The Economics of Rotational Grazing in the Gulf Coast Region: Costs, Returns, and Labor Considerations

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Abstract: Labor and profitability associated with continuous grazing at three stocking rates and rotational grazing at a high stocking rate are compared. Profits are lowest for low stocking rate continuous grazing and high stocking rate rotational grazing. Labor is greatest on per-acre and per-cow bases with rotational grazing.

Keywords: Time and Motion Study, Conservation, Louisiana, Cow-Calf

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Introduction

Rotational stocking (grazing) of pastures has been promoted by a number of groups as having natural environment advantages over continuous stocking (grazing) at similar stocking rates. In cases where continuous grazing is chosen over rotational grazing, lower stocking rates (animals per acre) generally have conservation benefits, as overgrazing and, hence erosion, is less likely to result. Though rotational grazing or continuous grazing at lower stocking rates may be preferred from an environmental perspective, these practices are not routinely used by all cattle producers, raising the questions, (1) Are they profitable for cattle producers in the short run and (2) How do they affect management and labor requirements?

Arguments for rotational grazing have been that it increases carrying capacity, results in better pasture persistence and productivity, provides for improved forage utilization, results in less forage being wasted by trampling, and reduces soil erosion relative to continuous grazing. Rotational grazing generally requires 5 to 10 fenced paddocks that are grazed 3 to 7 days and rested 25 to 35 days, allowing forages to rest and regrow while other paddocks are grazed. Costs associated with rotational grazing have included significant capital investment, such as additional fencing and watering equipment, and increased labor required for moving animals. Advantages and disadvantages to rotational and continuous grazing are listed by LSU Agricultural Center Publication #2884.

Despite significant advantages attributed to rotational grazing, only 19% of Louisiana beef producers reported using it with at least 5 paddocks in 2002 (Kim). Previous unpublished surveys

used by Boucher and Gillespie (1999) in determining costs of beef production suggest that stocking rates vary widely among farmers in Louisiana.

Given the low adoption rate of rotational grazing in Louisiana and the apparent low interest in future adoption, as well as the wide array of stocking rates used for continuous grazing, the objectives of this study were to determine, for the U.S. Gulf Coast region, differences in (1) the profitability associated with rotational grazing using a high stocking rate and continuous grazing using high, low, and medium stocking rates, and (2) labor requirements under rotational and continuous grazing. This study differs from previous grazing studies not only because it deals with grazing in a particular region, but also because it uses data collected from a detailed time and motion study to analyze the differences in a key input: labor.

Previous Literature

A substantial body of literature has amassed on the effects of stocking rate and rotational grazing on animal productivity. A relatively small subset of these studies has addressed the associated economics of these systems, though the authors are aware of no other study that has an extensive empirical evaluation of labor requirements.

A number of studies have found no differences between rotational grazing and continuous grazing at the same stocking rates in the end-of-season standing crop (Jung et al., Pitts and Bryant, Anderson, and Thurow et al.). Comparing rotational to continuous grazing of fescue pastures at equivalent stocking rates, Chestnut et al. did not find dramatic increases in forage availability with rotational grazing. Derner et al. found that grazed heights of little bluestem were similar between continuous and rotational grazing systems compared at equal stocking rates. Cassels et al., on the other hand, found an increase in forage availability with tall prairie grass with rotational compared to

continuous grazing at similar stocking rates. In terms of differences in forage quality between continuous and rotational grazing strategies, the results have been inconsistent (Bertelson et al.; Hafley, Aiken, and Popp et al.).

Animal performance is an important aspect of grazing strategy. Most comparisons have been made with growing steers or heifers. Some studies have compared rotational and continuous grazing at different stocking rates (e.g., Bertelson et al., Hafley, Aiken). Studies that have compared the two strategies at equal stocking rates have included (1) Hart et al., who concluded that steer average daily gain on Coastal bermudagrass was unaffected by strategy when adjusted to equivalent grazing pressure; (2) Gillen et al., who found that stocker cattle gains per head and per acre were lower for rotational compared with continuous grazing; and (3) Bransby et al., who found no differences in average daily gain and gain per unit land area on ryegrass pastures. Bransby et al. did, however, find greater individual and per-unit land area average daily gains for continuous grazing at lower stocking rates and for rotational grazing at higher stocking rates. Wachenheim et al. estimated a quadratic response function to determine the economically optimal stocking rate on alfalfa pasture. They found that the economically optimal stocking rate was higher than that which maximized animal performance and lower than that which maximized pasture productivity.

Several studies have compared grazing strategies under cow-calf production. Heitschmidt et al. evaluated cow-calf production on heavily and moderately stocked continuously grazed and very heavily stocked rotationally grazed pastures under extensive rangeland conditions. Mean conception rates, weaned calf crops, and production per cow did not differ among grazing methods, but production per unit land area was greater for very heavily stocked rotational grazing compared with the lower-stocked continuous grazing systems. Net returns per cow and per unit land area did not differ among the

grazing systems. The authors concluded that stocking rate had a greater impact on cow-calf production than did grazing method. Chestnut et al. reported no difference between continuous and rotational grazing of fescue pastures at equal stocking rates for cow or calf average daily gain or calf 205-day weight. Similarly, McCann found that calf weaning weights were unaffected by grazing method, but weaning weights per unit land area of cow-calf pairs grazing bermudagrass-fescue pastures was 36% greater for short-duration rotational grazing compared with continuous grazing systems at equal stocking rates.

A number of studies have been conducted on rotational grazing versus continuous grazing, as well as stocking rate comparisons, but little detailed information is available to provide guidance to Gulf Coast cow-calf producers about selecting a grazing strategy. Furthermore, previous studies have not addressed the substantial differences associated with labor among grazing strategies.

Methods

This study was designed as an economic and biological experiment at the Iberia Research Station in Jeanerette, Louisiana. Four stocking rate / grazing management treatments were used in this study. For Field 1, 16-acre pasture groups were used, while in Field 2, 10-acre pasture groups were used. Treatments were randomized to pastures by field with repeated measures by pasture over years 1999, 2000, and 2001. The four treatments were low stocking rate continuous grazing (CL) with 0.5 cows per acre, medium stocking rate continuous grazing (CM) with 0.8 cows per acre, high stocking rate continuous grazing (CH) with 1.1 cows per acre, and high stocking rate eight-paddock rotational grazing system (RH) with 1.1 cows per acre. The design allowed the researchers to characterize the effects of stocking rate in continuously stocked pastures and to compare continuous and rotational grazing at the high stocking rate. Stocking rates were determined based upon results of unpublished

surveys of Louisiana beef producers used in annual beef costs and returns estimates (Boucher and Gillespie, 1999).

Mature, spring-calving, straight-bred Brangus cows and their suckling calves were stocked onto treatment pastures year-round (for three years) beginning in February 1999. Cows were weighed and scored for body condition, and calves were weighed in late April or early May (pre-breeding for cows) and again in late July (post-breeding for cows). Forage mass was determined monthly by clipping five 10 m^2 areas to ground level in each pasture. Simulated bite samples (four samples per pasture) were obtained twice monthly to determine diet quality. Depending on forage growth rate, these samples were obtained in RH pastures one-to-two days following rotation. This procedure was adopted in the RH pastures in an attempt to reflect average diet quality. At times when forage availability became low, cows and their calves were moved to a drylot and fed hay, protein, and mineral supplement. Constructed shades were available for the cows in each pasture; they were moved along with the cows and calves in the RH pastures.

Detailed costs and input records were kept for each pasture by year. A field book was kept such that each time any labor activity was conducted, a description of the activity, date, time required, and number of persons conducting the activity was reported. These detailed data were the basis for the time and motion study conducted for each system. The time and motion study in this analysis, however, did not take the additional step of many time and motion studies to evaluate how efficiency can be improved within a grazing strategy; rather, labor is compared among grazing strategies. Barnes provides extensive guidance for conducting time and motion studies.

It is recognized that labor time on a state-run experiment station can differ from that of some farmers. Field staff used in this study were, however, trained extensively in conducting all required

tasks. Only trained, conscientious staff that enjoyed working with cattle were allowed to work on this study. The researchers assert that if actual differences in labor time do vary between staff and some farmers (as we are certain they do for some farmers), the relative differences among grazing strategies would not be expected to differ greatly.

Equipment records were kept, including field operation, date, time, and equipment used. Seed, fertilizer, lime, herbicide, and insecticide use were recorded, including amount, cost, and date applied. Hay yields were recorded. Feedstuffs used and days in the drylot were recorded. All cattle purchases and sales were recorded, including the reason for removal. Cows were removed if they palpated open, failed to calve, died, or had an injury or disease. They were subsequently replaced with another cow and her suckling calf.

Costs and returns estimates were developed for each pasture each year. Cow-calf production budgets by Boucher and Gillespie for 1999-2001 were modified to reflect costs associated with each pasture. *Direct expenses* included costs associated with harvesting hay from pasture (done only in the last year), protein block, mineral mix, ear tags, vaccinations and dewormers, marketing commission, pasture expenses, fuel, repairs and maintenance, and interest on operating capital. *Fixed expenses* included depreciation and interest on machinery and equipment. Boucher and Gillespie's (1999-2001) budgets were modified in the following ways: (1) replacement heifers were not kept, so there was no entry for a cull heifer as cull cows were replaced by cows with calves; (2) because of (1), a 100% calving rate is assumed, a limiting assumption that overstates income to be expected, albeit consistently across pastures by year; (3) feedstuffs were adjusted according to amounts used in the experiment for each pasture by year; and (4) field operations were adjusted to those used in the experiment for each pasture by year, in turn leading to changes in machinery use.

Calf prices were estimated for each pasture based upon calf prices during the observed years and calf weight. Monthly calf prices per hundredweight reported in Louisiana auctions for 1999-2001 for 4 size classes, 300-400 lbs, 400-500 lbs, 500-600 lbs, and 600-700 lbs, were available. Using this data, the following equation was estimated:

$$P_{calf} = b_0 + b_1 * Steer + b_2 * Wght + b_3 * Wtr + b_4 * Spr + b_5 * Sum + b_6 * Y2000 + b_7 * Y2001 + e, \quad (1)$$

where *Steer* is a dummy variable indicating the animal is a steer (versus a heifer); *Wght* is the calf weight; *Wtr*, *Spr*, and *Sum* are dummy variables for Winter, Spring, and Summer, with Fall as the base; and *Y2000* and *Y2001* are dummy variables for years 2000 and 2001, respectively, with 1999 as the base. The equation was estimated using ordinary least squares regression. Mean calf weights for each pasture were subsequently input into (1) to determine expected price. Input prices used in each of the costs and returns estimates were collected via annual surveys of Louisiana agricultural businesses during 1999-2001 for the annual costs and returns estimates for beef cattle (Boucher and Gillespie, 1999-2001).

Labor was divided into six general categories, with each entry in the daily log placed into one of the six categories. *Working Cows and Calves* involved body condition scoring and palpating cows, weighing animals, weaning calves, administering fly tags, brucellosis testing, vaccinating animals, deworming, and similar tasks. *Daily Checking and Routine Tasks* involved (1) daily checking of animals, fences, and grass height; (2) pulling calves; (3) burying animals; (4) administering medicine; and (5) placing hay bales, feed blocks, and minerals in the drylot as needed. *Forage Management* involved clipping, fertilizing, baling hay, planting ryegrass, and spraying pastures. *Repairs and*

Maintenance involved repairing fencing and shades. *Moving Animals and Shades* involved measuring forage availability, moving animals to the drylot if there was not enough forage available, and moving animals among paddocks in the rotational grazing treatment. *Total Labor* was a summation of all labor used in the operation.

Differences in labor usage, costs, returns, and net returns among treatments were determined using a mixed model with treatments fixed, pastures within treatments random, and years as fixed repeated measures effects. The Kenward-Roger Degrees of Freedom method was used.

Results

Labor usage and costs and returns estimates are shown in Table 1. Each is shown on both per-acre and per-cow bases. The farmer with a fixed amount of land on which to graze cattle might have greater interest in the per-acre comparisons, while the farmer who can vary the land input may have a greater interest in the per-cow comparisons. Both are included and, as expected, can lead to different conclusions as to the preferable grazing strategy.

Labor Usage

Table 1 presents total labor used, as well as labor used in each of the six categories. The greatest labor requirement in working cows and calves, per cow, was with the CL strategy, at 4.53 hours per cow. Actual corral and process time was prorated by animal. Substantial effort (time) is required to corral animals into the working area. While less time is required to corral more animals, the increased time is not proportionate to the number of animals; e.g., it requires similar amounts of time (labor) to corral five animals as it does to corral 20 animals. Conversely, the CL treatment required the fewest hours per acre, at 2.20 hours per acre, as there were fewer animals to process. Differences in

labor for working cows and calves among the grazing strategies on a per-acre basis were not, however, significant at the 0.05 level.

Checking animals and other routine tasks did not differ among grazing strategies on a per-cow basis. On a per-acre basis, however, CL required less labor in this category than CH or RH, and CM had a lower requirement than RH. This is due primarily to greater drylot time at the higher stocking rates, as drylot time requires that feed be brought to the animals. Increased hours per acre for RH versus CH is attributed to the increased time required to navigate around fencing when conducting field operations.

Forage crop management labor decreased on a per-cow basis with continuous grazing as stocking rate increased, decreasing from 1.26 hours with CL to 0.48 hours with CH. This is attributed to time required for field operations being allocated over more animals at the higher stocking rates. The greater forage management labor requirement with RH relative to CH is attributed to the greater effort required to navigate cross-fencing when conducting field operations. Though the time requirement per acre was numerically lower as stocking rate increased with continuous grazing, differences were not found at the 0.05 level.

Repairs and maintenance on fencing and shades decreased numerically (but not significantly at the 0.05 level) on a per-cow basis with stocking rate under the continuous grazing treatments, but not on a per-acre basis. As expected, RH required more labor for fence and shade repair than did any of the conventional grazing strategies, roughly a 10-fold increase per acre. This was due to the increased amount of temporary cross-fencing.

Labor used for moving animals and shades did not differ on either per-cow or per-acre bases among the continuous grazing strategies. RH, however, required greater labor time, at 2.53 hours per

cow and 2.76 hours per acre, as animals were moved to new paddocks when forage availability required it. Miscellaneous labor did not differ among any of the treatments.

Total labor was greatest with RH, at 9.61 hours per cow and 10.60 hours per acre. The second highest on a per-cow basis was CL, at 8.22 hours per cow, though CL was the lowest on a per-acre basis, at 3.99 hours per acre. The CM and CL treatments did not differ on per-cow bases, though CH labor requirements exceeded CM requirements on a per-acre basis.

To summarize, RH requires substantially greater total labor on both per-cow and per acre bases. This is due primarily to the increased time requirement associated with repairs and maintenance and moving animals and shades. If the opportunity cost of operator labor or the actual cost of hired labor were $9.60/hour, as listed by Boucher and Gillespie (2006), then the total labor cost per cow would range from $55.78 with CH to $92.26 with RH, a difference of $36.48. The total labor cost per acre would range from $38.04 with CL to $101.76 with RH, a difference of $63.72. While these costs are not included in the following costs and returns analysis, the magnitudes of the differences are striking.

Costs and Returns

Table 2 presents cow and calf weights at weaning and prices at sale. Calf prices per hundredweight were determined from equation (2):

$$(2)\quad P_{calf} = \underset{}{118.719} + \underset{(0.589)}{10.042}*Steer - \underset{(0.003)}{0.089}*Wght + \underset{(0.833)}{2.685}\,Wtr + \underset{(0.833)}{1.316}\,Spr + \underset{(0.833)}{0.144}\,Sum$$

$$+\underset{(0.722)}{14.709}*Y2000 + \underset{(0.722)}{13.301}*Y2001.$$

Numbers in parentheses are standard errors of the estimates. Estimates for *Steer, Wght, Wtr, Y*2000, and *Y*2001 were significant at the 0.05 level with $R^2 = 0.875$. As expected, steers commanded higher

prices ($10.04 more per hundredweight), while heavier animals commanded lower prices ($0.09/cwt less for each additional pound). Season and year also resulted in different prices.

Due to reduction in quality forage available to an individual cow, increased stocking rate led to lower cow and calf weights at weaning. Therefore, calves from the higher stocking rates were lighter weight and prices received were higher. In spite of the higher prices, total income per cow was greater for CL and CM than for CH and RH because of the sale of heavier calves and cull cows. On a per-acre basis, however, CH and RH had the greatest associated incomes, as more volume was sold per acre, followed by CM and, finally, CL.

Total direct expenses per cow were highest with CL. Direct expenses per cow did not differ at the 0.05 level among CM, CH, and RH. This is primarily because of repairs and maintenance on fencing being allocated to fewer animals with CL. Direct expenses per acre differed among all treatments, in order from highest to lowest: RH, CH, CM, and CL. Returns over direct expenses per cow (per acre) were highest for CM (CH).

Fixed expenses per cow were highest for CL, followed by RH, CM, and finally CH. Fixed expenses were allocated over greater output among the continuous grazing treatments; RH had greater per-cow fixed expenses than CM or CH because of the increased capital investment associated with cross-fencing and the machinery effort devoted to moving animals and maintaining pastures. On a per-acre basis, fixed expenses were highest for RH, followed by CH, CM, and finally CL.

Total specified expenses per cow were highest for CL, with the remaining treatments having total specified expenses that did not differ at the 0.05 level. Total specified expenses per acre were highest for RH, followed by CH, CM, and finally CL.

Returns over specified expenses per cow were highest for CM and CH, which did not differ at the 0.05 level of significance. Returns over specified expenses for RH and CL did not differ at the 0.05 level of significance. The highest returns over specified expenses per acre were with CH, followed by CM, RH, and finally CL. These results suggest that a medium-to-high stocking rate with continuous grazing results in the highest profit in the Gulf Coast region.

Conclusions and Discussion

Results suggest that rotational grazing at a high stocking rate is less profitable than continuous grazing at the same or a "medium" stocking rate. Returns over total specified expenses were lower for RH than for either CH or CM. If labor costs were added to the analysis, RH would become much more costly (and thus even less profitable), as the labor analysis based upon the time and motion study suggests that about 67 percent more labor is required with RH than CH on a per-acre basis. This study calls into question the commonly heard claim that, for beef producers, rotational grazing has economic advantages over continuous grazing in the Gulf Coast region.

Should farmers use rotational grazing in the Gulf Coast region? To answer this, one needs to consider (1) the universality of the results of the present study and (2) the farmer's preferences. This study was conducted under relatively controlled conditions at specific stocking rates using procedures carefully considered and determined by the researchers to be most representative of area farmers. It is possible that different results could be found by comparing rotational grazing with equal-stocking-rate continuous grazing at a different or lower common stocking rate. The advantage of rotational grazing, however, would have to be substantial, given the significant differences in expenses and labor requirements between the two. Further studies on the economics of rotational and continuous grazing compared at similar stocking rates are justified.

Forage species is also an important consideration. Typical Gulf Coast grasses such as Bahia and Bermuda, are low-growing grasses, storing carbohydrate reserves in the rhizomes and stolons, while upright species, such as switchgrass and bluestem, store reserves in the stem base areas that are easily accessible to grazing animals. Grazing these low-growing Gulf Coast grasses for extended periods is less likely to compromise forage productivity than similar grazing pressure on more upright species. Hence, rotational grazing might show greater economic benefit with other species. Labor with rotational grazing is expected to greatly exceed that of continuous grazing regardless of region or forage species. Any benefits or reduced costs that might be associated with other species or conditions would have little impact on the overall labor requirement.

The second consideration for selection of a grazing method is farmer preference. Though our study did not find rotational grazing to be as profitable as continuous grazing at the similar high stocking rate, rotational grazing is promoted as having substantial environmental benefits. This needs to be considered in the adoption decision. In addition, if the farmer does not object greatly to the substantial labor increase associated with rotational grazing and finds other aspects of it to be positive for his or her farm, then it may be the most preferred practice. Education on programs such as EQIP would be particularly useful for producers with a preference for rotational grazing particularly if society deems this to be a preferred BMP.

Further research is recommended on the cumulative effects of grazing method over longer periods (multiple years). Equations (1) and (2) suggest that longer-term impacts of higher stocking rates could emerge if cow culling rates, body condition, and pregnancy rates become negatively impacted by available nutrition. Other studies have recognized the potential for significant long-run versus short-run impacts of stocking rate on profit (e.g., Torzell, Lyon, and Godfrey). Since it is

common for cattle producers to retain cows for 10 or more years, longer-term experiments with large numbers of animals would help to determine whether the short-term differences observed between these grazing systems are consistent over time.

References

Aiken, G.E. "Steer Performance and Nutritive Values for Continuously and Rotationally Stocked Bermudagrass Sod-Seeded with Wheat and Ryegrass." *Journal of Production Agriculture* 11(1998): 149-150, 185-190.

Anderson, D.M. "Seasonal Stocking of Tobosa Managed under Continuous and Rotation Grazing." *Journal of Range Management* 41(1988): 78-83.

Barnes, R.M. *Motion and Time Study: Design and Measurement of Work*, 7th Edition. Wiley, New York: 1980.

Bertelson, B.S., D.B. Faulkner, D.D. Buskirk, and J.W. Castro. "Beef Cattle Performance and Forage Characteristics of Continuous, 6-Paddock, and 11-Paddock Grazing Systems." *Journal of Animal Science* 71(1993): 1381-1389.

Boucher, R.W., and J.M. Gillespie. "Projected Costs and Returns for Beef Cattle, Dairy, Broiler, and Forage Crop Production in Louisiana, 1999" A.E.A. Information Series No. 171, Louisiana State University Agricultural Center, January 1999.

Boucher, R.W., and J.M. Gillespie. "Projected Costs and Returns for Beef Cattle, Dairy, Boiler, and Forage Crop Production in Louisiana, 2000" A.E.A. Information Series No. 180, Louisiana State University Agricultural Center, January 2000.

Boucher, R.W., and J.M. Gillespie. "Projected Costs and Returns for Beef Cattle, Dairy, Broiler, and Forage Crop Production in Louisiana, 2001" A.E.A. Information Series No. 188, Louisiana State University Agricultural Center, January 2001.

Boucher, R.W., and J.M. Gillespie. "Projected Costs and Returns for Beef Cattle, Dairy, and Forage Crop Production in Louisiana, 2006." A.E.A. Information Series No. 233, Louisiana State University Agricultural Center, January 2006.

Bransby, D.D., D.D. Kee, and W.H. Gregory. "Intensive Rotational Grazing Not Always Beneficial." *Alabama Highlights* 36,4(1989): 3.

Cassels, D.M., R.L. Gillen, F.T. McCollum, K.W. Tate, and M.E. Hodges. "Effects of Grazing Management on Standing Crop Dynamics in Tallgrass Prairie." *Journal of Range Management* 48(1995): 81-84.

Chestnut, A.B., H.A. Fribourg, D.O. Onks, J.B. McLaren, K.D. Gwinn, and M.A. Mueller. "Performance of Cows and Calves with Continuous or Rotational Stocking of Endophyte-Infested Tall Fescue-Clover Pastures." *Journal of Production Agriculture* 5,3(1992): 405-408.

Derner, J.D., R.L. Gillen, F.T. McCollum, and K.W. Tate. "Little Bluestem Tiller Defoliation Patterns under Continuous and Rotational Grazing." *Journal of Range Management* 47(3): 220-225.

Gillen, R.L., F.T. McCollum, M.E. Hodges, and K.W. Tate. "Livestock Response to Grazing Systems and Stocking Rate on Tallgrass Prairie." Oklahoma Agricultural Experiment Station MP-136, 1992: 420-425.

Hafley, J.L. "Comparison of Marshall and Surrey Ryegrass for Continuous and Rotational Grazing." *Journal of Animal Science* 74(1996): 2269-2275.

Hart, R.H., W.H. Marchant, J.L. Butler, R.E. Hellwig, W.C. McCormick, B.L. Southwell, and G.W. Burton. "Steer Gains Under Six Systems of Coastal Bermudagrass Utilization." *Journal of Range Management* 29,5(1976): 372-375.

Heitschmidt, R.K., J.R. Connor, S.K. Canon, W.E. Pinchak, J.W. Walker, and S.L. Dowhower. "Cow/Calf Production and Economic Returns from Yearlong Continuous, Deferred Rotation and Rotational Grazing Treatments." *Journal of Production Agriculture* 3,1(1990): 92-99.

Jung, H.G., R.W. Rice, and L.J. Koong. "Comparison of Heifer Weight Gains and Forage Quality for Continuous and Short-Duration Grazing Systems." *Journal of Range Management* 38(1985): 144-148.

Kim, S.A. "The Effect of Economic Factors on the Adoption of Best Management Practices in Beef Cattle Production." Unpublished Ph.D. Dissertation, Chonman National University, Korea, 2004.

Louisiana State University Agricultural Center. "Beef Production Best Management Practices." Publication 2884, LSU Agricultural Center, 2002.

McCann, M.A. "Rotational vs. Continuous Grazing." In Proceedings of the Southeastern Sustainable Animal Waste Management Workshop, Tifton, GA, 1997.

Pitts, J.S., and F.C. Bryant. "Steer and Vegetation Response to Short Duration and Continuous Grazing." *Journal of Range Management* 40,5(1987): 1381-1389.

Popp, J.D., W.P. McCaughey, and R.D.H. Cohen. "Effect of Grazing System, Stocking Rate, and Season of Use on Diet Quality and Herbage Availability of Alfalfa-Grass Pastures." *Canadian Journal of Animal Science* 77(1996): 111-118.

SAS Institute, Inc., Cary, NC, 2002.

Thurow, T.L., W.H. Blackburn, and C.H. Taylor, Jr. "Some Vegetation Responses to Selected Livestock Grazing Strategies, Edwards Plateau, Texas." *Journal of Range Management* 41(1998): 108-114.

Torzell, L.A., K.S. Lyon, and E.B. Godfrey. "Long Run vs. Short Run Planning Horizons and the Rangeland Stocking Rate Decision." *American Journal of Agricultural Economics* 73,3(August 1991): 795-807.

Wachenheim, C.J., J.R. Black, M.L. Schlegel, and S.R. Rust. "Grazing Methods and Stocking Rates for Direct-Seeded Alfalfa Pastures III: Economics of Alternative Stocking Rates for Alfalfa Pastures." *Journal of Animal Science* 78,8(2000): 2209-2214.

Table 1. Labor Use, Income, Expenses, and Returns Over Expenses.

Labor Measure	Continuous Low	Continuous Medium	Continuous High	Rotational High	Continuous Low	Continuous Medium	Continuous High	Rotational High
	Per Cow				Per Acre			
Labor Usage, Hours								
Total Labor	8.22[a]	6.35[b]	5.81[b]	9.61[c]	3.99[n]	5.13[o]	6.28[p]	10.60[q]
Working Cows and Calves	4.53[a]	3.44[b]	2.69[b]	2.67[b]	2.20[n]	2.78[n]	2.90[n]	2.94[n]
Checking and Routine Tasks	1.78[a]	1.82[a]	2.25[a]	2.34[a]	0.86[n]	1.47[no]	2.44[op]	2.58[p]
Forage Management	1.26[a]	0.67[bc]	0.48[b]	0.78[c]	0.61[n]	0.54[n]	0.52[n]	0.86[o]
Repairs and Maintenance	0.28[a]	0.20[a]	0.13[a]	1.48[b]	0.14[n]	0.16[n]	0.14[n]	1.53[o]
Moving Animals and Shades	0.22[a]	0.15[a]	0.20[a]	2.53[b]	0.11[n]	0.12[n]	0.37[n]	2.76[o]
Miscellaneous Tasks	0.15[a]	0.08[a]	0.06[a]	0.08[a]	0.07[n]	0.06[n]	0.06[n]	0.08[n]
Income, Expenses, and Returns Over Expenses, Dollars								
Total Income	524.96[a]	511.79[a]	480.80[b]	471.46[b]	254.65[n]	413.27[o]	518.81[p]	519.51[p]
Direct Expenses	285.44[a]	228.41[b]	227.11[b]	248.17[b]	138.58[n]	184.44[o]	245.03[p]	273.40[q]
Returns Over Direct Exp	239.53[ac]	283.38[b]	253.68[a]	223.29[c]	116.07[n]	228.83[o]	273.78[p]	246.11[q]
Fixed Expenses	145.65[a]	118.58[b]	107.57[c]	126.65[d]	70.66[n]	95.75[o]	116.11[p]	139.52[q]
Total Specified Expenses	431.09[a]	346.99[b]	334.68[b]	374.82[b]	209.23[n]	280.20[o]	361.13[p]	412.93[q]
Returns Over Specified Exp	93.88[a]	164.80[b]	146.12[b]	96.64[a]	45.41[n]	133.07[o]	157.68[p]	106.58[q]

Least squares means within a row (and under the same subheading, i.e., “per acre” and “per cow”) having any superscript in common do not differ at the 0.05 level of significance.

Table 2. Cow and Calf Weights at Weaning, Used in Costs and Returns Analysis.

Year and Pasture	Continuous Low		Continuous Medium		Continuous High		Rotational High	
	Weight	*Price*	*Weight*	*Price*	*Weight*	*Price*	*Weight*	*Price*
	Calves[1]							
1999, 1	583	71.58	546	74.85	509	78.22	485	80.34
1999, 2	500	78.97	514	77.74	478	81.01	448	83.69
2000, 1	555	88.79	501	93.58	474	96.04	454	97.87
2000, 2	542	89.95	509	92.91	427	100.23	454	97.83
2001, 1	536	89.08	525	90.05	460	95.89	418	99.67
2001, 2	537	88.96	502	92.14	427	98.82	421	99.42
Mean	542	84.46	516	86.79	462	91.61	446	93.04
	Cows[2]							
1999, 1	1229	32.70	1220	32.70	1151	32.70	1150	32.70
1999, 2	1309	32.70	1240	32.70	1111	32.70	1055	32.70
2000, 1	1249	36.58	1206	36.58	1112	36.58	1093	36.58
2000, 2	1284	36.58	1260	36.58	1113	36.58	1088	36.58
2001, 1	1264	40.55	1193	40.55	1121	40.55	1059	40.55
2001, 2	1319	40.55	1237	40.55	1146	40.55	1096	40.55
Mean	1276	36.61	1226	36.61	1126	36.61	1090	36.61

1. Calf weights are least squares means of adjusted 205 day weaning weights, determined using a mixed model with treatments fixed, pastures within treatments random, and years as fixed repeated measures effects.
2. Cow weights are actual (raw) means.