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Effect of rotational or continuous stocking method of winter pasture on beef heifer performance

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**EFFECT OF ROTATIONAL OR CONTINUOUS STOCKING METHOD
OF WINTER PASTURE ON BEEF HEIFER PERFORMANCE**

A Thesis

**Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Science**

in

**The Interdepartmental Program of
Animal Sciences**

**by
David G. Skeans
B.S., Nicholls State University, 2005
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ABSTRACT

Considerable research has been conducted comparing the effect of continuous and some form of rotational stocking method on animal and forage performance, but most research utilizes put-and-take stocking rates. The purpose of this research was to determine the effect of 12-paddock rotational stocking method (ROT) or continuous stocking method (CONT) of winter wheat (*Triticum aestivum*) and annual ryegrass (*Lolium multiflorum*) pastures on beef heifer and forage performance while maintaining a continuous stocking rate of 3.7 heifers/ha. Two experiments were conducted and analyzed separately due to confounding year and location. Heifer ADG and WG/ha tended to be increased by ROT compared to CONT in Exp 1 ($P = 0.10$). Differing from Exp 1, heifer ADG and WG/ha was not affected by stocking method in experiment 2 ($P = 0.36$). Forage mass (Exp 1) was increased by ROT compared to CONT in a time by treatment manner ($P < 0.005$). Forage mass (Exp 1) was increased by ROT compared to CONT in the final four sampling periods. Forage mass below 500 kg DM/ha in CONT pastures (Exp 1) may have limited heifer DMI in the final two sampling periods. Similar to Exp 1, forage mass (Exp 2) was increased by ROT when compared to CONT in the final two sampling periods ($P < 0.05$). However, CONT forage mass was not limited in Exp 2. Forage CP (Exp 1) was increased in ROT compared to CONT in a time x treatment manner ($P < 0.05$). Forage IVTD, NDF, and ADF (Exp 1) were not affected by stocking method, but were influenced by time. Forage nutritive value in Exp 2 was increased by CONT compared to ROT on d 113 in a time x treatment manner ($P < 0.05$). The results of this research indicate that ROT does increase forage mass on winter wheat and annual ryegrass pastures and may sustain higher stocking rates compared to CONT. However, greater heifer ADG under ROT only occurred when CONT forage mass was limited. The use of ROT compared to CONT under continuous stocking rates of 3.7 heifers/ha does not consistently increase heifer ADG or WG/ha.

CHAPTER I

INTRODUCTION

Winter annuals are often used to complement summer grazing by providing high quality forage throughout winter months (Gunter et al., 2002). The cool, damp winters common in Louisiana and the southern United States make cool season annuals an option for winter grazing (Feazel and Morris, 1992). As a result, many Louisiana cattle producers rely on winter annuals for cool season grazing (Wyatt et al., 1986). Growing stocker calves and replacement heifers require a high plane of nutrition, and are capable of making fast efficient gains when compared to mature animals (Bagley et al., 1984). Morrison (1990) reported that the most critical period of beef heifer development is the interval from weaning to breeding. Thus, grazing stocker calves or replacement heifers on winter annual pasture is generally an economically efficient practice and holds potential for profitability (Hafley, 1996b). However, rising input costs associated with preparing winter pastures require efficient utilization of high quality forage to be economical (Hafley, 1996b). Stocking method is one aspect of grazing management that has been of particular interest to stocker grazers.

Morrison (1996) reported that the main comparison of stocking method is between continuous and some form of rotational stocking method. Research has shown that when compared to continuous stocking method, rotational stocking method maintains greater put-and-take stocking rates (stocking rate adjusted to fit variable supply of forage) and results in greater WG/ha (Bertelsen et al., 1993; Hafley, 1996a; Aiken, 1998). The apparent benefit of high intensive rotational stocking systems is the forage response to periods of regrowth following stocking sessions. However, individual animal performance has been inconsistent in comparisons of stocking methods.

CHAPTER II

LITERATURE REVIEW

INTRODUCTION

The goal of stocker production is to maximize profit by optimizing animal production per ha of winter pasture (Morrison, 1996). The performance of grazing animals is determined by genetic potential, forage nutritive value, and quantity. Morrison (1996) reported that forage nutritive value and quantity are affected by grazing management and strategy, forage type, planting method, soil type, climate, and rainfall.

Hafley (1996b) suggested that grazing management decisions include determining optimum stocking rate and stocking method. Stocking rate affects forage availability and subsequent animal performance. As stocking rates increase, forage availability and individual animal gains will decrease; however, live weight gain per ha will increase until reaching a maximum at an intermediate stocking rate before decreasing (Mott, 1960; Morrison, 1996).

Mooso and Morrison (1994) reported that optimum stocking rate is determined by minimizing cost of gain. The cost of prepared winter pasture is fixed; thus, increasing production per ha will reduce cost of gain. However, variable cost associated with the addition of each animal requires individual animal performance to remain high enough to account for negative margins associated with buying and selling calves. It is reported that optimum stocking rate of grazing cattle is affected by stocking method (Hull et al., 1967; Bertelsen et al., 1993; Aiken, 1998).

GRAZING MANAGEMENT

Stocking method is a grazing management practice that has been of interest to cattle producers for the last few decades (Aiken, 1998). The main comparison of stocking methods is between continuous and some form of rotational stocking (Morrison, 1996). Bertelsen et al.

(1993) documented that continuous stocking is a common practice of grazing management practiced by United States beef producers.

The Forage and Grazing Terminology Committee (1991) define continuous stocking as the unrestricted grazing of a specific pasture or range by livestock throughout a year or grazing season. Continuous stocking is often preferred because of low labor requirements and low costs for additional fencing. Additionally, the risk associated with continuous stocking is low because changes in forage availability are generally slow. Hull et al. (1967) observed that continuous stocking method results in greater individual animal performance at low stocking rates because animals are allowed to selectively graze. However, as stocking rates increase continuous stocking is more prone to reductions in forage availability that results in reduced animal performance (Hull et al., 1967; Aiken, 1998; Bertelsen et al., 1993).

The Forage and Grazing Terminology Committee (1991) define rotational stocking method as the grazing of two or more paddocks in sequence followed by a rest period for the recovery and regrowth of the grazed forage. Mckown et al. (1991) noted that a major objective of rotational stocking is to increase livestock production per unit area by increasing efficiency of harvest while maintaining nutrient intake and individual animal performance. Dairymple (1996) suggests that the concept behind rotational stocking is to restrict grazing to the top, leafy layers of the canopy to maintain a quality diet and provide tall stubble to enhance regrowth yields. Savory (1978) further commented that rotational stocking will reduce the percentage of ungrazed plants, while improving livestock distribution. Grazing management practices such as rotational stocking have reported to increase stocking rate per unit land while maintaining or improving individual animal performance (Bertelsen et al., 1993; Aiken, 1998).

Morrison (1996) suggests that determining optimum stocking rate is the single most important factor of grazing management. Stocking animals is generally done in one of two methods: set stocking or put-and-take stocking. Set stocking rates designate a fixed number of

animals to a given land area for a stocking period. Put-and-take stocking method adjusts the number of animals grazing to fit the variable supply of forage. Williams et al. (2002) reported that put-and-take stocking rates would maximize animal output by utilizing available forage. Bertelsen et al. (1993) reported that optimum forage mass of alfalfa (*Medicago sativa* L.), tall fescue (*Festuca arundinacea*), and orchardgrass (*Dactylis glomerata* L.) occurs between 1,200 and 1,600 kg DM/ha. Martz et al. (1999) documented that maximum DMI of steers grazing mixed cool-season grasses and legumes occurred when forage mass was in excess of 1,800 kg DM/ha. Redmon et al. (1995) further documented that forage allowance above 24 kg DM/100 kg BW was optimum for steers grazing winter wheat pasture. Williams et al. (2002) reported that bahiagrass (*Paspalum notatum*) pasture maintaining forage mass below 500 kg DM/ha would limit DMI of growing heifers.

Stocking Rate

Hull et al. (1967) compared stocker performance of continuous and rotational stocking method on orchardgrass, ryegrass (*Lolium perenne*), tall fescue, Ladino clover (*Trifolium repens*), and strawberry clover (*Trifolium fragiferum*) pastures at medium (7.25 head/ha) and high (10.69 head/ha) stocking rates. Average daily gain and WG/ha favored continuous stocking method at a medium stocking rate, and favored rotational stocking method at a heavy stocking rate. Under continuous stocking method, additional alfalfa hay was required at times to supplement limited forage availability (Hull et al., 1967). Bertelsen et al. (1993) further reported that while grazing beef heifers on alfalfa, tall fescue, and orchardgrass, put-and-take stocking rates of 3.03 and 4.0 heifers/ha were maintained for continuous and 11-paddock rotational stocking methods, respectively. Hafley (1996a) observed that steers grazing annual ryegrass maintained put-and-take stocking rates of 3 to 3.6 steers/ha and 5.4 to 6 steers/ha for continuous and 6-paddock rotational stocking method, respectively. Aiken (1998) further documented that steers grazing winter wheat (*Triticum aestivum*), and annual ryegrass (*Lolium multiflorum*),

maintained stocking pressures of 1,638 and 2,273 kg BW/ha for continuous and 11-paddock rotational stocking methods, respectively.

Mooso and Morrison (1994) stated that the disadvantage of put-and-take stocking is that additional animals are not normally available in the spring when forage is abundant. The authors compared stocker cattle grazing sod seeded winter annuals at set stocking rates of 2, 3, 4, and 5 steers/ha. Average daily gain decreased as stocking rate increased, but live weight gain per ha was maximized at 4 steers per ha. Redmon et al. (1995) further documented that while grazing steers on winter wheat pasture, optimum forage availability was maintained by utilizing a put-and-take stocking rate ranging from 2.9 to 3.4 steers/ha.

Comparisons of Stocking Methods

Aiken (1998) compared continuous and rotational stocking methods of annual ryegrass and winter wheat. Nutrient response variables reported were comparable between stocking methods. Crude protein and IVTD were comparable between continuous and pregraze rotational forage samples. Aiken (1998) observed a decrease in IVTD and CP from pregraze to postgraze in the rotational paddocks, but noted that digestibility of postgraze herbage was adequate to provide moderate weight gain. Cool season annuals have reduced concentrations of stem and higher quality leaf even in lower depths of the canopy, in comparison to warm season perennials. Thus, they seem to maintain acceptable quality over most of the growing season, regardless of depth in the canopy. Aiken (1998) documented that stocking rates were increased in rotationally grazed paddocks due to an increase in forage production. Average daily gains were not significantly different at 0.94 and 1.0 kg for continuous and 11-paddock rotational stocking methods, respectively. Increasing stocking rate resulted in increasing live weight gain/ha of land. Gains of 428 and 693 kg/ha for continuous and 11-paddock rotational stocking systems occurred (Aiken, 1998). Bertelsen et al. (1993) compared continuous and 11-paddock rotational stocking of beef heifers on alfalfa, tall fescue, and orchardgrass. Rotational stocking method maintained a higher

pregraze CP level in comparison to continuous stocking. However, postgraze samples showed no difference between methods. Pregraze forage mass was 1,986 and 2,350 kg DM/ha for continuous and 11-paddock rotational stocking methods, respectively. Greater forage mass maintained higher stocking rates. Average stocking rates were reported as 3.03 and 4.00 heifers/ha for continuous and rotational stocking methods, respectively. Individual animal performance was maintained, ADG were reported as 365 and 367 g for continuous and rotational stocking methods, respectively. Overall gain/ha was documented as 133.2 and 179.0 kg/ha for continuous and 11-paddock rotational stocking, respectively.

Mooso (1990a) compared continuous and 15-paddock rotational stocking of annual ryegrass and crimson clover. The author documented that short duration grazing increased forage availability without affecting nutritive value. The increase in forage availability supported a stocking rate 23% greater than did continuous stocking method. The increase in stocking rate was obtained with no difference in ADG, 1.04 and 1.01 kg, for continuous and rotational stocking methods, respectively. Live weight gain was reported as 689 and 846 kg/ha for continuous and rotational stocking methods, respectively.

Hafley (1996a) compared continuous and 6-paddock rotational stocking of annual ryegrass. Steers moved to a new paddock according to canopy height. Crude protein was increased in rotational compared to continuous stocking method samples. Forage IVTD were greater in continuous compared to rotational stocking method, and NDF and ADF levels increased from pregraze to postgraze samples. Hafley (1996a) reported that put-and-take stocking rates under rotational stocking method were 83% greater than those under continuous stocking method. However, individual animal performance was reduced. Average daily gains were 1.32 and 0.92 kg/day for continuous and 6-paddock rotational stocking, respectively. They suggested that the reduction in ADG could be attributed to the increased stocking rate. The

increased stocking rate can be realized in live weight gain per ha that is reported as 301 and 403 kg/ha for continuous and 6-paddock rotational stocking, respectively.

Nelson et al. (1989) compared continuous and 8-paddock rotational stocking of wheatgrass. No difference was reported in CP or IVTD between stocking method. However, a linear decline in CP and IVTD was noticed as grazing season progressed. Forage mass increased in 8-paddock rotational compared to continuous stocking method and resulted in a greater chance for selective grazing. Stocking rates were consistently greater for 8-paddock rotational stocking method. Average daily gains were reported as 0.73 and 0.79 kg for continuous and 8-paddock rotational stocking method, respectively. Thus, 8-paddock rotational stocking method resulted in an increase in live weight per hectare of land (Nelson et al., 1998).

Mooso (1990b) compared continuous and short duration stocking of bermudagrass pastures. Set stocking rates were utilized and ADG were 0.38 and 0.5 kg for continuous and rotational stocking methods, respectively, resulting in a 35% increase in beef produced per ha in favor of rotational stocking method. Williams et al. (2002) compared continuous and rotational stocking methods of bahiagrass while maintaining constant stocking rates. Stocking method did not affect forage produced, nutrient concentration, or heifer performance. However, forage mass was affected by year, and heifer performance was correlated with forage mass.

Rotation Intensity

The number of paddocks, length of stocking, and regrowth period following stocking are factors that may influence animal performance. Also, Savory (1978) suggests that livestock should be rotated through no less than 8 paddocks per grazing area, and that the stocking period of each paddock should be 5 days or less followed by 4 or more weeks of rest. Savory (1978) recommends that livestock be moved more quickly during periods of active growth than in dormancy. Bertelsen et al. (1993) compared 11-paddock and 6-paddock rotational stocking method and found that ADG were no different at 0.37 and 0.34 kg, respectively. Stocking rate

was higher for 6-paddock rotational stocking method, but there was no significant difference in weight gain/ha. Aiken (1998) compared 11-paddock and 3-paddock rotational stocking method of cool season annuals, and reported that ADG was not affected by rotation intensity. Live weight gain was not significantly different at 671 and 693 kg/ha for 3-paddock and 11-paddock rotational stocking methods, respectively.

The success of rotational stocking method not only depends on the number of paddocks, but also on the duration of stocking and period of regrowth for each paddock. Olson et al. (1989) evaluated how the rapid defoliation that occurs under high stocking rates of intensive rotational stocking affects livestock nutrition. Using crested wheatgrass, stocking periods should be no longer than 2 days before nutritive value of forage is compromised. Length of stocking periods in paddock must be monitored and controlled to insure that fluctuating forage conditions do not negatively impact animal nutrition and overall animal performance. They monitored nutritive value over time during rotational stocking periods and found a significant decline in CP was observed in forage mass from day 2 to 3 of stocking. The sward physical structures, CP, IVTD, and fiber components affect intake. Olson et al. (1989) suggest that an increase in nutritive value is positively correlated with forage intake due to high leaf content. Fiber is determined by the leaf to stem ratio, which is negatively correlated with intake. Thus, as fiber increases, accessibility of available leaf will decrease and animals will decrease their bite rate in an attempt to increase selectivity. They concluded that actively growing vegetation should be rotated very rapidly. Chilibroste et al. (2000) evaluated regrowth characteristics of actively growing perennial ryegrass over a 30 day period and reported that CP content reached its highest level after 16 days of regrowth, while sward mass and fiber content peaked on day 30.

WINTER ANNUAL SELECTION

Wyatt et al. (1986) and Bagley and DeRamus (1984) reported that annual ryegrass is the principal winter annual utilized in Louisiana. Ryegrass may be available for grazing as early as

late November. However, the growing pattern of ryegrass in typical Louisiana winters results in low forage production in the fall and winter followed by high forage yield in the spring (Bagley and DeRamus, 1984). Other winter annuals can be planted with ryegrass to complement its growing season. Cereal grains such as cereal rye (*Secale cereale*), winter wheat, or oats (*Avena sativa*), produce forage earlier than annual ryegrass. The inclusion of cereal grains into a winter annual mix will complement the ryegrass growing season and extend grazing days.

Bagley and DeRamus (1984) reported that the inclusion of cereal rye into an annual ryegrass mixture was more efficient for grazing than planting ryegrass alone. The inclusion of cereal rye into a winter annual mixture increased forage mass during the critical months of December and January. Additionally, mixtures containing cereal rye were more resistant to changes in forage mass as a result of grazing pressure. Bagley et al. (1984) compared wheat, rye, and oats by including them in winter annual mixture containing annual ryegrass and arrowleaf clover (*Trifolium vesiculosum* Savi). Winter annual mixtures were grazed and evaluated for forage yields and subsequent steer performance. Mixtures containing wheat had the highest forage production across the grazing season. Total forage production was 10,959, 10,484, and 10,334, kg DM/ha for wheat, rye, and oats mixtures, respectively. Steer performance was not affected, ADG were 1.01, 1.03, and 1.08 kg for wheat, rye, and oats annual mixtures, respectively. Wheat had the highest number of grazing days while oats had the fewest. Bagley et al. (1984) reported that live weight gain per ha was highest for oats annual mixture followed by wheat.

Legumes

Hill et al. (1980) reported that the inclusion of legumes, specifically red clover (*Trifolium pratense*), into winter annual mixtures is of interest because it increases forage yield, further improves forage nutritive value, extends the grazing season, and reduces N requirements of forage mixtures. Clover seed is inoculated with *Rhizobium* bacteria; these bacteria are located on

the nodules of the plant root and are capable of fixating atmospheric nitrogen. The *Rhizobium* bacteria convert atmospheric N into a readily available form of N. This N fixation process reduces the nitrogen requirement of the legume. Hafley (1996b) reported that legumes do not need N fertilization, and that grass grown with legumes for several years will be supplied with enough N to equal 110 to 280 kg/ha/year. Along with reducing fertilization requirements, legumes may complement the forage CP. Cool season annuals such as ryegrass and cereal grains contain CP that is rapidly degradable in the rumen. Hafley et al. (1994) reported that the CP contained in clover may be broken down slower in the rumen compared to ryegrass. Thus, a clover and ryegrass mixture has a complementary protein effect.

The variety of clover planted into a winter annual mixture will affect forage production and subsequent animal performance. Because annual ryegrass is the principal winter annual used in Louisiana production systems, clovers or clover mixtures have been compared to annual ryegrass or annual ryegrass mixtures (Hill et al., 1980; Wyatt et al., 1985; Broussard and Gates, 1987; Feazel and Morris, 1992; Hafley, 1996b).

Broussard and Gates (1987) reported that berseem clover (*Trifolium alexandrinum* L.), had high forage production and a low incidence of bloat in grazing cattle. Comparing berseem clover to annual ryegrass, berseem clover has total DM yields comparable to that of annual ryegrass while maintaining higher quality. With respects to animal performance, ADG was 1.23 and 1.11 kg for cattle grazing ryegrass and berseem clover, respectively. Berseem clover maintained a higher stocking rate and live weight gain/ha, gains of 263 and 200 kg/ha were obtained for berseem clover and ryegrass, respectively.

Hill et al., (1980) evaluated red clover production and subsequent animal performance. A mixture of ryegrass and oats or ryegrass and red clover were evaluated. Steers grazing ryegrass and oats gained faster within the first 56 days, ADG were 0.61 and 0.44 kg for the oats mixture and red clover mixture, respectively. This result supports previous research that cereal grains

complement ryegrass to increase fall gains. However, steer gains during the early spring growing season were higher in ryegrass and red clover, ADG were 0.61 and 0.75 for the oats mixture and red clover mixture, respectively.

Clovers tend to complement ryegrass by adding forage mass and nutritive value in the spring. No difference in ADG occurred, but differences were noted in forage DM production and subsequent steer performance by period of the grazing season.

Hafley (1996b) compared multiple clover varieties and mixtures of annual ryegrass with clover for forage DM production and subsequent animal performance. Weight gain/ha was maximized with a forage mixture containing annual ryegrass, white clover, and berseem clover. However, annual ryegrass alone and a mixture of ryegrass and berseem clover were comparable in forage production and animal performance.

Feazel and Morris (1992) compared annual ryegrass to ryegrass and white clover, ryegrass and crimson clover (*Trifolium incarnatum*), and ryegrass and arrowleaf clover for forage DM production, stocker performance, and forage carrying capacity. Little difference was observed in individual animal performance. Average daily gains were 1.28, 1.28, 1.25, and 1.19 kg for ryegrass, ryegrass and white clover, ryegrass and crimson clover, and ryegrass and arrowleaf clover, respectively. However, differences in animal grazing days and stocking rates resulted in total weight gains of 371, 330, 378, and 321 kg/ha for ryegrass, ryegrass and white clover, ryegrass and crimson clover, and ryegrass and arrowleaf clover, respectively.

PLANTING METHOD

Hafley (1996b) reported that the majority of cool season forages planted in Louisiana are annuals. Thus, a decision on planting must be made on a yearly basis. Method of planting varies from broadcasting seed onto permanent summer perennial pasture to a completely prepared seedbed. Wyatt et al. (1995) reported that under Louisiana weather conditions, prepared seedbeds can be planted in October resulting in grazing in late November or early December;

whereas, overseeding on permanent sod requires a later planting date to avoid competition from summer perennials. Feazel (1986) reported that prepared seedbeds have additional costs associated with planting that must be evaluated. However, Hafley (1996b) documented in a cost benefit analysis of prepared seedbeds and sodseeding summer perennials that prepared seedbeds returned the most profit. An increase in grazing days of prepared seedbeds more than compensated for the increase in costs. Coffey et al. (2002) reported that prepared seedbeds are more consistent in their production of forage stands and produce more forage mass per unit land. Both authors state that greater animal gains can be expected per unit land by a prepared seedbed.

Feazel (1986) reported that although winter forage production is variable, sodseeding usually provided excellent early spring grazing. Sodseeding is a means of extending the grazing season with high nutritive value forage while maintaining summer perennial pasture. Coffey et al. (2002) reported that sodseeding offers potential to improve land use efficiency by improving animal gains relative to gains expected from other dormant forages. The goal of sodseeding is to have good soil-to-seed contact with minimal soil disturbance. Minimal soil disturbance in planting generally results in quicker bermudagrass recovery.

Another concern that may affect a producers planting decision is soil type and climatic conditions. Poorly drained clay soils combined with wet winters may cause problems in prepared seedbeds. Wyatt et al. (1988) reported that Louisiana soils and weather conditions make trampling and bogging a problem with prepared seedbeds. Compared to prepared seedbeds, ryegrass drilled into bermudagrass sod pastures will reduce trampling and bogging associated with cold and wet weather (Wyatt et al. 1988; Hafley, 1996b).

CHAPTER III

EFFECT OF ROTATIONAL OR CONTINUOUS STOCKING METHOD OF WINTER PASTURE ON BEEF HEIFER PERFORMANCE

INTRODUCTION

Considerable research has been conducted evaluating continuous and some form of rotational stocking of winter annual pastures. However, most research that examined rotational stocking utilized put-and-take stocking rates. The problem that arises with put-and-take stocking rates is that few commercial producers have additional animals to add or remove throughout the grazing season. Therefore, the objective of this research was to determine the effect of 12-paddock rotational stocking method (ROT) in comparison to continuous stocking method (CONT) while maintaining a set stocking rate of 3.7 heifers/ha.

MATERIALS AND METHODS

The LSU Agricultural Center Animal Care and Use Committee approved all animal procedures. The experiments were conducted at the Idlewild Research center (2006 to 2007) located near Clinton, LA (30°86'N, 91°02'W) and at the Reproductive Biology Center (2007 to 2008) located in St. Gabriel, LA (30°25'N, 91°10'W).

Experiment One

Site Preparation and Design

The Idlewild experiment site was on a moderately well drained dexter loam soil (fine-mixed, thermic Ultic Hapludalf) with slow rolling hill topography. Planting was conducted on October 4, 2006. Four 8.09 ha pastures were lightly disked and planted with 'Ranger' winter wheat (*Triticum aestivum*) and 'Marshall' annual ryegrass (*Lolium multiflorum*) at a rate of 78.6 and 33.7 kg/ha, respectively. Fertilizer was applied at planting in the form of 13-13-13 at a rate of 224 kg/ha providing 29 kg/ha of N, P, and K. Urea (46-0-0) was applied November 20, 2006

providing 51.6 kg/ha of N. An additional application of urea was applied January 15, 2007 providing 51.6 kg/ha of N.

Two 8.09 ha pastures were left intact and designated for continuous stocking method. Each of the two remaining pastures were subdivided into 12- 0.67 ha rectangular paddocks using a single strand of electrified polywire. Each paddock was constructed with a gate at one end of each paddock, and a common area approximately 5 m wide was set on one side of each rotational pasture for movement of heifers to individual paddocks. Water access to each paddock was provided by running flexible water lines that were fitted with connection valves at each paddock. Portable water troughs (455 L) were fitted with automatic floats, and troughs were rotated with heifers providing ad libitum access to clean water. Bloat preventative mineral supplement (Purina Sweetlix© *Wheat Pasture Mineral with Bloat Guard* containing 4.41% Poloxalene) was offered free choice. Bermudagrass hay $7.85 \pm 0.5\%$ CP, $46 \pm 3.8\%$ IVTD, $74 \pm 2.8\%$ NDF, and $42 \pm 4.8\%$ ADF was offered free choice and disappearance was recorded in kg DM. Hay disappearance was monitored and additional hay was provided in response to disappearance. Hay disappearance data was of interest but was not analyzed for statistical significance.

Heifer Backgrounding

One hundred twenty crossbred heifers (25 to 50% *Bos indicus*) were received d – 63 and offered free-choice grass hay $7.85 \pm 0.5\%$ CP and 5 kg/head/day of soybean hulls. Heifers were vaccinated against infectious bovine rhinotracheitis (IBR), bovine viral diarrhea virus (BVD), parainfluenza (PI3), infectious bovine respiratory syncytial virus (BRSV), and leptospirosis (Pyramid 9, Fort Dodge Animal Health, Fort Dodge, IA). Heifers were treated for internal and external parasites on d –56 (Aspen Ivermectin Pour-On For Cattle, Aspen Veterinary Resources, Liberty, MO). A second dose was administered for IBR, PI3, BVD, BRSV, and leptospirosis on d – 42.

Grazing Trial

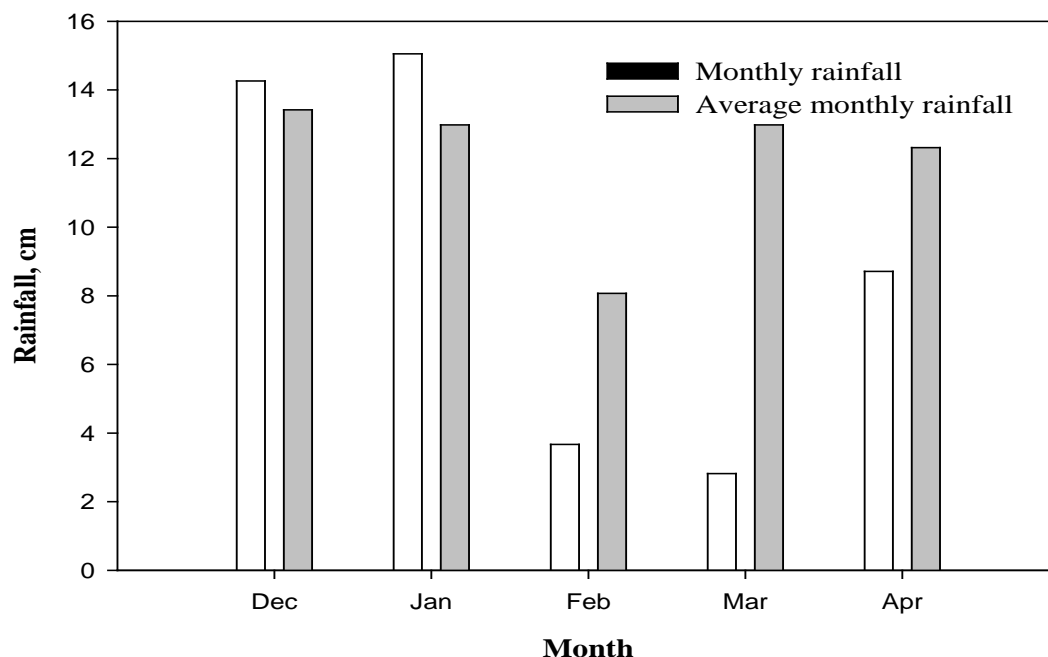
Stocking was initiated December 8, 2006 and extended through April 17, 2007. Heifers were blocked by BW and randomly assigned to either continuous stocking method or 12-paddock rotational stocking method. Initial heifer BW was 249 ± 6 kg. Shrunken weights were taken on d 0 and 132 by fasting heifers for 14 to 16 h. Interim weights were measured without prior removal from pasture and water at approximately 28 d intervals throughout the trial. Heifers allotted to continuous stocking method were allowed to graze the entire 8.09 ha pasture without restriction. Heifers allotted to rotational stocking were rotated to a different paddock on Mondays, Wednesdays, and Fridays resulting in 2 or 3 d of stocking followed by 28 d of regrowth. Stocking rate was continuous at 3.7 heifers/ha (924 kg/ha on d 0) for continuous and rotational pastures. Stocking density was 44.5 heifers/ha for each grazed paddock in the rotational treatment.

Rainfall

Monthly and average monthly rainfall (30 yr average) at Idlewild Research Station is presented in figure 3.1. Rainfall was collected onsite at Idlewild Research Station. Total rainfall from December through April was 51.4 cm, 22.5 cm below the average of 73.9 cm for the time frame at the given location.

Forage Sampling and Analysis

Forage mass was monitored using a rising plate meter (Jenquip, Feilding, New Zealand), which was similar in design and weight to the one recommended by Sanderson et al. (2001). Plate meter measurements reflect bulk density of available forage. To account for multiple forages at various stages of growth, three rising plate meter calibrations were made at each sampling date and then averaged to estimate forage in kg DM/ha. Calibrations were conducted by taking a plate meter reading of a randomly selected area then collecting a 0.09 m² forage sub-sample of that area. Forage sub-samples were clipped to a height of 2 cm then dried in a forced



(Figure 3.1) Monthly and average monthly rainfall at Idlewild Research Station.

air oven at 60° C. Dry matter of that sample was recorded in g and divided by the plate meter reading recorded in units. Rising plate meter calibrations were equated to kg DM/ha using the formula:

$$1 \text{ unit} = \text{g DM} / 0.09290304 \text{ (sub-sampling area)} \times 10,000 \text{ m}^2 \text{ per ha} / 1,000 \text{ g per kg.}$$

Plate meter estimations were taken on 33 d intervals. Each pasture was sampled by taking 40 plate meter readings for each grazing pasture. Individual readings were taken approximately 20 m apart and sampling was taken in a “Z” shaped pattern across sampling area. Individual samples were unbiased, but dung piles and drainage ditches were avoided. Plate meter estimations taken from pastures allotted to rotational stocking method were taken from a different paddock on each sampling date to account for paddock differences within pasture. Each paddock sampled had received 26 to 28 d regrowth. The 40 samples from each pasture were averaged and then adjusted using the calibration coefficient to estimate forage mass in kg DM/ha.

Forage samples for evaluating nutritive value were taken on 33 d intervals to correspond with plate meter estimations. Forage samples were clipped to a height of 2 cm from 3 randomly selected 0.09 m² areas in each pasture. Pregraze samples were taken from each continuous and rotational pasture. Samples were taken randomly from pastures in the continuous stocking method. Samples were unbiased, but did exclude dung piles or areas where forage dropped below 3 cm. Samples taken from rotationally grazed pastures were taken from a single paddock at each sampling date and were taken monthly in correlation with rising plate meter estimations. Each sampling date sampled a different paddock to account for difference within each pasture. Each paddock that was sampled received 26 to 28 d regrowth before sampling. Samples were weighed, then dried at 60° C for 48 h then weighed and ground (1-mm screen). Samples were sent to the Forage Quality Laboratory at the Southeast Research Station, Franklinton, LA for quality analysis by near infrared reflectance spectroscopy (NIR-Systems 6500, Perstrop, Silver Spring, MD). Calibration samples for a closed population were analyzed by wet chemistry for CP (Kjeldahl N x 6.25; AOAC, 1984 modified for automated analysis), NDF, ADF (Robertson and Van Soest, 1981), and in vitro true DM digestibility (IVTD) (Goering and Van Soest, 1970). Hay samples were taken to assess nutritive value each year by taking six core samples, each from a randomly selected bale. Core samples were processed and analyzed using the above mentioned procedure.

Experiment Two

Site Preparation and Design

St. Gabriel experiment site was on moderate to poorly drained silty loam and silty clay loam soil (fine-silty, mixed, nonacid, thermic Aeric Fluvaquents) with flat topography. Pastures in Exp 2 were prepared and planted in the same manner and rate as discussed in Exp 1 on October 10, 2007. Pastures were fertilized at planting with potash (0-0-60) at a rate of 112 kg/ha providing 67 kg/ha of K. Urea fertilizer (46-0-0) was applied on November 12, 2007 and

February 4, 2008 providing 51.6 kg of N/ha at each application. Water and mineral were offered as discussed in Exp 1. Bahiagrass hay $5.6 \pm 0.8\%$ CP, $53 \pm 3.1\%$ IVTD, $69 \pm 2.8\%$ NDF, and $44 \pm 2\%$ ADF was offered free choice and disappearance was recorded in kg DM as discussed in Exp 1.

Heifer Backgrounding

One hundred twenty heifers (25 to 50 % *Bos indicus*) were received d -59. Heifers were offered grass hay $5.6 \pm 0.8\%$ CP, and were supplemented 2.2 kg/head/day of mixed feed $25 \pm 4\%$ CP. On d -55 heifers were vaccinated against brucellosis by a licensed veterinarian, were administered Micotil 300 (Elanco Animal Health, Greenfield, IN), and were treated for internal and external parasites as in Exp 1.

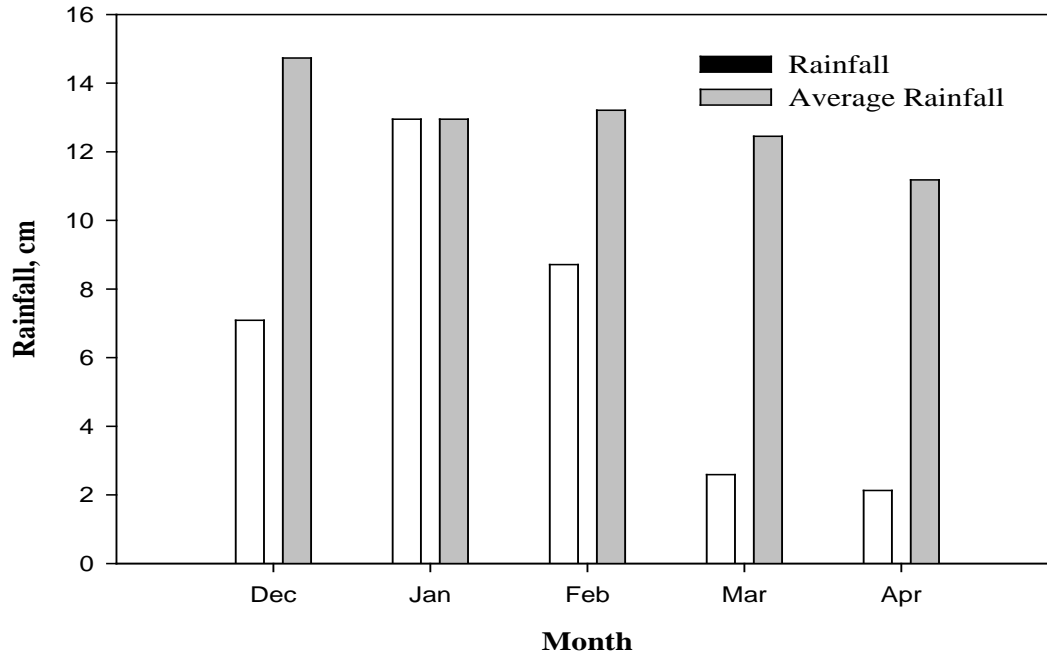
Grazing Trial

Stocking was initiated December 17, 2007 and extended through April 9, 2008. On d 0, heifers were sorted by weight and randomly assigned to treatment. Initial heifer weight was 233 ± 6 kg. Shrunken weights were taken for d 0 and 113 by fasting heifers for 14 to 16 h. Interim weights were measured without prior removal from pasture and water at approximately 33 d intervals throughout the trial. Stocking methods were conducted as described in Exp 1. As seen in Exp 1 heifers were stocked at a rate of 3.7 heifers/ha (865 kg/ha on d 0). A total of 5 heifers (3 ROT from a single pasture and 2 CONT from a single pasture) were removed from trial for health issues. Each heifer was replaced with a grazing steer approximately 240 ± 5 kg to maintain stocking rates. Performance data from removed heifers was not included in analysis and no performance data was collected for replacement grazing steers. Forage estimations, collections, and analysis were consistent across experiments.

Rainfall

Monthly and average monthly rainfall (30 yr average), at St. Gabriel Research Station is presented in figure 3.2. Rainfall was collected onsite at St. Gabriel Research Station. Total

rainfall from December through April was 33.5 cm, 31 cm below average of 64.5 cm for the time frame at the given location.



(Figure 3.2) Monthly and average monthly rainfall at St. Gabriel Research Station.

Statistical Analysis

Experiment 1 and 2 were conducted at different locations and in succeeding years. The two locations differed in soil type and topography and the two years differed in rainfall and environmental conditions. Therefore, the two experiments were analyzed separately. Statistical analyses reported below were applied to both experiments unless stated otherwise.

Response variables of interest were average daily gain (ADG), weight gain per ha (WG/ha), body weight (BW), forage mass, crude protein (CP), in vitro true dry matter digestibility (IVTD), neutral detergent fiber (NDF), and acid detergent fiber (ADF). Pasture was considered the experimental unit for all analyses, and heifer was the sampling unit for ADG and BW. All dependent variables were analyzed using the MIXED procedure (Littell et al., 1996) of SAS.

Body weight was analyzed including in the model treatment (CONT and ROT), sampling period (0 to 6 for Exp 1 and 0 to 5 for Exp 2) and their interactions as fixed effects. Pasture within treatment, and sampling period by pasture within treatment were included as random effects. Average daily gain was analyzed including in the model treatment as a fixed effect and pasture within treatment as a random effect. Weight gain/ha was analyzed including in the model treatment as a fixed effect. Forage mass, CP, IVTD, NDF, and ADF were analyzed including in the model treatment (CONT and ROT), d (0, 33, 66, 99, and 132 for Exp 1 and 113 for Exp 2) and their interaction as fixed effects. The slice option was used to test for treatment effect within each sampling day. Measurements taken over time were analyzed as repeated measures. The covariance structure was selected by choosing the best fitting model according to the Akaike Information Criterion. The following covariance structures were used: compound symmetry for forage mass, heterogeneous ante-dependent for BW, CP, and NDF, and first-order autoregressive for IVTD and ADF. Heifer and pasture within treatment were the subject of the repeated statement for BW and pasture measurements, respectively.

Response variables measured on d 0 were not included in the analysis as covariates do not reduce the number of degrees of freedom available to test the treatment effect. Data collected on d 0 were included as such and as contrast statement was built to test for treatment effect without d 0. Values reported are least square means. Significance was declared at $P \leq 0.05$, and a trend was reported if $0.05 < P \leq 0.10$.

RESULTS AND DISCUSSION

Heifer Performance

In Exp1, heifers allotted to 12-paddock rotational stocking method (ROT) tended to have greater ADG compared with heifers in continuous stocking method (CONT) ($P = 0.10$; Table 3.1). Average heifer weight on d 132 (interim weights not shown) was increased in ROT

compared to CONT ($P < 0.05$; time x treatment). Weight gain per ha tended to be greater under ROT compared to CONT ($P = 0.10$; table 3.1)

In Exp 2, ADG in heifers stocked on winter wheat and annual ryegrass pastures did not differ between ROT and CONT ($P = 0.36$; Table 3.2). Average heifer weight was not affected by treatment ($P = 0.16$). Gain/ha was not affected by stocking method ($P = 0.36$).

(Table 3.1) Average daily gains, body weights, and weight gain per ha of heifers on ROT and CONT (experiment 1).

Item	ROT	CONT	(<i>P</i> -value)	SEM
ADG, kg	0.79	0.41	0.10	0.09
Initial average weight, kg	248	248		5.7
Final average weight, kg	352	303	0.05	6.0
Gain per ha, kg/ha	387	202	0.10	44.1

(Table 3.2), Average daily gains, body weights, and weight gain per ha of heifers on ROT and CONT (experiment 2).

Item	ROT	CONT	(<i>P</i> -value)	SEM
ADG, kg	0.66	0.77	0.36	0.07
Initial average weight, kg	233	233		5.6
Final average weight, kg	308	320	0.16	6.2
Gain per hectare, kg/ha	278	323	0.36	29.7

Average heifer weight at trial end was of particular interest because of the effect of average BW on puberty. Patterson et al. (1992) reported that heifers should be at 60 to 66% of their mature BW at breeding. Average heifer weight in both experiments was in excess of 60% of mature BW (assuming a mature BW of 500 kg).

Heifer ADG (Exp 1) was increased by 92% in ROT compared to CONT. Differing from Exp 1, heifer ADG (Exp 2) was not affected by stocking method. Heifer ADG were lower than that reported for steers grazing ryegrass and crimson clover pasture under similar Louisiana conditions and stocking rates, reported ADG was 0.87 kg (Mooso and Morrison, 1994).

Similar to Exp 2, Aiken (1998) reported no difference in steer ADG grazing winter wheat and annual ryegrass pastures in an 11-paddock rotational or CONT. Aiken (1998) reported steer ADG of 1.0 and 0.94 kg for 11-paddock rotational and CONT, respectively. Mooso (1990)

reported no difference in steer ADG grazing annual ryegrass and crimson clover pastures in 15-paddock rotational or CONT (1.01 and 1.04 kg, respectively). Nelson et al. (1989) reported no difference in heifer ADG grazing wheatgrass pastures in 8-paddock rotational and CONT (0.79 and 0.73 kg, respectively). Differing from our results, Hafley (1996a) reported steer ADG grazing annual ryegrass pastures were greater in CONT compared to 6-paddock rotational stocking method (1.32 and 0.92, respectively).

Gain per ha in Exp 1 was 185 kg greater in ROT compared to CONT. Similar to Exp 1, previous research consistently reported greater WG/ha under rotational stocking method compared to CONT. Weight gain per ha was reported as 693 and 428 kg/ha for 11-paddock ROT and CONT, respectively (Aiken, 1998), 846 and 689 kg/ha for 15-paddock rotational and CONT, respectively (Mooso, 1990), and 403 and 301 kg/ha for 6-paddock rotational and CONT, respectively (Hafley, 1996a). However, Exp 2 resulted in no difference in WG/ha between ROT and CONT. Results of Exp 2 differed from previous research in that continuous stocking rates did not result in increased WG/ha in ROT compared with CONT. Hafley (1996a) reported increased WG/ha in ROT compared to CONT despite CONT maintaining greater individual animal performance because of increases in stocking rate.

Forage Mass

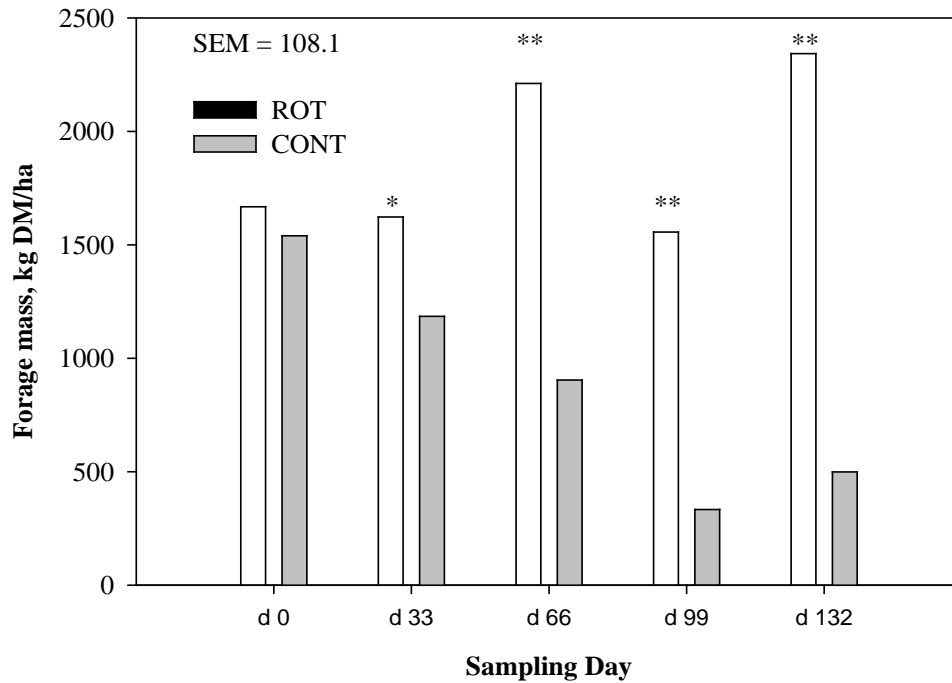
Forage mass in Exp 1 was increased in a time x treatment interaction in ROT compared to CONT on the final four sampling periods ($P < 0.005$; time x treatment; Fig. 3.3). Forage mass was similar for both stocking methods at the initiation of the stocking period, and initial forage mass was above 1,500 kg DM/ha. Forage mass in ROT pastures remained above 1,500 kg DM/ha, and peaked on d 132 at 2,340 kg DM/ha. Forage mass under CONT decreased linearly through the trial, and fell below 350 kg DM/ha on d 99.

Forage mass in Exp 2 was increased in ROT compared to CONT on the final 2 sampling periods ($P < 0.05$; time x treatment; Fig. 3.4). Forage mass did not differ between stocking

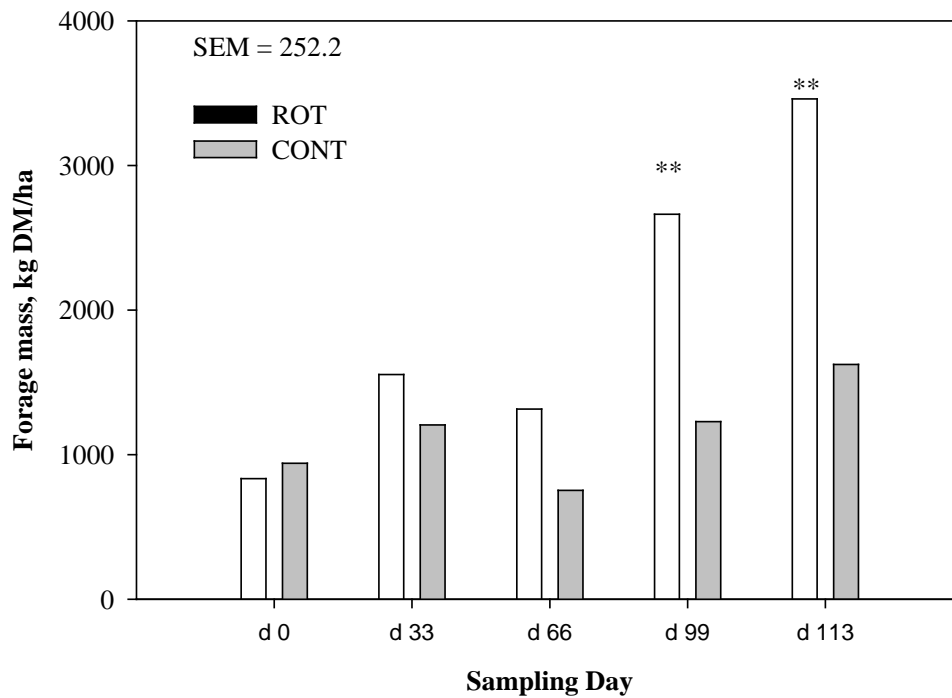
methods in the first three sampling dates. Forage mass in ROT was increased from 830 kg DM/ha on d 0 to above 1,550 kg DM/ha by d 33. Forage mass decreased following d 33 to 1,300 kg DM/ha on d 66 before increasing linearly for the remainder of the trial. Forage mass of ROT was greater than CONT in the final two sampling dates. Forage mass in CONT was maintained above 1,200 kg DM/ha for the final two sampling dates and was maintained above 750 kg DM/ha the entire trial.

Forage mass was increased by ROT compared to CONT in both experiments. However, the critical period of forage mass occurred in CONT (Exp 1); forage mass below 500 kg DM/ha may have limited heifer DMI in the final two grazing periods. Williams et al. (2002) documented that utilizing bahiagrass pastures, heifer DMI was limited when forage mass fell below 500 kg DM/ha. Similarly, the NRC (1996) reported that intake was 60 % of maximum when forage mass fell below 450 kg DM/ha. The linear decline in forage mass observed in CONT pastures (Exp 1) was the result of stocking rates being too high. At the same continuous stocking rate of 3.7 heifers/ha, forage mass in ROT remained above 1,500 kg DM/ha for the entire trial, suggesting that ROT could maintain greater stocking rates compared with CONT. McCollum et al. (1992) reported that utilizing winter wheat pastures, peak stocker DMI occurred at a forage mass of 1,247 kg DM/ha. Similarly, Bertelsen et al. (1993) reported forage DMI was maximized at 1,200 kg DM/ha for heifers grazing alfalfa, orchardgrass, and tall fescue pastures. Forage mass in ROT pastures (Exp 1) reached 2,300 kg DM/ha on d 132, suggesting that stocking rates were not high enough to utilize available forage in the final grazing period.

Similar to Exp 1, forage mass in Exp 2 was increased in ROT when compared to CONT in the final two sampling periods. However, in the final two sampling periods, CONT forage mass was not limited and remained above 1,200 kg DM/ha. Forage mass in CONT pastures (Exp 2) was below levels required for peak heifer DMI on d 0 and 66 (below 1,200 kg DM/ha); however, CONT forage mass did not differ from ROT forage mass on d 0 or 66.



(Figure 3.3) Least square means of forage mass across time for ROT and CONT in experiment 1 (* = $P < 0.05$; ** = $P < 0.005$).



(Figure 3.4) Least square means of forage mass across time for ROT and CONT in experiment 2 (** = $P < 0.05$).

Forage mass in both CONT and ROT pastures was below 1,000 kg DM/ha at the initiation of stocking. Morrison (1996) reported that ROT pastures are more sensitive to limited forage mass when compared to CONT pastures because of greater stocking densities. Our results support this claim, visual observations of forage mass in individual ROT paddocks indicated that forage mass was limited before the 2 or 3 d stocking session was ended. Similarly, Bertelsen et al. (1993) suggest that high stocking densities of individual ROT paddocks often results in limited forage mass before stockers are rotated, and subsequently reduces the ability of stockers to selectively graze. Aiken (1998) reported that utilizing “put-and-take” animals on winter wheat and annual ryegrass pasture, stocking rates were adjusted to maintain a forage height of 3 cm in post graze analysis of rotational paddocks. Using 3 cm as a determinate for limited forage mass, visual post graze observations of ROT paddocks suggests that forage mass in ROT paddocks (Exp 2) may have limited heifer DMI in the first round of stocking. Using the same standard, forage mass in ROT pastures (Exp 1) did not limit heifer DMI. The results of these experiments suggests that the high stocking densities of ROT require a pregraze forage mass of 1,500 kg DM/ha to maintain peak heifer DMI for the entire 2 or 3 d of stocking session.

Along with low initial forage mass (Exp 2), ROT pastures were affected by trampling following heavy rains in the months of December and January (despite below average rainfall; fig. 3.2). Due to the greater stocking densities of ROT compared to CONT pastures, trampling seems to have a greater effect on forage mass of individual ROT paddocks. Wyatt et al. (1986) reported that trampling is a common problem on prepared seedbeds under Louisiana conditions. Rainfall was below average for both years (figure 3.1 and 3.2) and trampling did not seem to affect forage mass in Exp 1. This suggests that the heavy clay soil and flat terrain at the Exp site in Exp 2 may have been more prone to trampling than the loam soil and rolling hills in Exp 1. Despite early differences between years, the effect of ROT on forage mass seemed comparable

for both years. The 28 d of regrowth following stocking seemed to result in adequate regrowth within each paddock before the next round of stocking.

Results indicate that ROT increases forage mass when compared to CONT. Similar to Exp 1 and 2, forage mass in an 11-paddock rotational stocking system was increased when compared to CONT on winter wheat and annual ryegrass pastures (Aiken, 1998). Also, Nelson et al. (1989) reported that forage mass in an 8-paddock rotational stocking system was increased when compared to CONT on wheatgrass pastures. Bertelsen et al. (1993) reported that forage mass in an 11-paddock rotational stocking system was increased when compared to CONT on alfalfa, orchardgrass, and tall fescue pastures.

Results suggest that a great deal of variability exists with the response of forage mass to the continuous stocking pressure of CONT, even at the same stocking rate. Forage mass in CONT pastures (Exp 1) ranged from 1,539 to 333 kg DM/ha, while forage mass in CONT pastures (Exp 2) ranged from 1,623 to 751 kg DM/ha. Similarly, Coffey et al. (2002) reported that utilizing CONT on winter wheat and ryegrass pastures over a 3 yr trial, forage mass ranged from 403 to 2,902 kg DM/ha with a mean forage mass of 1,341 kg DM/ha. Also, Mader et al. (1983) reported that utilizing CONT on winter wheat pastures forage mass ranged from 365 to 1,664 kg DM/ha with a mean forage mass of 838 kg DM/ha.

Hay Disappearance

In Exp 1 total hay disappearance was 1,816 and 17,100 kg DM for ROT and CONT, respectively. Hay disappearance under ROT (Exp 1) was similar throughout the trial. From d 0 to 66, 894 kg DM disappear while from d 66 to 132, 922 kg DM. On the other hand, under CONT hay disappearance increased in the later portion of the trial due to lack of forage mass. From d 0 to 66 disappearance was 4,500 kg DM, but from d 66 to 132 it was 12,600 kg DM. This increase in hay disappearance in the second half of the grazing trial under CONT is directly related to the low forage mass available (Figure 3.3).

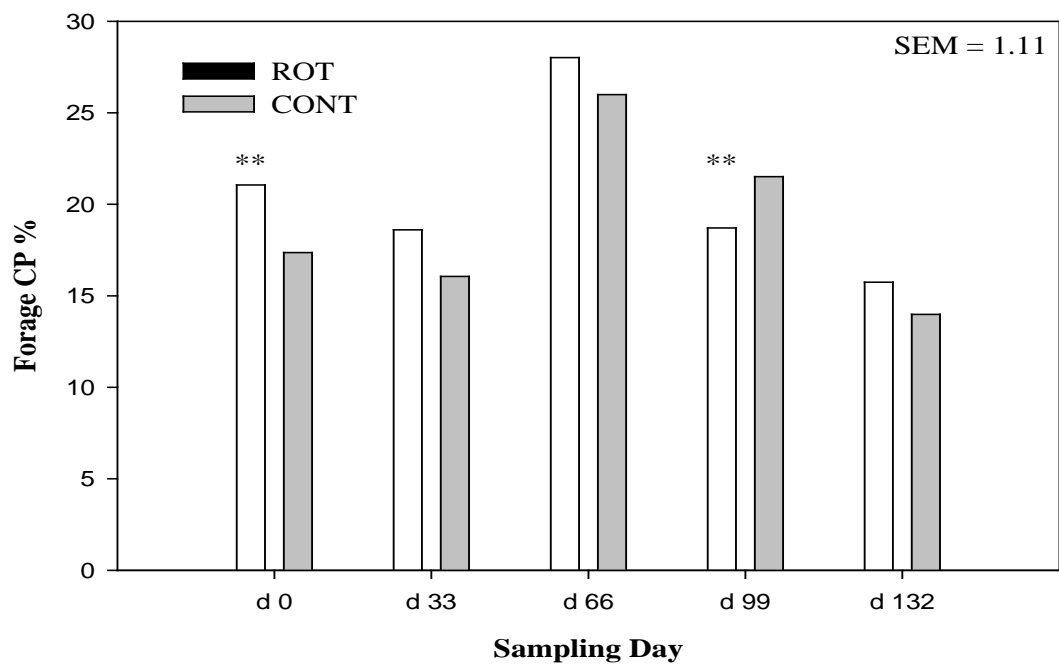
In Exp 2 hay disappearance was 4,626 and 4,050 kg DM for ROT and CONT, respectively. Hay disappearance under ROT (Exp 2) was 2,376 kg DM d 0 to 66 and 2,250 kg DM d 66 to 113. Similarly, hay disappearance under CONT (Exp 2) was 1,800 kg DM d 0 to 66 and 2,250 kg DM d 66 to 113.

Forage CP

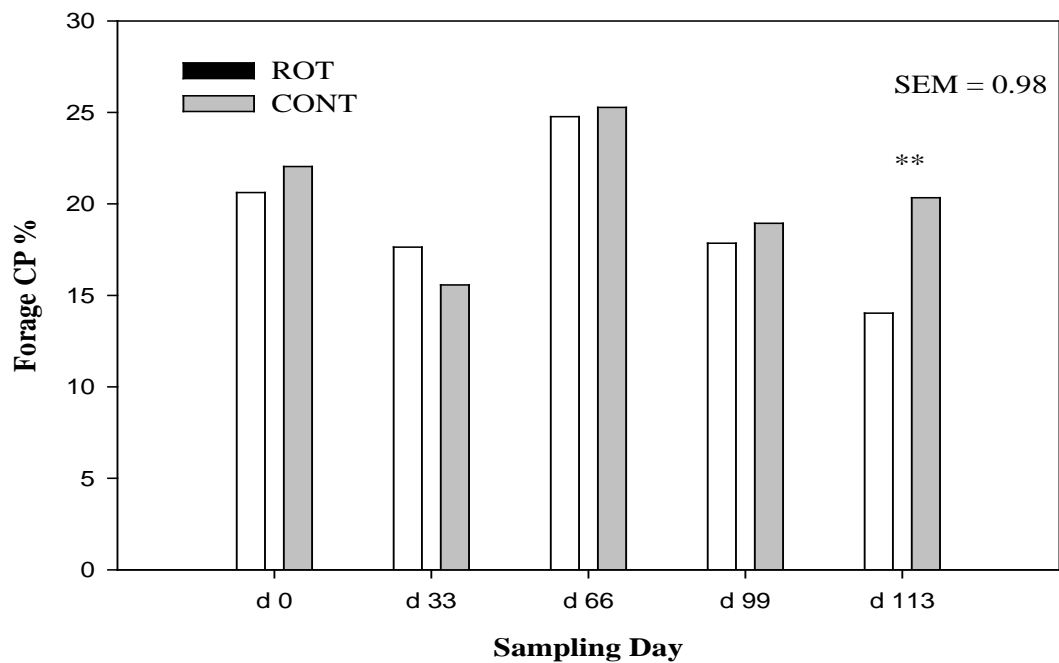
In Exp 1, forage CP concentration was affected in a time x treatment interaction in ROT when compared to CONT on d 0 and d 99 ($P < 0.05$; time x treatment; Fig. 3.5). Forage CP at the initiation of stocking was 21 and 17.4% for ROT and CONT, respectively. Forage CP in ROT peaked on d 66 at 28% before decreasing linearly to 15.7% on d 132. Forage CP in CONT peaked on d 66 at 26% before decreasing linearly to 14% on d 132.

In Exp 2, forage CP was increased in CONT when compared to ROT in a time x treatment interaction on d 113 ($P < 0.05$; time x treatment; Fig. 3.6) Forage CP in ROT peaked on d 66 at 24.8% before declining linearly to 14% on d 113. Forage CP in CONT peaked at 25.3% on d 66, and was increased 6% compared to ROT CP on d 113.

The effect of stocking method on forage CP differed between the two experiments. Similar to Exp 1, Hafley (1996a) reported that forage CP of annual ryegrass pastures was increased under ROT when compared to CONT. Bertelsen et al. (1993) reported that forage CP of alfalfa, orchardgrass, and tall fescue pastures was greater in rotational compared to CONT. Differing from Exp 1, forage CP in Exp 2 was greater in CONT compared to ROT. The main difference in forage CP occurred on d 113, and may be attributed to forage maturity. The steady stocking pressure of CONT appeared great enough to keep the forage in a vegetative state. Whereas, seedheads observed in ROT on d 113, suggests that the 28 d regrowth period in the final round of stocking was sufficient for forage maturation. Chilibroste et al. (2002) observed that forage CP of mixed cool season grasses was affected by length of regrowth, ranging from 27 to 18% for 16 and 30 d regrowth, respectively.



(Figure 3.5) Least square means of crude protein across time for ROT and CONT in experiment 1 (** = $P < 0.05$).



(Figure 3.6) Least square means of crude protein across time for ROT and CONT in experiment 2 (** = $P < 0.05$).

Similar to Exp 1 and 2, Coffey et al. (2002) reported that over a 3 yr trial grazing ryegrass and winter wheat pastures, forage CP ranged from 10.3 to 29.9% CP with a mean of 19.6% CP. Feazel (1990) reported forage CP of ryegrass, white clover, and crimson clover ranged from 14.7 to 19.7%. Feazel and Morris (1992) reported similar CP ranging from 11 to 18% utilizing ryegrass and clover mixtures (white, crimson, and arrowleaf clover). Forage CP peaked following mid trial urea fertilizer (46-0-0) application; CP (Exp 1) peaked on d 66 at 28 and 26% for ROT and CONT, respectively. Similarly, following fertilizer application, forage CP (Exp 2) peaked on d 66 at 24.8 and 25.3% for ROT and CONT, respectively. Similar to both experiments, Hafley (1996a) reported that utilizing annual ryegrass pastures, forage CP peaked at 27% following a mid trial fertilizer application before declining to 19%.

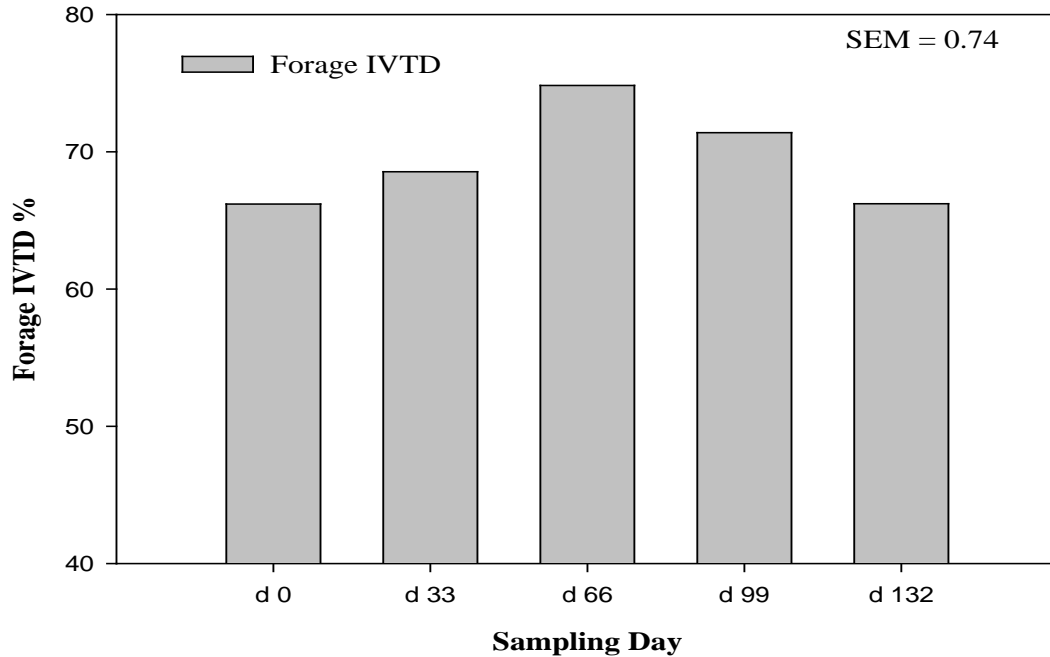
Forage IVTD

In Exp 1, forage in vitro true DM digestibility was not affected by stocking method, however it was influenced by time ($P < 0.005$; Fig. 3.7). Forage IVTD did not differ between ROT and CONT in Exp 1. Forage IVTD ranged from 66.2% at the initiation of stocking to 74.8% on d 66. Forage IVTD declined linearly following d 66, to 66.2% on d 133.

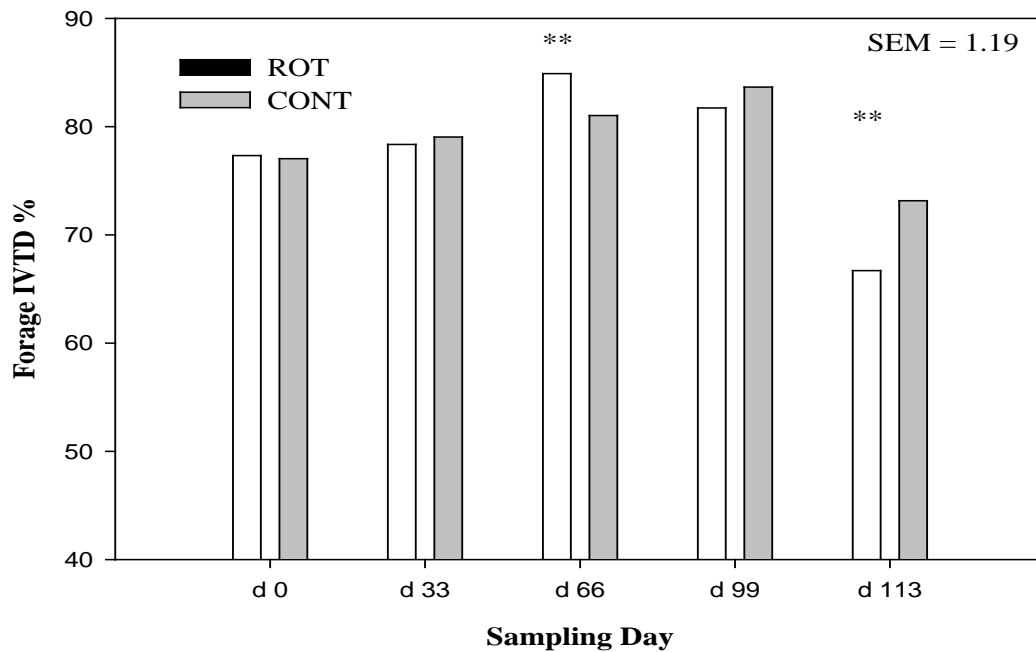
In Exp 2, forage IVTD was affected in a stocking method x time interaction on d 113 ($P < 0.05$; time x treatment; Fig. 3.8). Forage IVTD in ROT ranged from 84.9% on d 66 to 66.7% on d 113. Forage IVTD in CONT differed in that it peaked on d 99 at 83.7% and reached a low on d 113 at 73.1%.

Similar to Exp 1, Aiken (1998) reported no difference in IVTD between ROT and CONT stocked winter wheat and ryegrass pastures. Differing from Exp 1, forage IVTD in Exp 2 was increased in CONT when compared to ROT. Despite greater IVTD in ROT compared to CONT on d 66, IVTD was increased by 6.5% in CONT compared to ROT on d 113. As seen with forage CP, maturity (of forage on d 113) may have affected forage IVTD. Similar to Exp 2, Hafley

(1996a) reported that forage IVTD levels of ryegrass were greater for CONT compared to rotational stocking method.



(Figure 3.7) Least square means of in vitro true DM digestibility across time in experiment 1.



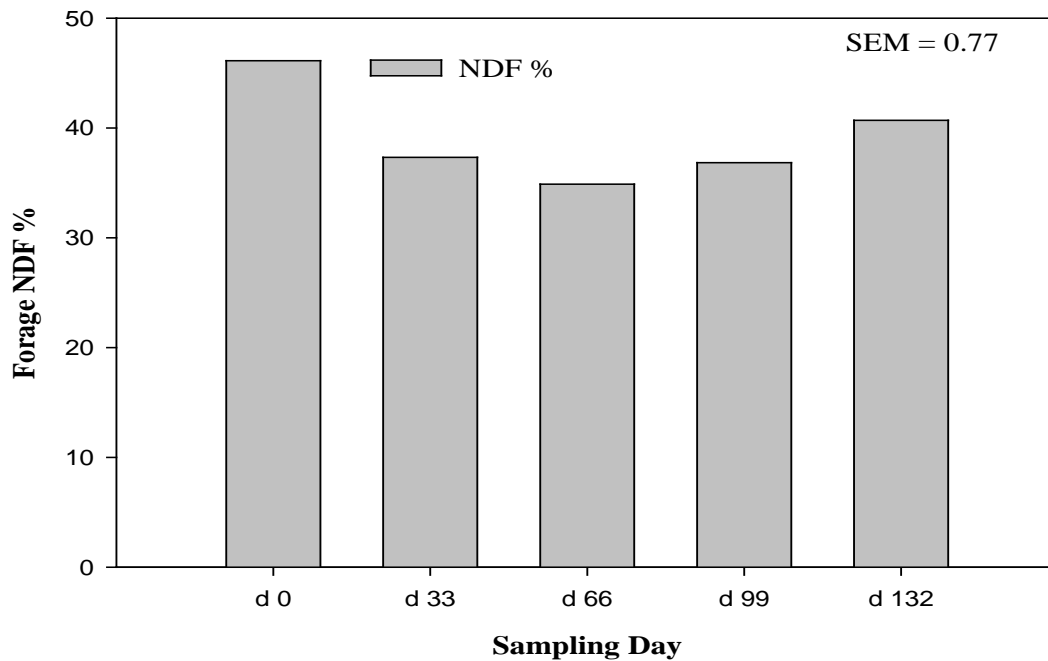
(Figure 3.8) Least square means of in vitro true DM digestibility across time for ROT and CONT in experiment 2 (** = $P < 0.05$).

Similar to Exp 1 and 2, Coffey et al. (2002) reported that utilizing ryegrass and wheat pastures IVTD levels ranged from 58.8 to 81.3% over 3 yr. Similar to Exp 1, Feazel (1990) reported that utilizing ryegrass, white clover, and crimson clover, IVTD levels ranged from 61.4 to 70.0%. Forage IVTD levels of annual ryegrass pastures ranged from 62.5 to 74.1% through a 2 yr trial (Hafley, 1996a).

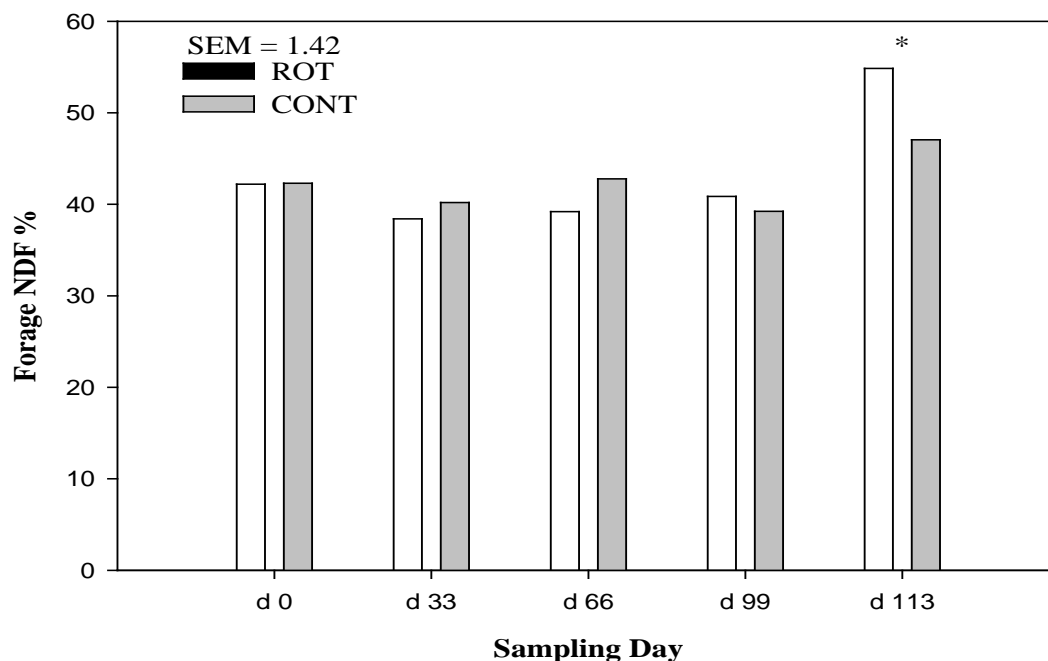
Forage NDF

In Exp 1, forage NDF was not affected by stocking method; however, it was influenced by time (Fig. 3.9). Forage NDF ranged from 46.1% on d 0 to 34.9% on d 66 before increasing linearly to 40.7% on d 133.

In Exp 2, forage NDF tended to differ between stocking methods in a time x treatment interaction on d 113 ($P = 0.10$; time x treatment; Fig. 3.10). Forage NDF in both ROT and CONT was maintained near 40% for most of the trial, but forage NDF was increased in ROT compared to CONT on d 113.



(Figure 3.9) Least square means of neutral detergent fiber across time in experiment 1.



(Figure 3.10) Least square means of neutral detergent fiber across time for ROT and CONT in experiment 2 (* = $P = 0.10$).

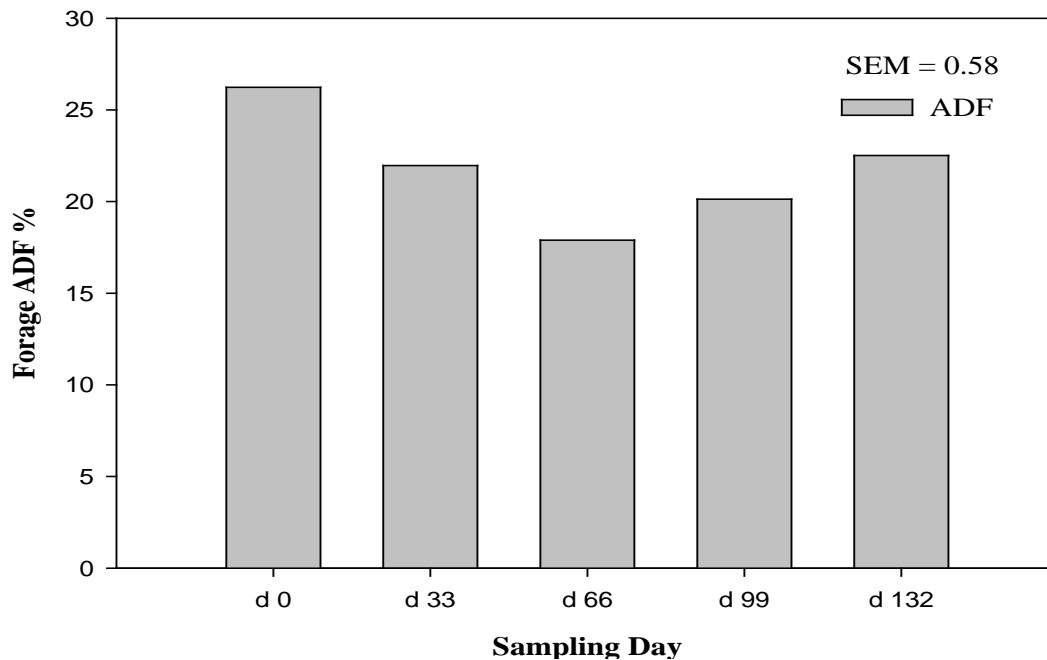
The effect of stocking method on forage NDF differed between Exp 1 and 2. In Exp 2, forage NDF was increased by ROT compared to CONT on d 113; NDF levels were 54.9 and 47% for ROT and CONT, respectively. Differing from Exp 2, Bertelsen et al. (1993) reported greater NDF levels in CONT compared to rotational stocking method of alfalfa, orchardgrass, and tall fescue pastures. Similar to Exp 2, Hafley (1996a) reported that forage NDF of annual ryegrass was increased by rotational compared to CONT. Increases in forage NDF can be expected as forage matures and stem to leaf ratio increases (Aiken, 1998). Increased forage NDF observed in ROT on d 113 further suggests that forage in ROT was more mature on d 113 when compared to forage in CONT. Chilibroste et al. (2000) reported that forage NDF levels of perennial ryegrass were affected by period of regrowth, and ranged from 42% on d 13 to 53% on d 30. Van Soest (1965) reported that fiber inhibited intake of forages with high cell wall intake, and concluded that decreased intake occurred above 50% NDF. Similarly, Lippke (1986) reported that grazing sessions of yearling cattle were ended when rumen fill of forage NDF

reached 1.3% BW. However, Chilbroste et al. (2000) reported that grazing perennial rye pastures, forage NDF was not the main signal to stop grazing. Chilbroste et al. (2000) suggested that the low DM of winter annuals resulted in rumen fill prior to limiting NDF levels.

Forage ADF

In Exp 1, forage ADF was not affected by stocking method; however, it was influenced by time (Fig. 3.11). Forage ADF ranged from 26.2 on d 0 to 17.9% on d 66 before increasing linearly to 22.5% on d 132.

In Exp 2, forage ADF was affected in a stocking method x time interaction on d 113 ($P < 0.05$; time x treatment; Fig. 3.12). Similar to forage NDF, forage ADF was increased under ROT when compared with CONT, ADF levels were 33.2 and 27% respectively.

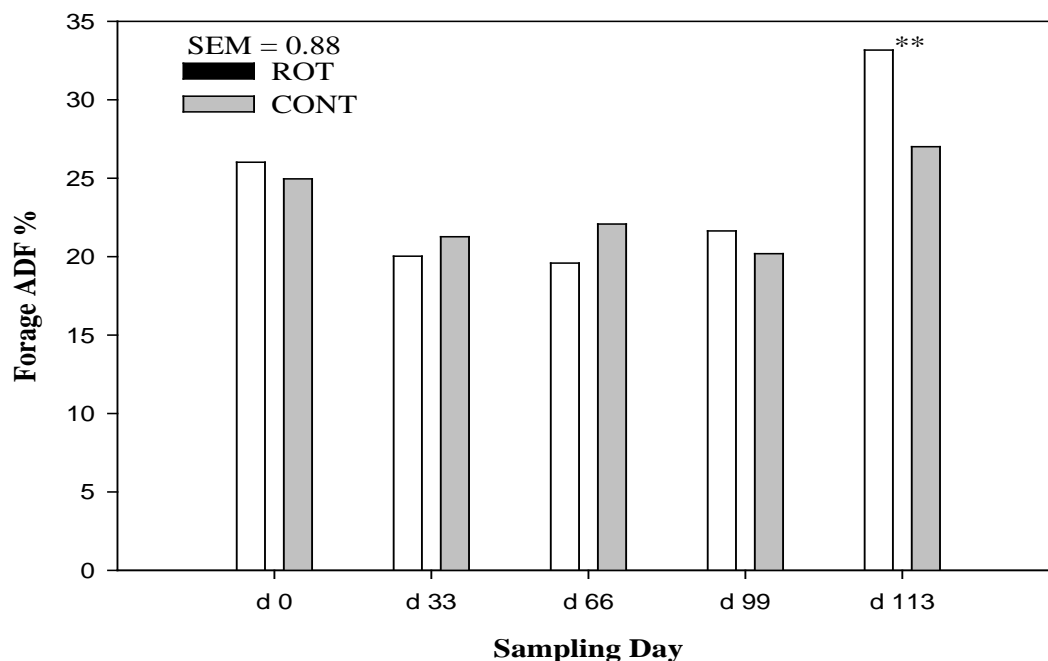


(Figure 3.11) Least square means of acid detergent fiber across time in experiment 1.

Experiment 2 differed from Exp 1 in that forage ADF was affected by stocking method on d 113.

Forage ADF in both years remained below levels that affect diet quality and limit digestibility

(Bertelsen et al., 1993).



(Figure 3.12) Least square means of acid detergent fiber across time for ROT and CONT in experiment 2 (** = $P < 0.05$).

CONCLUSIONS

The effect of ROT compared to CONT of winter wheat and annual ryegrass pastures on heifer performance was inconsistent between experiments. Heifer ADG and WG/ha were increased by ROT compared to CONT in Exp 1. Limited forage mass occurred in CONT (Exp 1) because stocking rates were too high for the given year and location. Forage mass in ROT (Exp 1) responded more favorably to stocking pressure while maintaining the same stocking rate of 3.7 heifers/ha. Differing from Exp 1, heifer ADG and WG/ha (Exp 2) were not affected by stocking method. Similar to Exp 1, forage mass in Exp 2 was increased in ROT compared to CONT in the final 2 sampling periods. However, forage mass in CONT (Exp 2) was not limited in the final 2 sampling periods (above 1,200 kg DM/ha), and remained above 750 kg DM/ha for the entire trial. Forage mass in Exp 2 did respond favorably to ROT and forage mass increased linearly throughout the trial. Continuous stocking rates did not result in the efficient utilization of available forage mass in ROT, and as a result no difference was observed in WG/ha.

The advantage of ROT is that the 28 d of regrowth following stocking seems to result in greater forage mass when compared to CONT. However, increases in heifer ADG by ROT only occurred when CONT forage mass was limited. The results of this trial suggest that ROT does increase forage mass and can sustain higher stocking rates than CONT. However, ROT pastures may utilize available forage mass more efficiently under put-and-take stocking rates. The usage of ROT under continuous stocking rate of 3.7 heifers/ha does not appear to consistently increase heifer ADG or WG/ha.

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APPENDIX: LIST OF ABBREVIATIONS

ADF.....	Acid detergent fiber
ADG.....	Average daily gain
CONT.....	Continuous stocking method
CP.....	Crude protein
DM.....	Dry matter
DMI.....	Dry matter intake
Exp.....	Experiment
ha.....	hectare
IVTD.....	In vitro true dry matter digestibility
NDF.....	Neutral detergent fiber
ROT.....	12-paddock rotational stocking method
WG.....	Weight gain

VITA

David Gregory Skeans, son of Faye and Larry Skeans, was born in Houma, Louisiana, in June, 1983. David has one younger sister, Haley. David was raised in Bayou Blue, Louisiana. After graduating high school from Central Lafourche in 2001, he attended Nicholls State University. In December of 2005, he completed a Bachelor of Science degree with a concentration in agricultural science. He entered graduate school in August of 2006 under the direction of Dr. Jason Rowntree. He is now a candidate for the degree of Master of Science in the School of Animal, Dairy, and Poultry Sciences at Louisiana State University.