reference [22] stocked ‘Nelson’ annual ryegrass at rates of 3.7 (low), 4.5 (medium low), 5.2 (me-

dium high), and 6.0 (high) steers per ha, with 275 kg BW = 1 steer. The average steer ADG was different ($P < 0.05$) between each stocking rate at 1.06, 0.85, 0.72, and 0.51 kg/d, respectively, for the low to high stocking rates. Gain per ha was greatest on low and medium low pastures at 366 kg/ha, compared to medium high at 291 kg/ha and high pastures at 187 kg/ha.

3.2.2. Supplementation Level

In our study, levels of daily supplementation resulted in different ($P < 0.0001$) stocker ADG of 0.93, 1.20, and 1.28 kg/d for 0, 0.4%, and 0.8% BW, respectively, across three stocking rates (LO, ME, and HI) on rye-ryegrass pastures (**Table 3**). Final BCS also increased as level of supplement increased ($P < 0.0001$), from 5.2 for non-supplemented stockers to 6.0 for stockers receiving 0.8% supplement. The original supplement ration used in this experiment was developed by Reference [23] and was designed to self-limit daily intake to 0.91 kg for stockers grazing wheat pastures to reduce incidence of bloat. Reference [24] made ingredient changes to this ration for two levels of intake and validated daily self-limiting intake of 0.91 kg/d and 1.8 kg/d for stockers grazing rye-ryegrass pastures.

Reference [25] conducted a two-year self-limiting supplement study for stockers grazing rye-ryegrass pastures. The non-supplemented stockers had a two-year average ADG of 1.05 kg/d which was less ($P < 0.05$) than the stockers on a self-limiting corn ration with Rumensin with an average ADG of 1.45 kg/d. The 300 kg BW stockers consumed a two-year daily average of 0.65 kg/hd supplement and had a gain:feed ratio of 0.45.

Table 3. Effects of level of daily supplement on ADG, final body condition score (BCS), and gain per ha.

Performance	Daily Supplement ¹ , %BW			SEM
	0	0.4	0.8	
ADG, kg/d	0.93 ^c	1.20 ^b	1.28 ^a	0.031
Final BCS	5.2 ^c	5.8 ^b	6.0 ^a	0.112
Gain/ha, kg/ha	838 ^e	1178 ^d	1322 ^d	61.0

Note: ¹ Supplement = cracked corn ration. ^{a-c} Within a row, means with different superscripts differ between treatment at $P < 0.0001$. ^{d-f} Within a row, means with different superscripts differ between treatment at $P = 0.0014$.

One measure of the efficiency of supplementation level is the ratio of extra gain to supplement. **Table 4** shows the extra gain: supplement for each stocking rate and supplementation level combination from our experiment. The least efficient level of daily supplement was 0.8% BW for cattle on LO pastures having an extra gain: supplement at 0.059. However, the most efficient level of extra gain: supplement was for HI cattle receiving 0.4% BW at 0.256. Both levels of supplement had the most efficient extra gain: supplement ratio at the HI stocking rate of 7.4 hd/ha. Supplementation resulted in significant ($P = 0.0014$) increase in gain per ha com-

pared to no supplement (**Table 3**). Stockers supplemented at 0.8% BW had highest gain per ha at 1322 kg/ha.

Table 4. Effect of level of supplement and stocking rate on extra gain:supplement.

Supplement (%BW/d)	Stocking rate (hd/ha)		
	3.7	5.2	7.4
	Extra gain: supplement		
0	---	---	---
0.4	0.091	0.185	0.256
0.8	0.059	0.119	0.149

Reference [26] grazed heifers on “Nelson” annual ryegrass at three stocking rates of 2.5 (low), 5.0 (medium), and 7.5 (high) hd/ha, with only the heifers on high stocked pastures receiving a daily supplement of either ground corn or soybean hulls at a rate of 1% BW or receiving no supplement. Heifer ADG of 1.08 kg/d from low stocked “Nelson” ryegrass pastures tended ($P < 0.06$) to differ from the medium stocked heifer ADG of 0.87 kg/d and differed ($P < 0.05$) from the high stocked non-supplemented heifer ADG of 0.57 kg/d. High stocked, supplemented heifer ADG was not increased with either supplement compared to non-supplemented heifer ADG. However, both supplements increased ($P < 0.05$) gain/ha from about 350 kg/ha to about 525 kg/ha on high stocked “Nelson” ryegrass pastures during this three-year study. These gain/ha on “Nelson” ryegrass were about half the gain from our stockers on rye-ryegrass pastures.

Reference [27] evaluated high starch (corn-based) vs high fiber (soybean hull/wheat middling) supplements, with both supplements containing monensin, on performance of fall-weaned calves stocked on winter wheat. Daily supplementation of 0.65% BW increased ($P < 0.01$) ADG from 0.92 kg/d for non-supplemented stockers to 1.07 kg/d for supplemented stockers. The ADG did not differ ($P > 0.45$) for supplement source. The conversion of supplement to increased gain/ha was similar ($P > 0.95$) at 5.4 and 5.0, respectively, for starch-based and fiber-based supplements. Use of either supplement allowed for an increase in stocking rate by about 33% and in ADG by 0.15 kg. Reference [28] stocked sod-seeded wheat with 240 kg BW steers at 1.23 hd/ha (low) and 1.85 hd/ha (high). Low stocked steers were either supplemented with soybean hulls at a level of 0.5% BW daily or were not offered supplement. High stocked steers were offered soybean hulls at a level of either 0.5% or 0.75% BW daily. Although steer ADG of about 1.00 kg/d was not affected by stocking rate or level of soybean hulls supplement, there was a potential to increase stocking rate by 33% and gain/ha by 60 to 65% by supplementing stockers at moderate levels.

3.3. Feedlot Performance and Carcass Attributes

Reference [29] reported on a 2-yr study on 176 steers and heifers stocked on “Ma-

ton” rye plus “TAM-90” annual ryegrass sod-seeded in bermudagrass pastures. Three stocking rates of high (H), medium (M), and low (L) resulted in different ($P < 0.03$) ADG at 0.37, 0.74, and 1.12 kg/d, respectively. Pasture stocking rates did not affect feedlot ADG of heifers at 1.82 kg/d; however, steers on L stocked pastures had lesser feedlot ADG than steers on M and H stocked pastures. Steers from low stocking rate pastures had greater HCW, ribeye area, back fat, and KPH. Heifers from low stocking rate pastures had greater HCW, back fat, KPH, and yield grade. Marbling was not affected by pasture stocking rate for steers or heifers.

For our experiment, the pasture treatment effects on overall feedlot performance are presented in **Table 5**. Stockers on HI stocked rye + ryegrass pastures had greater ($P = 0.026$) feedlot ADG of 1.96 kg/d compared to stockers on LO and ME pastures at 1.86 and 1.81 kg/d, respectively. Thus, some compensatory gains in feedlot were likely due to the lesser ADG on pasture. Level of supplement on pasture did not affect subsequent feedlot ADG ($P = 0.231$). Steers had feedlot ADG of approximately 2 kg/d, whereas heifer ADG was less ($P < 0.0001$) at 1.77 kg/d. Cattle were initially allotted to 4 feedlot pens according to off-pasture BW in order to create uniformity for pen sales to the abattoir. However, because treatment affected off-pasture BW, the resulting weight-based grouping resulted in some degree of separation among treatments. Generally, LO steers supplemented at 0.8% (heaviest BWs) were grouped together in a pen as were the HI heifers with no supplement (lightest BWs). The length of the feedlot period for a specific pen was determined by visual estimate of 1.27 cm backfat for the cattle in that pen. Days on feed (DOF) were different ($P < 0.001$) for all three stocking rates and ranged from 119 days (LO) to 157 days (HI) (**Table 5**). The DOF were longer ($P < 0.0001$) at 148 d for non-supplemented cattle compared to cattle receiving either level of supplement. Heifers were fed longer ($P = 0.0004$) at 140 d vs steers at 129 d.

Reference [30] evaluated the effects of steer performance on winter pasture on subsequent feedlot performance and carcass traits. Steers with initial 250 kg BW had 2-yr ADG of 1.21 kg/d, 0.61 kg/d, and 0.16 kg/d, respectively, from wheat pastures stocked at 1.1 hd/ha (low) and 2.45 hd/ha (medium), and from dormant tallgrass native range stocked at 3 ha per steer with 0.91 kg/d of cottonseed meal. Feeding steers to a common backfat thickness resulted in similar feedlot ADG among wintering treatments of 1.80 kg/d in year 1 and 1.68 kg/d in year 2. Steers that had the greatest pasture ADG had the greatest HCW. All other final carcass traits did not differ due to winter treatments.

Table 5. Pasture treatment effects on days on feed (DOF) and feedlot ADG.

Treatment	Days on feed		Feedlot ADG (kg/d)	
	Mean	SEM	Mean	SEM
Stocking Rate				
LO (3.7 hd/ha)	119 ^c	2.84	1.86 ^{fg}	0.041

Continued

ME (5.2 hd/ha)	129 ^b	2.74	1.81 ^g	0.041
HI (7.4 hd/ha)	157 ^a	2.74	1.96 ^f	0.040
Supplement (%BW/d)				
0	148 ^a	2.77	1.90	0.040
0.4	132 ^b	2.77	1.82	0.041
0.8	125 ^b	2.77	1.90	0.040
Stocker Sex				
Male	129 ^d	2.34	1.98 ^a	0.033
Female	140 ^e	2.32	1.77 ^b	0.033

Note: ^{a-c} Within a column, within a Treatment group, means with different superscripts differ between treatment at $P < 0.0001$. ^{d-e} Within a column, means with different superscripts differ between treatment at $P = 0.0004$. ^{f-g} Within a column, means with different superscripts differ between treatment at $P < 0.03$.

Reference [31] reviewed the literature to summarize and document potential carry-over effects of management strategies for stocker cattle on subsequent feedlot performance and carcass traits. The citation of 39 publications for stockers backgrounded on forage-based diets revealed that as backgrounding ADG increased, feedlot ADG, dry matter intake, and days on feed decreased ($P < 0.01$), while hot carcass weight and ribeye area increased ($P < 0.01$); however, there were no effects ($P = 0.45$) on marbling. They showed that placement BW in the feedlot was the single most important predictor of finishing phase performance. Thus, BW at termination of stocking and initiation of the feeder phase was one of the primary determinates of value when the cattle from our experiment were placed in the feedlot.

In our study, carcass traits of cattle stocked on rye-ryegrass pastures at three stocking rates and three levels of supplement are shown in **Table 6**. Hot carcass weight was different ($P = 0.05$) between cattle on HI stocking rate at 419 kg vs cattle on ME stocking rate at 397 kg. Dressing percentage (DP) was higher ($P < 0.001$) for cattle on HI stocking rate at 62.0% vs cattle on ME at 61.4% and LO at 61.0%. Dressing percentage was also affected ($P < 0.0001$) by supplementation, with cattle that received 0.8% having a DP of 61%, and those not supplemented or supplemented at 0.4% having a DP of 62%. There were no differences in any other carcass traits due to stocking rate or level of supplementation.

Table 6. Carcass traits of cattle stocked on rye-ryegrass pastures at three stocking rates and three levels of supplement, sorted into feedlot pens based on off-pasture body weight, and harvested at similar backfat thickness.

Carcass trait	Stocking rate (hd/ha)				Supplement (%BW/d)			
	3.7	5.2	7.4	SEM	0	0.4	0.8	SEM
Dressing (%)	61.0 ^c	61.4 ^b	62.0 ^a	0.16	61.8 ^d	61.5 ^d	61.1 ^e	0.16
Hot carcass BW (kg)	401 ^{fg}	397 ^g	419 ^f	6.1	408	403	406	5.3

Continued

Back fat (cm)	1.20	1.24	1.22	0.15	1.20	1.26	1.20	0.14
Marbling score*	391	392	382	11.7	383	397	385	10.1
Quality grade	680	678	675	8.8	674	685	674	7.6
Longissimus dorsi area (cm ²)	99.4	98.8	97.7	2.38	99.5	97.0	99.4	2.06
KPH (%)	1.87	1.86	1.91	0.03	1.86	1.88	1.89	0.03
Yield grade	2.48	2.51	2.73	0.25	2.53	2.67	2.53	0.23

Note: ^{a-c} Within a row, means with different superscripts differ at $P < 0.0001$. ^{d-e} Within a row, means with different superscripts differ at $P < 0.001$. ^{f-g} Within a row, means with different superscripts differ at $P < 0.05$. * 300 = slight; > 350 = high select; 400 = small, low choice.

3.4. Applications

Stocking rate for stockers on pasture is the most decisive management strategy for sustainable and profitable pasture-beef systems. In southeastern states, rye-ryegrass pastures moderately stocked with fall-weaned cattle can achieve individual animal gains of more than 1.25 kg/d and gains per unit area of more than 1050 kg/ha. Recognizing forage allowance x animal performance relationships for cool-season annual grasses such as cereal rye + annual ryegrass, and utilizing the bi-modal forage production of these grasses, final BW of stockers can increase to more than 400 kg during backgrounding for feedlot. Supplementation strategies are based on desire and need to increase gain per animal and/or gain per unit area. With added supplementation of 0.4% or 0.8% BW, these gains per unit area can increase to about 1250 kg/ha. Level of daily supplement has shown to be most efficient in terms of extra gain: supplement using 0.4% BW for stockers on medium or high stocked pastures. The cost of pastures and/or supplementation to achieve gain may be estimated prior to the backgrounding for fall-weaned stockers. Cattle on feedlot may exhibit some compensatory gain due to the gain on pasture. With the level of stocker gain on rye-ryegrass pastures and follow-up feedlot strategies to meet desired backfat levels, our experiment showed minimum carryover effects on carcass traits due to stocking rate and/or supplementation levels.

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Conflicts of Interest

The authors declare no conflicts of interest regarding this data and manuscript.

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