Progress Report: Effect of Stockpiling Initiation Method on Winter Forage Yield and Quality of Midwestern Cool-season Grass Pastures for Fall-calving Beef Cows

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Summary and Implications

An ongoing two-year trial is being conducted to evaluate the effects of three different methods of initiating forage stockpiling on the quality and mass of forage available over the winter months (October through January). Methods of initiating stockpiling were spring strip-grazing, summer strip-grazing, and summer hay harvest. Forage mass, nutritional, and weather data were input into a ration balancing program with supplemental feed provided to maintain a body condition score (BCS) of five throughout the winter for fall-calving beef cows. Partial budget models were used to evaluate costs associated with the different treatment methods and compared to a standard winter hay feeding regime in a drylot scenario.

Spring strip-grazing generated the greatest stockpiled forage mass compared to all other treatments, but also had the lowest dry matter digestibility across sampling dates. There were no differences in crude protein (CP) content among different methods of initiation. The carrying capacity of drylot models was greatest but did not differ between stockpiling models. There was a tendency for drylot models to incur greater total costs ($/ac) than stockpile models. There were no statistical differences in total cost ($/ac) between models using stockpiled forage grazing by different methods of initiation and no statistical differences in gross ($/hd/d) or net ($/hd/d) costs across treatments. While spring strip-grazing resulted in greater forage mass, the quality of this forage was lower than summer treatments. With similar costs, the lower yields from summer stockpiling models (strip-grazing or hay harvest) could be compensated for by the higher nutritional quality of the forage.

Introduction

Winter feed costs represent a significant proportion of operational expenses in Midwest, beef cow-calf production systems. The desire to maximize grazing days and minimize winter feed costs has renewed attention in stockpile grazing strategies. Stockpiling of forages is a practical management technique by which forage is allowed to rest and mature for future use and allows cow-calf producers to extend the length of their grazing season, while reducing the amount of purchased feeds needing to be stored and fed during the winter months. Traditionally, stockpiling has been initiated by hay harvest in late summer to allow for spring and summer pasture utilization while maximizing of the nutritional quality of the winter forage. Alternatively, stockpiling could be initiated through the use of high-density grazing practices such as strip-grazing.

Cool-season, perennial, mixed grass pastures lend themselves well for use as winter stockpiled forage due to additional fall shoot growth. A prime example is tall fescue (*Festuca arundinacea)*, which is prevalent throughout much of the Midwestern United States and maintains a high nutritional value throughout the winter, even after dormancy. The addition of fall nitrogen fertilization further supports this late year growth period and aids in the development of nonstructural carbohydrate reserves in the stockpiled forage, increasing the nutritional value to livestock over the winter months.

The utilization of tall fescue as a forage source is not without risk. The majority of tall fescue stands are infected with a fungal endophyte (*Neotyphodium coenophialum*). While the endophyte conveys exceptional host defenses for the plant, it also produces ergopeptide alkaloids which are toxic to grazing livestock. Common clinical symptoms associated with fescue toxicosis include poor conception rates, abortion, reduced milk production, and loss of hooves and tails. While alkaloid content is highest in the summer, there is alkaloid production during the fall growth stage and this production is enhanced with the addition of fall nitrogen fertilization. Thus, endophyte-infected tall fescue could adversely impact beef cows grazing stockpiled winter forage.

While work has been done to evaluate the nutritional quality of stockpiled forages after initiation with hay harvest, little research has been conducted to assess different methods of initiating the stockpiling of cool-season grass pastures in the Midwest, and the effect on endophyte-infected tall fescue, in particular. Thus, the objective of this research is to determine the effects of different stockpiling initiation methods on the nutritional quality and biomass of cool-season grass pastures, predominately composed of endophyte-infected tall fescue, and evaluate the economic costs associated with the differing methods.

Materials and Methods

At the McNay Memorial Research Farm near Chariton, Iowa, nine, 0.405-ha (1-ac) paddocks were blocked in triplicate with one paddock within each block being randomly assigned to one of three treatment methods to initiate stockpiling. Treatments included: spring strip-grazing, summer strip-grazing, and summer hay harvest; thereby allowing 155-d, 80-d, and 66-d of stockpiling, respectively. Paddocks assigned to strip-grazing treatments were stocked with ten mature, fall-calving, Angus cows at a live forage allowance of 2.4 % BW/d. Live forage allowance was determined with a falling plate meter (4.8 kg/m^2) prior to installment of strips with temporary electric fencing. Forage in paddocks assigned to hay treatments were harvested in August as large, net-wrapped, round bales and stored on the ground outdoors. All paddocks were fertilized in September with 50.4 kg of nitrogen/ha (45 lb/ac) as urea and a urease inhibitor included at a rate of 3.1 L/tonne (0.743 gal./ton) of urea.

Samples of stockpiled forage from each paddock were collected monthly from October through January from six, random, 0.25-m^2 (0.82-ft^2) locations within each paddock. Samples were hand-clipped to a height of 2.54-cm (1-in.), pooled by paddock, and frozen. Hay bales were weighed and core sampled at the time of harvest in August, and core sampled, weighed, dissected, and reweighed to determine nutrient composition, storage losses, and recovery of un-weathered material in November. Forage and core samples were weighed, oven-dried for 48 h at 65°C (149°F), and re-weighed to determine dry matter (DM). Samples were ground through a 1-mm screen using a Wiley Mill and analyzed for in vitro dry matter digestibility (IVDMD), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), and crude protein (CP).

In October, additional samples were taken from six, random, 0.25-m^2 (0.82-ft^2) locations within each paddock, hand-clipped to a height of 2.54-cm (1-in.), pooled by paddock, and hand-sorted for botanical composition assessment (grass, legume, and weed species, and unidentifiable plant debris). Samples were weighed, oven-dried for 48 h at 65°C (149°F), and re-weighed to determine the relative botanical contribution to the biomass of each treatment paddock. At this time, tall fescue tillers (100/paddock) were also collected from each paddock and analyzed for *Neotyphodium* endophyte using a Phytoscreen immunoblot kit (Agrinostics, Ltd. Co., Watkinsville, GA).

The Cornell Net Carbohydrate and Protein System was populated with nutrient analysis data from each paddock to determine required dry matter intake for lactating, fall-calving, beef cows (523 kg or 1150 lb shrunk body weight) and balanced with distillers dried grains (DDGS) to meet metabolizable energy requirements. The carrying capacity of each of the stockpiled paddocks was determined the available forage divided by the daily forage intake based on initial stockpiled forage biomass in October, adjusted for grazing efficiencies of 60% for spring strip-grazing, and 70% for summer strip-grazing and hay pastures. The carrying capacity of a drylot system, comparable to the summer hay treatment but without winter grazing of stockpiled forage, was calculated from the available forage biomass in October in hay treatment paddocks plus the amount of hay produced during the summer season, adjusted for harvest, storage, and feeding losses.

Economic assumptions were derived from the Ag Decision Maker website (Iowa State University Extension and Outreach, Ames, IA) to generate operational expenses associated with the different treatment models (Table 2). Gross feed costs ($/hd/d) included the cost of land rental ($52.00/ac), supplemental DDGS ($100.00/ton), fencing ($0.89/ft), custom hay mowing and raking ($20.55/ac), custom hay baling ($15.20/bale), fertilizer (urea = $296.50/ton; PO_4 = $444.00/ton; K_2O = $317/ton), and winter labor ($15/h; with either four hours per month allocated for electric fencing of strip-grazing paddocks or 0.5-h per hay bale fed to drylot cattle), all on a fixed land base (100-ac), divided by the calculated carrying capacity for a given model. Net feed costs ($/hd/d) were calculated as gross costs on a fixed land base (100-ac), less the opportunity cost of summer grazing ($26.00/AUM) or hay harvest ($62.5/ton), divided by the carrying capacity. Total costs ($/ac) were then calculated for each of the given systems.

Data were analyzed using the MIXED procedure in SAS (SAS Inst. Inc., Cary, NC) with repeated measures and a Tukey-Kramer adjustment for fixed effects of treatment, month, block, and their interactions.

Results and Discussion

Greater forage biomass was stockpiled after spring strip-grazing (155-d) than summer strip-grazing (80-d, $P < 0.05$) or hay harvest (66-d, $P < 0.05$; Figure 1). No interaction was detected between treatment and sample month. Yet, across treatments, greater forage mass was available in October than January ($P < 0.05$). There were no effects of stockpiling treatment ($P > 0.10$) nor treatment by month interactions ($P > 0.10$) on CP (Figure 2). However, across treatments, CP was greater in October than January ($P < 0.05$; Figure 2). There were treatment by month interactions for NDF ($P < 0.05$) and ADF ($P < 0.05$; Figure 3), most likely a reflection of varying weather conditions during the sampling period. Fiber components would be expected to steadily increase over the winter as a percentage of the total forage. Thus, the warm, wet winter with intermittent periods of freeze-thaw, causing additional leaching of soluble nutrients, likely generated the results seen in this study. There were no effects of stockpiling treatment ($P > 0.10$) or month ($P > 0.10$) nor treatment by month interactions ($P > 0.10$) for ADL (Figure 3). Forage stockpiled after spring strip-grazing had a lower IVDMD than summer strip-grazing ($P < 0.05$) or hay harvest ($P < 0.05$; Figure 4). Across treatments, IVDMD was lower in November ($P < 0.05$), December ($P < 0.05$), and January (*P*

< 0.05) than October. The percent of endophyte-infected tall fescue is presented in Table 1. Intake of forage and supplemental DDGS utilized to calculate carrying capacity are depicted in Figure 5.

Hay paddocks generated 2.76 tons of DM/ac at harvest and averaged 78% recovery after storage and weathering losses to yield 1.73 tons of DM/ac. At harvest, NDF and ADF concentrations of core samples were 61.2% and 34.7%, respectively, and 64.4% and 35.9%, respectively, in November. While NDF and ADF components of harvested hay were comparable to stockpiled forage, the IVDMD of harvested hay was less than summer strip-grazed and hay harvest paddocks, with an initial digestibility of 37.4% at harvest and 34.8% in November. Crude protein of harvested hay was also lower than stockpiled forage, at 9.9% in November.

Due to greater harvest efficiency, the carrying capacity of drylot models was greater compared to all other models ($P < 0.05$). However, carrying capacity did not differ between stockpile-grazing models ($P > 0.10$; Table 3). Neither gross nor net costs differed between models ($P > 0.10$). Although facility costs and manure spreading costs weren't included in the analysis, drylot models incurred greater ($P < 0.05$) total costs than stockpile-grazing systems. However, there were no significant statistical differences in total costs between stockpile-grazing systems ($P > 0.10$). While not statistically significant, numerical differences in net costs between systems ranging from \$0.03/hd/d to \$0.44/hd/d, were noted and could have implications for the economic viabilities of the different systems.

While initiating stockpiling with strip-grazing in spring returned greater forage biomass, the nutritional quality of this stockpiled forage was lower than summer treatments. Furthermore, because of the increased maturity of the stockpiled forage, cattle grazing forage stockpiled by spring strip-grazing are more likely to encounter problems associated with fescue toxicity, such as the sloughing of hooves and loss of tails. Compared to spring strip-grazing, the lower stockpiled forage biomass associated with summer strip-grazing or summer hay harvest are compensated for, at least in part, by greater stockpiled forage biomass. However, there were no differences in forage mass or nutritional quality of forage stockpiled either by strip grazing or hay harvest in summer. Although drylot systems had greater total costs, there were no differences in gross or net costs with the economic assumptions utilized in this study. However, costs related for facilities and manure hauling associated with the drylot system were not considered in the analysis. In addition, several factors should be considered when assessing the economic viability of production systems, such as changes in land costs and the availability of byproduct feeds. In this analysis, a land rental price of \$52.00/ac was assumed. If rental prices were to increase, the profitability of a stockpiling system may be more dependent on shear forage biomass generation than nutritional quality, favoring spring stockpiled forage grazing although the possibility of fescue toxicosis must be considered. However, if the availability of byproduct feeds, such as DDGS (assessed here at \$100/ton), was to diminish it would drive up the cost of supplemental feeds thus nutritional quality may be of more significance to winter feed costs and profitability.

Acknowledgements

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Figures and Tables

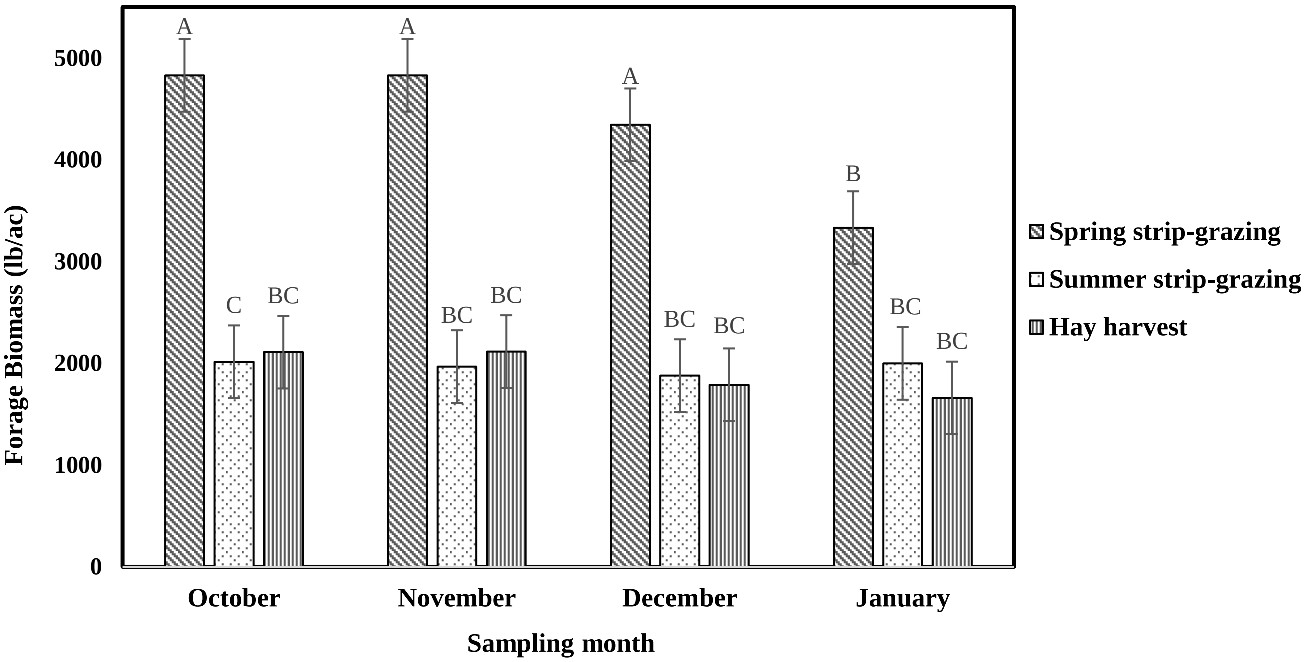

Figure 1. Biomass generated by stockpile treatments over winter sampling months during year 1 (2015-2016). Data presented as least square means. Error bars represent 2 times the standard error (n=3 for each mean). $^{A\text{-}C}$Least square means without common lettering differ ($P < 0.05$).

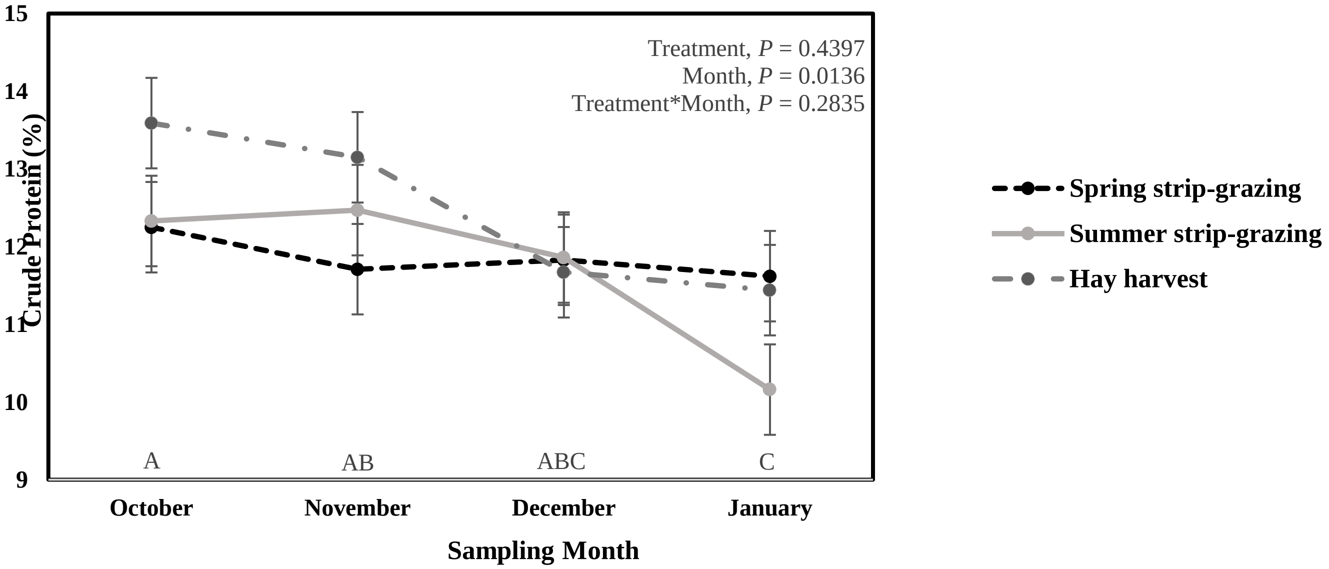

Figure 2. Crude protein content of stockpile treatments over winter sampling months during year 1 (2015-2016). Data presented as least square means. Error bars represent 2 times the standard error (n=3 for each mean). $^{A\text{-}C}$Sampling month least square means without common lettering differ ($P < 0.05$).

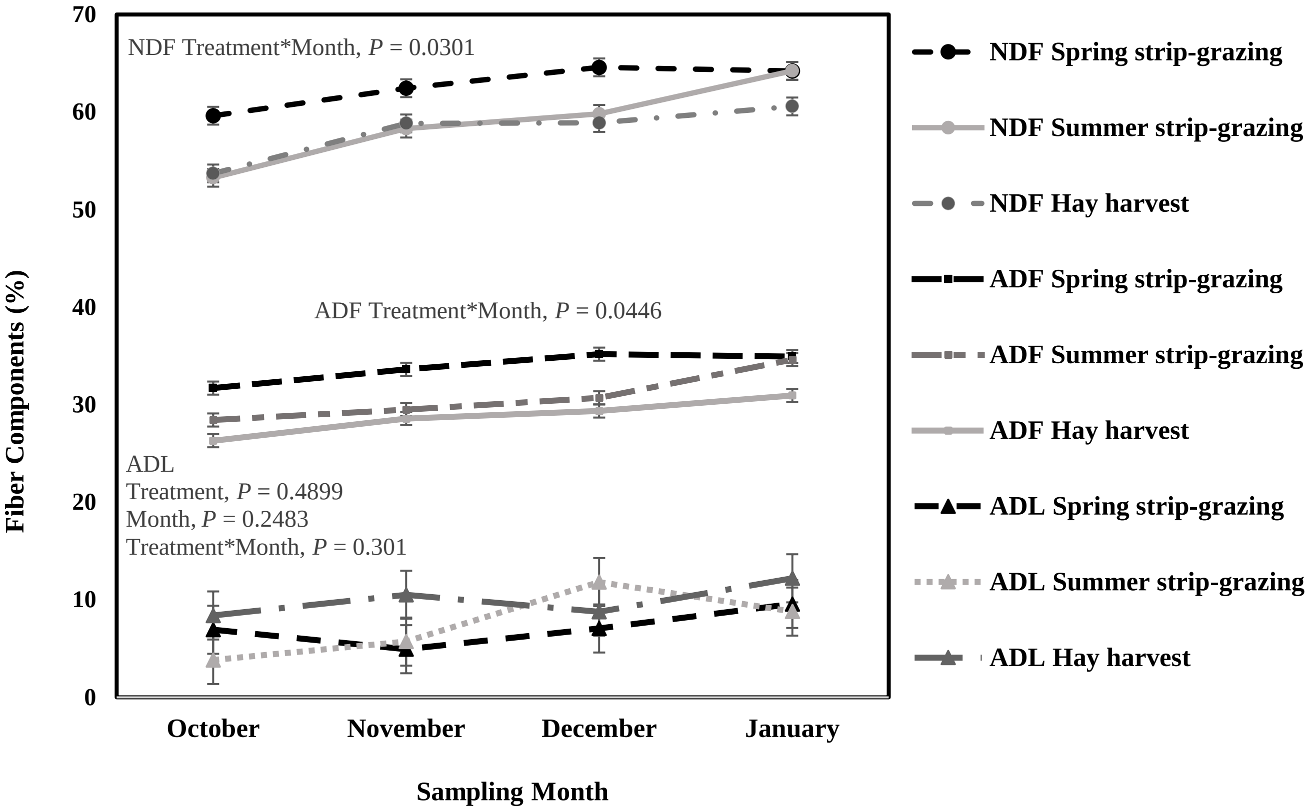

Figure 3. Fiber components (NDF, ADF, and ADL) of stockpile treatments over winter sampling months during year 1 (2015-2016). Data presented as least square means. Error bars represent 2 times the standard error (n=3 for each mean).

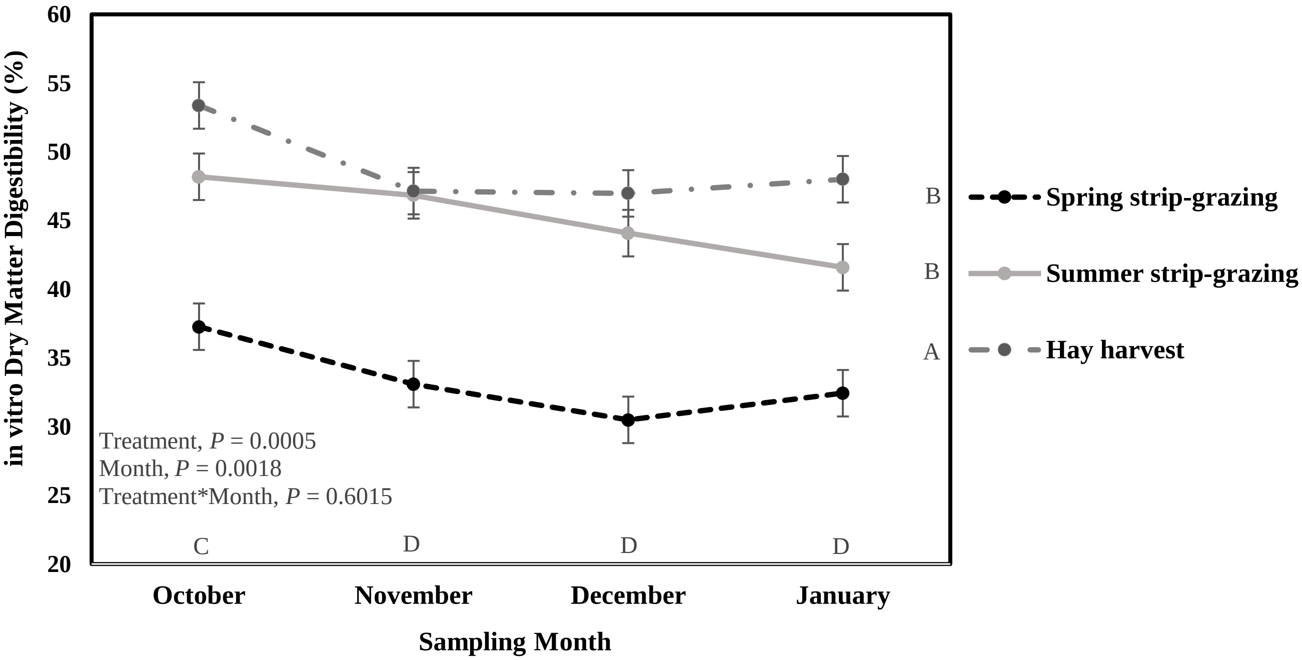

Figure 4. IVDMD of stockpile treatments over winter sampling months during year 1 (2015-2016). Data presented as least square means. Error bars represent 2 times the standard error (n=3 for each mean). $^{A-B}$Treatment least square means without common lettering differ ($P < 0.05$). $^{C-D}$Sampling month least square means without common lettering differ ($P < 0.05$).

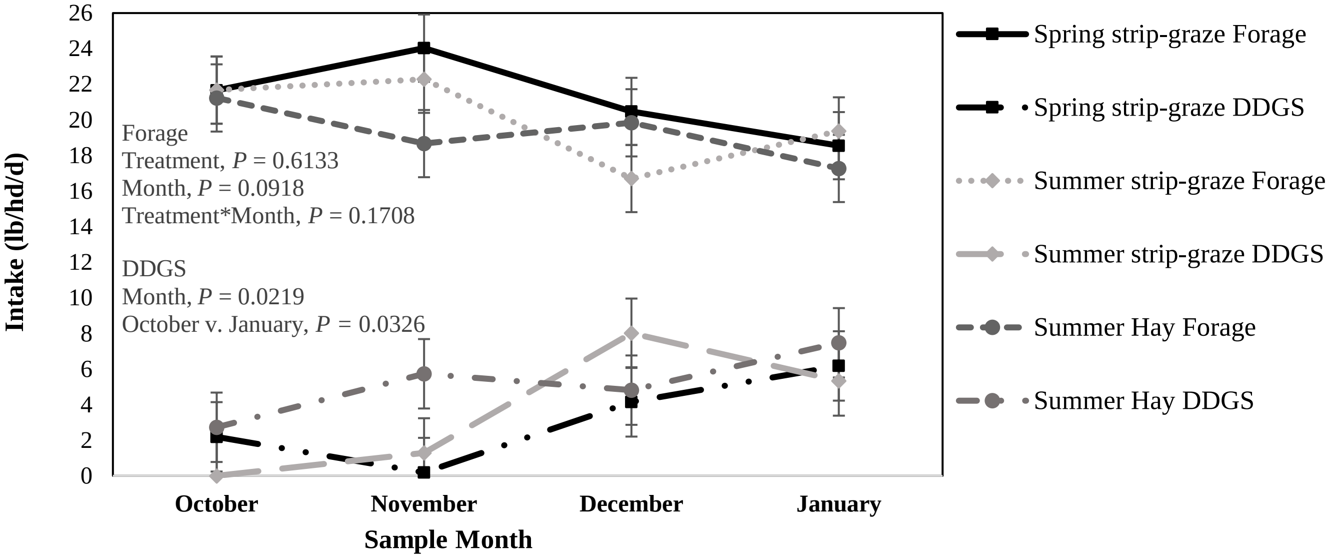

Figure 5. CNCPS Predicted intake of stockpiled forage with supplemental DDGS by treatment over winter sampling months during year 1 (2015-2016). Data presented as least square means. Error bars represent 2 times the standard error (n=3 for each mean).

Table 1. Proportion of stockpiled tall fescue tillers infected with endophytes[1]

Treatment	Endophyte infection (%)
Spring strip-graze	63.67
Summer strip-gaze	63.67
Summer hay harvest	65

[1] Data presented as sample means for each treatment (n=3).

Table 2. Variables utilized to calculate economic parameters[1]

	Treatment Model			
Variables	Spring strip-grazing	Summer strip-grazing	Summer hay harvest	Drylot
Harvest efficiency, %	60	70	70	78
Land rental				
Cost, \$*ac^{-1}	52	52	52	52
Acreage, ac	100	100	100	100
Total cost, \$	5200	5200	5200	5200
DDGS				
Cost, \$*ton^{-1}	100	100	100	100
Amount required, lb*hd^{-1}	3.2	3.7	5.2	5.3
Total cost, \$	2493.07	2128.91	1897.86	2210.13
Fence				
Price, \$*ft^{-1}	0.89	0.89	0.89	0.89
Amount required, ft	4174	4174	4174	0
Depreciation, yr	25	25	25	25
Total cost, \$	148.60	148.60	148.60	0
Custom hay mowing and raking				
Rate, \$* ac^{-1}	20.55	20.55	20.55	20.55
Acreage mowed, ac	0	0	100	100
Total cost, \$	0	0	2055	2055
Custom hay baling				
Rate, \$*bale^{-1}	15.20	15.20	15.20	15.20
Bales produced, #	0	0	105	143
Total cost, \$	0	0	1596.18	2185.94
Urea				
Amount applied, lb*ac^{-1}	100	100	100	100
Price, \$*ton^{-1}	296.50	296.50	296.50	296.50
Total Cost, \$	1482.50	1482.50	1453.83	1443.24
Phosphorous				
Price, \$*ton^{-1}	444	444	444	444
Loss, lb*ac^{-1}	0	0	2013.37	1470.16
P_2O_5 needed, tons	0	0	0.5537	0.4043
Total cost, \$	0	0	245.83	179.51
Potassium				
Price, \$*ton^{-1}	317	317	317	317
Loss, lb*ac^{-1}	0	0	2013.37	1470.16
K_2O needed, tons	0	0	1.21	1.66
Total cost, \$	0	0	384.48	526.55
Winter labor				
Price, \$*hr^{-1}	15	15	15	15
Total labor, hr	19.36	19.36	19.36	65.71
Total cost, \$	290.32	290.32	290.32	985.65
Summer grazing				
Days grazed, d	14	90	0	0
Total AUMs	38.46	143.90	0	0
Pasture rent, \$*AUM^{-1}	26	26	26	26
Total opportunity cost, \$	1000.05	3741.48	0	0
Hay sales				
Price, \$*ton^{-1}	62.50	62.50	62.50	62.50
Total yield[2], ton*ac^{-1}	0	0	73.51	0
Total opportunity cost[2], \$	0	0	3160.85	0

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[1] Data presented as means for each system (n=3).

[2] In the drylot model all hay harvested is assumed to be fed.

Table 3. Carrying capacity and economic estimates between winter feeding systems[1]

	Treatment					
Economic estimates	Spring strip-graze	Summer strip-graze	Summer hay harvest	Drylot	SEM[2]	*P-value*
Carrying Capacity, hd*ac^{-1}	0.8517^{A}	0.4957^{A}	0.4494^{A}	0.5511^{A}	0.085	0.1471
Gross Cost, \$*hd^{-1}*d^{-1}	0.7819^{A}	1.1756^{AB}	1.3477^{AB}	1.7979^{B}	0.097	0.0488
Net Cost, \$*hd^{-1}*d^{-1}	0.4105^{A}	0.6724^{AB}	1.5060^{AB}	1.7979^{B}	0.143	0.0519
Total Cost, \$*ac^{-1}	86.1445^{A}	48.4660^{A}	100.45^{AB}	148.52^{B}	5.349	0.0165

[1] Costs derived from unit costs found in Table 2.

[2] Mean standard error of least square means; n=3.

$^{A-B}$Least square means without a common letter differ ($P < 0.05$).