Economic Returns to Different Stocking Rates for Cattle on Ryegrass under Contract Grazing and Traditional Ownership

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January 10, 2006

Research partly funded by the Alabama Agricultural Experiment Station.

Selected Paper prepared for presentation at the
Southern Agricultural Economics Association Annual Meetings
Orlando, Florida, February 5-8, 2006

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Abstract: Economic returns to stocker production were estimated using results of a grazing experiment. If resources to buy cattle are not limited, traditional ownership was superior to contract grazing under all but extremely unfavorable price spreads. If capital to purchase stockers is limited, contract grazing may provide more returns.

Key Words: Stockers, Grazing, Ryegrass

JEL Code: Q100

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In much of the Southeast, beef cattle production is a major enterprise. In Alabama, beef cattle rank second only to broilers in terms of cash income to farms (Economic Research Service, 2006). Beef production in Alabama involves mainly cow-calf operations, with most feeder calves being shipped to other states. However, over the past decade more cattlemen have been retaining ownership of their calves through the stocker phase, and in some cases, through the finishing phase as well (NASS, 2005; McKinnon, 2001; Rathwell, 2000). Most calves in the Southeast are weaned in autumn before cool season pastures are ready for grazing. Therefore, stocker systems are typically based on cool season pastures. Most calves in the Southeast are weaned in autumn before cool season pastures are ready for grazing. Therefore, stocker systems are typically based on cool season pastures but they often include a period during which animals need to be fed prior to initiation of grazing.

Analysis of stocker production systems requires consideration of both production and economic factors. Production factors include variables such as stocking rate, supplementation, and feeding regime prior to grazing, while examples of economic factors are ownership of cattle (whether animals are bought and sold, or contract grazed), buying and selling prices, and pasture-related costs. The objective of this study is to examine the effect of stocking rate on economic returns from stocker cattle production under both contract grazing and traditional ownership.

Background and Literature Review

Annual ryegrass (*Lolium multiflorum* L.), a cool-season grass, has been evaluated in several grazing trials in Alabama. Among the ryegrass cultivars evaluated (Jackson, Gulf, Surrey II, Jumbo, Winter star, Common annual, Marshall and others), results indicate that Marshall performed best. Under continuous stocking, this variety was superior to Gulf in average daily gain (ADG), gain per acre and economic return per acre (Bransby et al., 1997). In south Alabama, Marshall ryegrass yielded 77 percent more average daily gain (ADG), weight gain per steer and weight gain per acre than Gulf ryegrass, while in north Alabama this advantage was 27 percent.

In Texas, Riewe et al. (1963) recorded 30 percent more live weight gain per animal and 13 percent more gain per acre for Gulf ryegrass than for tall fescue, even though, the tall fescue had a 39 percent higher average stocking rate. In other studies in Alabama, Marshall ryegrass continuously grazed at stocking rates of 2.2, 3.5, and 2.0 steers per acre for 168, 194 and 209 days produced 567, 649 and 709 pounds of live weight per acre, in the south, central and north portions of the state, respectively (Jones, 1994). Hafley (1996) also recorded production between 580 and 800 pounds of gain per acre over grazing periods of 98 to 140 days for Marshall ryegrass.

With respect to nutritional value, ryegrass typically supplies more protein (100 to 271 g/kg), and digestible dry matter (627 to 721 g/kg) (Syfrett, 2003; Hafley, 1996; Riewe et al., 1963) than that required for optimal growth of grazing steers. According to the Nutrient Requirements of Beef Cattle (2000), the maximum crude protein content required for optimum growth of steers up to 500 kg is 100 g/kg. Even though crude protein content and digestible dry matter of ryegrass decreases and the structural components increase with plant maturity (Syfrett

2003, Hafley, 1996), it has frequently been possible to achieve an ADG of 2.2 pounds (1 kg) or more, and in some cases as high as 3 pounds. In one study steers were fattened on Marshall ryegrass to a condition suitable for slaughter (1075 to 1200 pounds of live weight) in a grazing period of 90 to 140 days, with associated income between $70 and $216 per acre and return over variable costs of up to $94 per acre (Bransby et al., 1999).

In summary, Marshall ryegrass has the potential to support highly productive and profitable stocker grazing systems during the winter season in Alabama. However, research is needed on whole stocker systems, as opposed to components of systems, to maximize economic returns from this opportunity and to verify projections made to date.

Data and Methods

Data on cattle weight gain at different stocking rates were obtained from an experiment conducted at the Beef Cattle Unit of the Alabama Agricultural Experiment Station's E.V. Smith Research Center, located in Macon County, Alabama (USDA climate zone 8a). The soil type at the experimental site is a Congaree loam series (fine-loamy, mixed, active, noacid, thermic typic udifluvent). It was formed in fluvial sediments and has thin strata of contrasting texture, pH, and organic matter, and is prone to flooding. Thirty four two-acre paddocks were plowed and disked in early fall of 2003 to prepare suitable seedbeds. Marshal ryegrass (*Lolium multiflorum*) was seeded at rate of 25 pounds/acre in October 2003 and fertilizer with 100 pounds of nitrogen per acre at planting in the fall and 50 pounds of nitrogen per acre in March in the form of ammonium nitrate. Phosphorous and potassium fertilization was according to soil test recommendation. (Details concerning the weather condition during this grazing experiment are available on request.)

A total of 144 weaned crossbred steers from commercial cow-calf operation were used. Steers arrived in January 28, 2004, and were weighed immediately before the start of grazing. Thirty four steer groups with different size (2, 3, 4, 5, and 6 steers) but similar average live weight per group were formed. Cattle weighed around 590 to 620 pounds each at the beginning of the study. Breed types were spread across groups. Steer groups were randomly assigned to paddocks to create stocking rates of 1, 1.5, 2, 2.5 and 3 steers per acre. All paddocks were continuously grazed from February 4 through May 27, a 112-day grazing period. A completely random design was used with uneven replication among stocking rate: the stocking rate of 1 steers/acre had four replicates, stocking rates of 1.5 and 2.5 steers/acre had seven replicates and stocking rates of 2 and 3 steers/acre had eight replicates. Increased replication, especially at high stocking rates, was used in an attempt to detect a significant response of average daily gain (ADG) to stocking rate.

If this experimental situation were to be replicated in a commercial operation, with animals purchased in late January, there would be no need for a pre-grazing feeding period. Therefore, for this study, the response of animal production and economic return to stocking rate over the grazing period were analyzed without considering any pre-grazing feeding.

Production data were analyzed using a mixed model procedure (Littell et al., 1996) with stocking rate as the fixed effect and paddocks as the random effect. The relationships between ADG and stocking rate, between ADG and herbage mass, and between gain/acre and stocking rate were examined by means of regression analysis. Resultant relationships facilitated calculation of the stocking rate at which gain/acre is maximized. All statistical inferences about fixed effects on response variables were made at the 5 percent level of significance.

Results

The relationships between herbage mass (HM), stocking rate (SR) and average daily gain per animal (ADG) were originally estimated using metric units (e.g. hectares and Megagrams) but have been converted to English units as presented below. (Original metric estimations are available on request.)

Herbage mass (HM) in tons per acre decreased with stocking rate by 1.1 tons per one unit increase in stocking rate per acre (p=0.0027). However, in general, the range of herbage mass observed in this study was substantially greater than that observed in several other studies (Gibb et al., 1997; Hodgson 1981; Hodgson and Jamieson, 1981; Stobbs 1973a,b). The estimated relationship between HM and SR is:

(1) $$HM = 11196.52 - 1.1(\pm 0.12)*SR$$

$$R^2 = 0.9661,\ p = 0.0027$$

Average daily gain (ADG) values were found to be between 2.2 to 2.7 pounds per animal. The relationship between ADG and herbage mass was quadratic (P=0.066) and was close to maximum between herbage mass levels of around 6250 to 8000 pounds (3.125 to 4 tons) per acre. These levels of ADG and herbage mass are considerable higher than those observed on Marshall ryegrass pastures in other studies at the same site (Jones, 1994; Ashley, 1993; Oberholster, 1990). The reason for this difference is that the grazing season in this study was essentially restricted to the time when ryegrass typically grows fast in the spring, whereas in other studies the grazing period started in the fall and extended through the winter (when growth of ryegrass is typically very slow) and spring.

The estimated equation of the relationship of ADG in pounds per animal and HM in tons per acre is presented below.

(2) $ADG = - 0.443 + 1.771\ (\pm 0.461)*HM – 0.00012\ (\pm .0035)*HM^2$

$R^2 = 0.9338$, $p = 0.0662$

The relationship between ADG per animal and stocking rate per acre was also quadratic, as reported below.

(3) $ADG = 1.72 + 1.17\ (\pm 0.375)*SR – 0.336\ (\pm 0.094)*SR^2$

$R^2 = 0.915$, $p = 0.0838$

Figure 1 provides a graph of the estimated relationship between average daily gain and stocking rate. In general, ADG was relatively stable at about 2.65 pounds between stocking rates of 1 to 2.50 steers/acre, but decreased with stocking rates above this point. These findings are in disagreement with those of other studies in which the relationship between ADG and stocking rate was linear (Mezzadra et al., 1992; Bransby et al., 1988; Hart, 1972; Bryant et al., 1965; Petersen et al., 1965; Riewe et al., 1963; Riewe, 1961), although Ashley, (1993) and Oberholster, (1990) reported a quadratic relationship between ADG and stocking rate for rye-ryegrass and ryegrass pastures. Again the reason for this discrepancy was probably the relatively high herbage mass observed in this study, largely because grazing occurred only in spring instead of in the entire fall-winter-spring period. The estimated relationship was:

(4) $ADG = 0.078 + 0.215\ (\pm 0.069)*SR – 0.025\ (\pm 0.007)*SR^2$

$R^2 = 0.9153$, $p = 0.0847$

Although, ADG was similar for all stocking rates, gain/acre increased due to the dominant effect of stocking rate (table 1). Gain/acre increased as stocking rate increased and attained a maximum of 752 pounds/acre at a stocking rate of 3 steers per acre. The calculated stocking rate at which gain/acre was maximum ($SR_{max)}$ falls at the end of the range of stocking rate evaluated. The SR_{max} in this study was greater than those found by Jones (1994) and Oberholster (1990) who reported a SR_{max} between 2 and 2.25 steeres per acre for ryegrass and and 2 and 2.1 steers per acre for oat pastures, respectively. Once again, these different results likely reflect the higher carrying capacity of pastures if they are grazed during the spring only, as was the case in this study, compared to grazing them over the longer fall-winter spring period..

Economic Analysis

Return per acre was calculated as the difference between total gross income per acre and total variable costs per acre. Returns were calculated for buying steers for grazing on ryegrass and then selling them, the traditional stocker grazing system, and for contract grazing steers in which case the owner of the steers pays a fee of $0.35 per pound of gain to an independent landowner who is responsible for the animals while they are on pasture.

Buying and selling price data were examined for the 11-year period from 1993 to 2004 to examine the variation in price spread (buying price minus selling price) over time. The buying and selling prices of stockers were obtained from the Alabama weekly livestock summary for feeder steers, classes medium and large 2, and medium and large 3 (USDA-Al. Department of Agriculture Market News, several years). On average, the price spread was $5.73/cwt over this period, but it was highly variable, ranging (in nominal terms) from an inverted spread of -$17.23 in 1996/97 to $20.06 in 1993/94. (Price data are available on request.)

Returns per acre for four alternative price spreads were estimated using the price and gain information along with estimated costs of a stocker steer operation. Costs per steer for traditional ownership systems were assumed to be equal to the purchase price plus a $43.50 per head fee to cover veterinary and medical expenses ($17.50/head), marketing expenses ($12.50/head), salt and minerals ($5.00/head), labor ($7 per head) and the beef promotion fee ($1.50/head). In addition, variable interest costs are accrued on the steers at a rate of 0.0219 percent per day (8 percent per year) for the 112 day carrying period, for an additional charge of 2.45 percent times the initial steer expenditure. In addition to the variable costs associated with the steers, variable costs for the pasture were calculated at a total of $185 per acre, comprised of $135 for maintenance and establishment of the ryegrass pasture, $20 per acre in land rent, $2 per acre for equipment maintenance and repair, and $28 per acre for general labor.

Returns per acre are reported in table. 2. Steers were assumed to average 600 pounds each when placed on pasture and ending weight was calculated based on the gains per acre provided in table 1. The optimal economic stocking rate was 2.5 steers per acre under the average price spread ($6/cwt) and a more favorable price spread ($2/cwt). Under an inverted price spread (-$6/cwt), the highest stocking rate of 3 steers per acre was optimal. Under a highly unfavorable price spread ($20/cwt), no stocking rate resulted in a profit but a stocking rate of 2 head per acre resulted in the smallest loss. Results are somewhat sensitive to assumptions about the variable costs associated with each steer. If additional variable costs are $25 per steer, rather than $43.50, the highest stocking rate yields the highest profits under both the inverted price spread and the favorable price spread ($2/cwt). Under the average price spread ($6/cwt), 2.5 steers per acre remains optimal even under the assumption of lower variable costs per steer.

Table 3 provides estimates of net return per acre under contract grazing, with a payment of $35/cwt for gain. It is assumed that the cattle owner carries the per-steer variable costs (veterinary etc.) except for labor at $7 per steer. In addition, it was assumed that pasture variable costs of $185 per acre would remain the same under contract grazing as under traditional ownership. Results indicate that for contract grazing, the optimal stocking rate occurs at the end of the data range, 3 steers per acre. It is therefore possible that even higher stocking rates may be preferred, but the data available do not allow for this analysis. Results further indicate that except for highly unfavorable price spreads (e.g. $20/cwt), contract grazing results in lower net income per acre than traditional ownership. For contract grazing to be more profitable than traditional ownership, the price spread would need to be about $14/cwt or higher. Further, contract details concerning responsibility for death loss, which were ignored in this analysis and which can vary considerably, would need to be carefully evaluated before determining the actual expected profit from a contract situation.

Green et al. (1995) reported that when operating capital was limiting and land was not, cattle producers could make more money from contract grazing than buying and selling cattle, even though the buying and selling option provided higher return/acre. To investigate this situation for the average price spread, it was assumed that $30,000 was available to purchase cattle, which were bought at 600 pounds each for $95/cwt ($570 per steer) and sold at $89/cwt. It was assumed that 200 acres of pasture were available and that $114,000 could be allocated for purchasing steers, which would allow an owner to buy 200 steers, for a stocking rate of 1 steer per acre. At this price spread, this stocking rate would result in negative net reruns under cattle ownership. By contract, contract grazing would allow the land owner to make a profit of $11,470 ($57.35 per acre). Because land and capital constraints are highly variable across producers, each producer with constrained capital will need to evaluate the potential benefits of contract grazing for his or her own situation.

The economic analyses conducted to this point have used cattle weights as determined on arrival at the experiment stations. However, in commercial operations, starting cattle weights are often obtained immediately after loading cattle onto a truck. If the animals are subsequently hauled a long distance, for up to 8 hrs, substantial shrinkage (von Borell, 2001) may result. To investigate the impact of shrinkage on returns/acre, shrinkage of 0, 2, 5, and 10 percent and return/acre was computed for each of these options. As shrinkage increased, return/acre decreased, but this effect was relatively greater for buying and selling cattle than for contract grazing. At shrinkage rates of ten percent, contract grazing becomes more profitable than traditional ownership when the price spread is approximately $9/cwt.

Discussion

Herbage mass in this study was greater than other studies, probably because pastures were grazed only in the spring instead of over the entire fall-winter-spring period. ADG did not decrease linearly with stocking rate, probably because of the relatively high levels of herbage mass observed. Gain/acre increased with stocking rate and reached a maximum of 752 pounds per acre at 3 steers/acre. Returns per acre, under traditional ownership, were highest at 2.5 steers per acre with "typical" price spreads, but the results were sensitive to extreme changes in price spreads. Under contract grazing, 3 steers per acre, the highest stocking rate in the data, was economically optimal.

Buying and selling steers provided more return/acre than contract grazing under almost all prices spreads, except extremely unfavorable price spreads which occur only rarely. But traditional ownership requires considerably more operating capital. If capital is limiting and land is not, contract grazing may provide more total income than buying and selling animals, even under normal price spreads. Further, results show that shrinkage rates can influence the relative profitability of contract grazing versus traditional ownership, making contract grazing preferred in some situations where ownership would be preferred with lower shrinkage. Finally, this analysis did not consider risk. Because highly unfavorable price spreads do occur on occasion, producers with high levels of risk aversion or those in precarious financial positions who cannot afford even one year of a large loss, may be better off under contract grazing.

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Figure 1

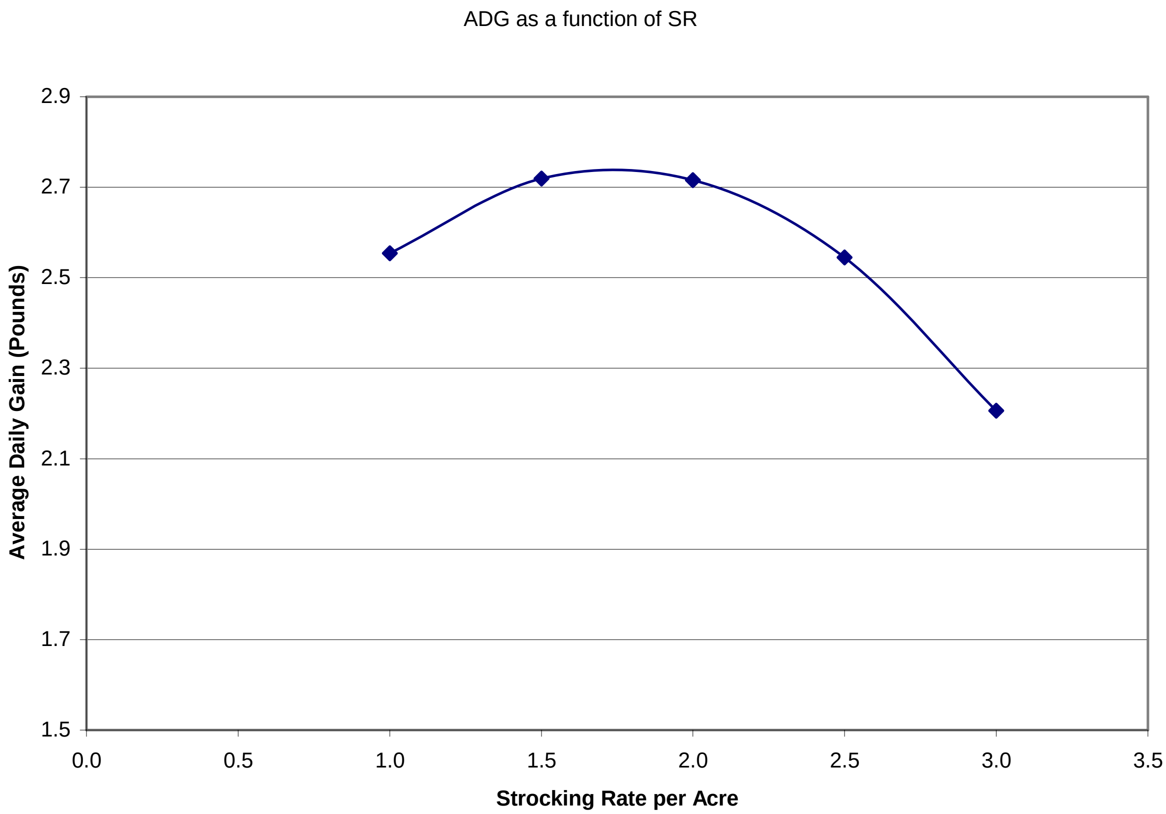
ADG as a function of SR
Average Daily Gain (Pounds)
2.9
2.7
2.5
2.3
2.1
1.9
1.7
1.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Strocking Rate per Acre

Table 1. Stocking Rate and Gain per Acre

Stocking rate (steers/ac)	Gain/ac[1] (pounds)
1	287.3
1.5	459.2
2	612.7
2.5	719.8
3	752.4

[1] Gain per acre calculated based on the regression function for ADG with stocking rate, multiplied by the length of the grazing period.

Table 2. Stocking Rate and Returns under Alternative Price Spreads

Stocking rate (steers/ac)	Expenditure at $85/cwt Buying Price	Total Steer Related Variable Costs	Gain/ac[1] (pounds)	Gross Revenue[2] $91/cwt Selling Price	Net Returns[3] per acre
1	510	566.00	287.3	789.67	38.68
1.5	765	848.99	459.2	1209.68	175.69
2	1020	1131.99	612.7	1613.33	296.34
2.5	1275	1414.99	719.8	1975.61	375.62
3	1530	1697.99	752.4	2271.67	388.69
Stocking rate (steers/ac)	**Expenditure at $95/cwt Buying Price**	**Total Steer Related Variable Costs**	**Gain/ac[1] (pounds)**	**Gross Revenue[2] $93/cwt Selling Price**	**Net Returns[3] per acre**
1	570	627.47	287.3	825.16	12.70
1.5	855	941.20	459.2	1264.05	137.85
2	1140	1254.93	612.7	1685.84	245.91
2.5	1425	1568.66	719.8	2064.40	310.74
3	1710	1882.40	752.4	2373.77	306.38
Stocking rate (steers/ac)	**Expenditure at $95/cwt Buying Price**	**Total Steer Related Variable Costs**	**Gain/ac[1] (pounds)**	**Gross Revenue[2] $89/cwt Selling Price**	**Net Returns[3] per acre**
1	570	627.47	287.3	789.67	-22.79
1.5	855	941.20	459.2	1209.68	83.48
2	1140	1254.93	612.7	1613.33	173.40
2.5	1425	1568.66	719.8	1975.61	221.95
3	1710	1882.40	752.4	2271.67	204.28
Stocking rate (steers/ac)	**Expenditure at $95/cwt Buying Price**	**Total Steer Related Variable Costs**	**Gain/ac[1] (pounds)**	**Gross Revenue[2] $75/cwt Selling Price**	**Net Returns[3] per acre**
1	570	627.47	287.3	665.46	-147.01
1.5	855	941.20	459.2	1019.39	-106.80
2	1140	1254.93	612.7	1359.55	-80.38
2.5	1425	1568.66	719.8	1664.84	-88.82
3	1710	1882.40	752.4	1914.33	-153.06

[1] Gain calculated based on estimated equations.
[2] Gross revenue is calculated as 600 pounds (beginning weight per steer) times the number of steers per acre plus the gain per acre, all multiplied by the selling price.
[3] Net revenue is calculated as gross revenue minus the sum of total steer related expenses and $185 variable costs for pasture. Steer related expenses are the purchase cost, plus $43.50 variable costs per steer, plus interest on the purchase price at 8 percent per year for 112 days.

Table 3. Net Returns from Contract Grazing

Stocking rate (steers/ac)	Gain/ac[1] (pounds)	Gross Income ($/acre)	Net Return ($/acre)
1.00	287.27	100.55	-91.45
1.50	459.19	160.72	-34.78
2.00	612.73	214.46	15.46
2.50	719.79	251.93	49.43
3.00	752.44	263.35	57.35

[1] Gains per acre from estimates reported in table 1. Contract grazing at a payment rate of $.35 cents per pounds of gain. Additional labor costs of $7 per steer paid by land owner. All other steer-related expenses paid by cattle owner. Land owner pays $185 per acre for pasture variable costs.