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Effect of Nitrogen Levels and Stocking Rates on Profitability of Winter Grazing

Numerous studies over many years have demonstrated the profitability of grazing lightweight yearling cattle on winter pasture in the lower south. Winter grazing research has been conducted at the MAFES Brown Loam Branch Experiment Station (located southwest of Jackson) for the last 26 years. During this period, net returns to land, labor, and management have ranged from -$92 to +$186 per acre, with a 26 year average of $62 per acre. Losses occurred in only four of the 26 years, three due to extreme cold and one to a high negative margin between calf buying and selling price.

The winter grazing research program at the Brown Loam Station in the last 15 years has been to graze 1.5 steer calves (540 lb/acre) on wheat-ryegrass pasture planted on a prepared seedbed and fertilized with 120-60-60 (N-P_2O_5-K_2O). Pastures were generally planted the second week in September, with grazing beginning the second week in November. This procedure usually resulted in 180 to 200 grazing days, with approximately 500 pounds of animal gain per acre.

In an attempt to increase net returns from the winter grazing practice, a study was designed to evaluate higher nitrogen and stocking rates than have customarily been used. Small plot studies have demonstrated that ryegrass will give a yield increase up to at least 400 pounds of nitrogen per acre. This increased production apparently would support a higher stocking rate. The question then becomes, what level of nitrogen and stocking rate would be the most profitable?

The objectives of this study were to evaluate three levels of nitrogen (148, 229, and 331 pounds per acre) and determine what stocking rates would most profitably utilize the forage produced. Previous studies have shown that 1.5 steers weighing 350 pounds per head can be grazed for the entire grazing period on pasture that has been fertilized with 120-130 pounds of nitrogen per acre---with little or no supplemental feed. Increasing the amount of nitrogen above this level will produce more forage in the fall and spring but during mid-winter, when the growth of wheat and ryegrass essentially stops, it would be difficult to graze more than 1.5 calves per acre. Therefore, alternative grazing management systems that called for removal of some or all of the cattle were designed so there would not be more than 1.5 animals per acre during the mid-winter period.

Experimental Procedure

Three grazing management systems were used for each of three levels of nitrogen during 1970-71, 1971-72, 1972-73, and 1973-74. The first two grazing management systems consisted of removing all but 1.5 steers per acre to drylot feeding. This was done about mid-December---in time to allow the 1.5 steers to remain on pasture without supplementary feed during the midwinter period. The other grazing management system allowed the cattle to graze until the forage supply was exhausted (usually about early January). All cattle were then moved to drylot feeding until the grass had enough regrowth to allow restocking. Reasons for comparing these grazing management systems were that previous work demonstrated that some feeding would be required with higher stocking rates, and some researchers had suggested the feeding period could be shortened if all cattle were removed---allowing a faster regrowth of the grass.

The resulting nine systems (Table 1) were: Systems 1, 2, and 3 received the lowest nitrogen level---148 pounds per acre. System 1 was stocked with 1.5 steers (540 lb/acre) for the duration of the season. System 2 was stocked with 2.0 steers (720 lb/acre) and, when the forage supply became short, a 0.5 steer equivalent was removed to

Table 1. Nitrogen levels, stocking rates, and grazing management systems, winter grazing study, MAFES Brown Loam Branch Station, 1970-74.

Systems	Nitrogen Level Lbs./A.	Stocking Rate Steers/A.	Stocking Rate Lbs./A.	Grazing Management Steers/A.
1	148	1.5	540	Remove 0
2	148	2.0	720	Remove 0.5
3	148	2.0	720	Remove all
4	229	2.0	720	Remove 0.5
5	229	2.5	900	Remove 1.0
6	229	2.5	900	Remove all
7	331	2.5	900	Remove 1.0
8	331	3.0	1,080	Remove 1.5
9	331	3.0	1,080	Remove all

drylot feeding until the forage had regrown. System 3 was stocked with 2.0 (720 lb/acre) steers that were allowed to graze until the forage supply was exhausted. All steers were then removed to drylot feeding until the forage had regrown enough to allow restocking. Systems 4, 5, and 6 received 229 pounds of nitrogen per acre and were stocked at 2.0, 2.5, and 2.5 steers per acre. Systems 7, 8, and 9 received 331 pounds of nitrogen per acre and were stocked at 2.5, 3.0, and 3.0 steers per acre. Grazing management for systems 4-6 and 7-9 paralleled that of systems 1-3 (Table 1).

Nine 6-acre plots were fallowed during summer each year and planted to wheat-ryegrass at the rate of 90 pounds of wheat and 20 pounds of ryegrass. Wheat was planted with a grain drill and ryegrass with a cultipacker seeder. All P_2O_5 and K_2O was applied before planting. Nitrogen applications were made at planting, December 1, February 15, and April 1. Hereford steer calves with an average weight of 361 pounds were used as test animals. Average stocking date was November 8. Data were analyzed as a RCB using four years as replications.

To make the economic data more relevant, cost data were calculated using 1976 input prices. (Current costs are about 35% higher than 1970-74 budgeted expenses.) Estimated annual production expenses for wheat-ryegrass pasture for the three levels of nitrogen are presented in Table 2. Miscellaneous expenses not included in pasture cost are presented in Table 3. The daily ration whi cattle were off pasture was 3 pounds of corn silage and 4.2 pounds of ground shelled corn pe head. Daily cost was 46 cents pe head.

A purchase price of $38.08/cw was used to calculate total cost pe grazing system. This is the averag price paid for this grade of catt over the last 10-year period.

Table 2. Estimated Annual Expenses Per Acre For Wheat-Ryegrass Winter Pasture On Prepared Seedbed, Mississippi, 1976.

Item	Unit	Number of units	Price per unit	Total Amount
Seed				
Wheat	lb.	90	$ .10	$ 9.00
Ryegrass	lb.	20	.18	3.60
Tractor & Equip.	acre	1	9.40	9.40
Lime	ton	0.2	15.00	3.00
Fertilizer				
P2O5	lb.	61	.19	11.59
K2O	lb.	61	.09	5.49
Nitrogen	lb.	148	.18	26.64
Nitrogen	lb.	229	.18	41.22
Nitrogen	lb.	331	.18	59.58
Total Expenses Per Acre: 148 lb. N Level				68.36
229 lb. N Level				82.94
331 lb. N Level				101.30

Table 3. Miscellaneous expenses, winter grazing study, MAFES Brown Loam Branch Station, 1970-74.

Interest	9% annual rate for 9 mos. on pasture cost and initial animal cost.
Death Loss	3% of initial animal cost.
Marketing & Transportation	$11.00/head
Veterinary & Medicine	5.00/head
Salt & Minerals	0.50/head
Supplementary Feed	0.46/head daily while off pasture
Daily Ration & Cost	32 lbs. urea-cornsilage @ $16.00/T. and 4.25 lbs. of ground shelled corn @ $2.75/bu.

Brown Loam steers on winter pastures.

Results and Discussion

Total beef production per acre increased with increasing nitrogen levels and stocking rates---from 555 pounds per acre with the low nitrogen level and stocking rate to 918 pounds per acre with the high nitrogen level and stocking rate (Table 4). In every case, the higher stocking rate and higher level of nitrogen produced greater gains per acre.

Average gain per steer generally decreased with increasing stocking rates (Table 5). Nitrogen levels generally had less influence than stocking rate on gain per animal. Although there were few significant differences, the lower stocking rates and grazing management systems where part of the cattle were left on pasture generally had higher gains per animal.

The number of grazing days per acre generally followed the same trend as total gain per acre (Table 6). As the nitrogen level increased, more grazing days resulted. Within each level of nitrogen the lower stocking rate gave a lower number of grazing days per acre. The grazing management systems where part of the cattle remained on the grazing plot all the time had a higher number of grazing days per steer than where all cattle were removed.

Table 4. Average total gain per acre, nine winter grazing systems, MAFES Brown Loam Branch Station, 1970-74.

System	Nitrogen Level Lbs/Ac.	Pounds/Acre[1]
8	331	918 a
9	331	848 b
7	331	798 c
6	229	767 c
5	229	760 c
4	229	691 d
2	148	642 de
3	148	624 e
1	148	555 f

[1]Means followed by the same letter are not different (P=.05) according to Duncan's New Multiple Range Test.

Table 5. Average gain per steer, nine winter grazing systems, MAFES Brown Loam Branch Station, 1970-74.

System	Nitrogen Level Lbs/Ac.	Pounds[1]
1	148	370 a
4	229	346 ab
2	148	321 bc
7	331	319 c
3	148	312 c
6	229	307 cd
8	331	306 cd
5	229	304 cd
9	331	281 d

[1]Means followed by the same letter are not different (P=.05) according to Duncan's New Multiple Range Test.

Table 6. Average number of grazing days per steer and per acre, nine winter grazing systems, MAFES Brown Loam Branch Station, 1970-74.

System	Per Steer	Per Acre[1]
8	170	511 a
9	156	469 b
7	179	447 bc
5	174	435 c
6	168	421 c
4	192	384 d
2	189	379 d
3	175	350 e
1	209	314 f

[1]Means followed by the same letter are not different (P=.05) according to Duncan's New Multiple Range Test.

Total costs per head increased only slightly as stocking rate and nitrogen level increased; however, cost per acre increased dramatically due to the increased stocking rate (Table 7).

Table 7. Average total cost per steer and per acre, nine winter grazing systems, MAFES Brown Loam Branch Station, 1970-74.

System	Per Steer	Per Acre
1	$219.62	$329.43
2	215.40	430.80
3	219.63	439.26
4	229.97	459.94
5	220.22	450.55
6	222.04	555.10
7	226.72	566.80
8	223.46	670.38
9	226.88	680.64

Calves on winter pasture, May 1962

Yearling steers on winter pasture.

Yearling steers on ryegrass, May 1966.

F_1 heifers on winter pasture, May 1974

Economic Analysis

Two key factors in evaluating the relative profitability of the nine grazing systems are margin (the difference in the buying and selling price per hundredweight of the same cattle) and price of nitrogen. Results obtained in the grazing systems experiment were compared at three margins (negative, zero, and positive) and three prices of nitrogen (9, 18, and 27 cents per pound).

Cattle were assumed to be bought for $38.08/cwt and sold for either $34.96, $38.08, or $41.20/cwt, giving margins of -$3.12, 0, or +$3.12. For the last 10 years this grade of cattle has sold for an average of $34.96/cwt, resulting in a $3.12 negative margin. Although the negative margin is more common, the zero and positive margins were used to determine whether the most profitable grazing system would change under the more favorable cattle price situation (Tables 8, 9, and 10).

The more relevant situation under present circumstances is the negative margin and 18 cents per pound nitrogen (center column of Table 8). Returns per acre to land, labor, and management ranged from +$43 for System 1 to -$26 for System 9. Three of the four most profitable systems used the low nitrogen level. System 4, which used medium nitrogen and the same stocking rate as System 2, produced the second highest average return.

The nitrogen price of 9 cents per pound (left column of Table 8) extended the number of systems that appeared economically feasible. Except for System 9, which showed a return to land, labor and management of only $5 per acre, the lowest return was $29 from System 6. At a nitrogen price of 27 cents per pound (right column of Table 8), only Systems 1, 2, and 4 appeared economically feasible, with net returns of $29, $18, and $13 per acre, respectively.

The effect of the more favorable cattle selling price of $38.08/cwt was to increase returns across all systems and nitrogen prices (Table 9). Except at the lowest nitrogen price, Systems 1, 2, and 4 were the most profitable.

When the margin was $3.12/cwt, differentiation between systems was more difficult (Table 10). For example, at 18 cents per pound nitrogen, returns to land, labor and management ranged from $90 for System 9 to $130 for System 8. Although no significant differences occurred, Systems 2 and 4 ranked near the top. At a nitrogen price of 9 cents per pound, returns from System 8 were higher than from Systems 1 and 2. At the high nitrogen price, Systems 2 and 4 were slightly more profitable than Systems 1 and 8. The general effect of the positive margin is to favor the higher nitrogen levels and stocking rates.

Table 8. Net returns per acre, three nitrogen costs and negative margin, nine winter grazing systems, MAFES Brown Loam Branch Station, 1970-74.[1] [2]

Nitrogen Cost					
$.09/Lb.		$.18/Lb.		$.27/Lb.	
System	Return/A ($)	System	Return/A ($)	System	Return/A ($)
1	57 a	1	43 a	1	29 a
4	51 ab	4	35 a	2	18 a
2	46 ab	2	32 ab	4	13 a
7	42 ab	3	17 b	3	3 b
8	41 ab	5	13 b	5	- 9 bc
5	35 ab	6	11 b	6	-11 bc
3	31 b	7	10 b	7	-22 c
6	29 b	8	10 b	8	-23 c
9	5 c	9	-26 c	9	-59 d

[1]Purchase price: $38.08
Selling price: 34.96
Margin: -3.12

[2]Means in the same column followed by the same letter are not different (P=.05) according to Duncan's New Multiple Range Test.

Table 9. Net returns per acre, three nitrogen costs and zero margin, nine winter grazing systems, MAFES Brown Loam Branch Station, 1970-74.[1 2]

Nitrogen Cost					
$.09/Lb.		$.18/Lb.		$.27/Lb.	
System	Return/A ($)	System	Return/A ($)	System	Return/A ($)
8	101 ns	4	78 a	1	62 a
4	94 ns	1	76 a	2	59 a
7	93 ns	2	73 a	4	56 a
1	90 ns	8	70 a	3	43 ab
2	87 ns	5	64 a	5	42 ab
5	86 ns	6	62 a	6	40 ab
6	84 ns	7	61 a	8	38 ab
3	72 ns	3	58 a	7	30 ab
9	64 ns	9	32 b	9	0 c

[1]Purchase price: $38.08
Selling price: 38.08
Margin: 0.0

[2]Means in the same column followed by the same letter are not different (P=.05) according to Duncan's New Multiple Range Test.

Table 10. Net returns per acre, three nitrogen costs and positive margin, nine winter grazing systems, MAFES Brown Loam Branch Station, 1970-74.[1 2]

Nitrogen Cost					
$.09/Lb.		$.18/Lb.		$.27/Lb.	
System	Return/A ($)	System	Return/A ($)	System	Return/A ($)
8	162 a	8	130 ns	2	100 a
7	145 ab	4	121 ns	4	99 a
4	137 abc	2	114 ns	8	98 a
5	136 abc	5	114 ns	1	95 a
6	134 abc	7	113 ns	5	92 a
2	129 abc	6	112 ns	6	90 a
1	124 abc	1	109 ns	3	84 a
9	123 bc	3	98 ns	7	81 ab
3	112 ac	9	90 ns	9	58 b

[1]Purchase price: $38.08
Selling price: 41.20
Margin: 3.12

[2]Means in the same column followed by the same letter are not different (P=.05) according to Duncan's New Multiple Range Test.

Another important determinant of returns is the cattle price level. Returns to land, labor and management from the nine grazing systems, using margins of -$3.12, 0, and +$3.12 per cwt and buying prices of $33.08, $38.08, and $43.08 are presented in Table 11. The higher price level resulted in greater net returns. Within a price level, systems with lower stocking rates generally ranked near the top when a negative margin was considered. Positive margins tend to favor the systems with higher stocking rates.

Over the range of margins and nitrogen prices considered, Systems 1, 2, and 4 appear to represent the best strategies for growing calves on winter pasture. These systems were best under the most adverse conditions (negative margin and moderate and high nitrogen prices), and were either best or near best for the zero-and positive-margin comparisons.

Of these three systems, System 1 appeared best when the margin was negative and poorest when the margin was positive. At the highest nitrogen price, System 2 always ranked before System 4 although the difference in net returns was not significant for any of the three margins.

In terms of negative results, System 9 ranked last in 8 situations and next to last in the other. Within a nitrogen level, the system where all animals were removed and fed in drylot always gave the lowest net returns.

Our results indicate that recommendations to produce should emphasize a winter grazi strategy best adapted to a range possible combinations of nitroge prices and margins. Nitroge prices of 18 cents per pound above are most likely, and negati margins are the general rule. Th favored systems under these co ditions are 1, 2, and 4, and the systems would not seriousl penalize the producer und favorable margins or lowe nitrogen prices.

Table 11. Net returns per acre at different cattle price levels, nine winter grazing systems, MAFES Brown Loam Branch Station, 1970-74.[1]

System	N Level	Buying price = $33.08/cwt. Selling price 29.96	33.08	36.20	Buying price = $38.08/cwt. Selling price 34.96	38.08	41.20	Buying price = $43.08/cwt. Selling price 39.96	43.08	46.20
1	148	$19.69	$52.95	$86.20	$43.14	$76.40	$109.65	$66.59	$99.85	$133.10
2	148	5.26	46.54	87.82	31.79	73.07	114.35	58.34	99.62	140.90
3	148	-8.81	31.87	72.60	16.86	57.57	98.28	42.53	83.23	123.94
4	229	6.06	48.96	91.86	34.95	77.85	120.75	63.84	106.74	149.64
5	229	-18.17	32.11	82.40	12.92	63.21	113.49	44.00	94.28	144.57
6	229	-20.23	30.31	80.85	11.22	61.76	112.30	42.65	93.19	143.73
7	331	-25.61	25.85	77.32	7.00	58.46	109.92	39.59	91.05	142.52
8	331	-28.12	32.56	93.24	9.56	70.24	130.92	47.22	107.90	168.58
9	331	-60.53	-2.15	56.23	-26.53	31.84	90.22	7.46	65.84	124.22

[1]Nitrogen price = $.18/lb.