203

Sustainable intensification of grazing operations using targeted supplementation

Beck, PA[1*]; Grigsby, ZN[1]; Adams, JM[2]; Moffet, C[3]; and Gunter, SA[3]

*Corresponding Author: 201 Animal Science; Oklahoma State University, Stillwater, OK 74078; paul.beck@okstate.edu

[1] Oklahoma State University Department of Animal and Food Sciences, Stillwater, OK, USA;

[2] Texas A&M University Department of Animal Science, College Station, TX

[3] United Stated Department of Agriculture-Agriculture Research Service Oklahoma and Central Plains Agricultural Research Centre; Livestock, Forage and Pasture Management Research Unit, El Reno, OK, USA

Key words: Grazing steers, Supplementation, Bermudagrass, Native Range, Finishing

Abstract

These projects were conducted in the subhumid rangelands (Klemme Research Range [KLEMME]) and on introduced forages Oklahoma (Eastern Research Station [ERS]) USA. Targeted supplementation to increase performance of growing cattle, maximise production per hectare, and replace synthetic fertiliser on pasture. Treatments at Klemme included: 1) Positive Control (PC)– 1 kg daily supplementation with distiller's grains (DDGS) cubes in late summer, or 2) High Supplement (HS) - DDGS cubes offered at 0.75% of liveweight all summer with 33% increase stocking rate. Treatments at ERS included: 1) Fertilized Control (FC) - no supplementation on N fertilized pastures; 2) Fertilized Supplement (FS) – steers fed 1.2 kg/day supplemental DDG cubes on N fertilized pastures throughout the summer; or 3) High Supplement (HS) – steers supplemented DDG cubes at 0.75% of BW/d on unfertilized pastures.. The HS treatment increased LW gain/ha by 89% compared with PC at KLEMME and increased steer performance while replacing synthetic N inputs in FC and FS treatments at ERS. At KLEMME, calculated N use efficiency, N2O emissions, methane emissions, total CO2 equivalent emissions and CO2 equivalent emission intensity (kg/kg LWG) were decreased in HS. At ERS calculated N use efficiency, N2O emissions, total methane emissions total CO2 equivalent emissions and CO2 emission intensity were intermediate for HS, but CO2 equivalent emission intensity was improved. Performance of steers followed through finishing on high-concentrate diets were not affected by previous supplementation treatment during grazing and increased gains prefinishing resulted in similar carcass weights with decreased days on feed and 15% less total feed required for finishing without impacting carcass quality. Targeted supplementation has the potential to increase performance in intensified grazing systems, increase beef production per hectare, and reduce grazed forage and harvested feeds with the potential to reduce the overall environmental impact of beef production.

Introduction

Producers are under significant economic pressures to maximize production per acre, which can prove harmful to the range condition, when desired forage species are overgrazed and decline in the stand. Feeding high levels of supplemental feed based on corn co-products of the ethanol production industry can offset forage consumption by 0.5 to 0.55 kg per kg supplemented in grazing calves (Adams et al., 2022a) and lead to higher stocking rates, without reductions in forage mass and animal performance (Wallis et al., 2023).

Research examining subsequent feedlot performance and carcass quality as affected by stocker supplementation programs continues to be limited and generally inconsistent (Reuter and Beck, 2013). A novel extruded dried distillers grains (DDG) cube (MasterHand Milling, LLC; Lexington, NE) has recently reached the market in the Great Plains states, expanding the potential utility in feeding these byproducts without feedbunks and losses to wind. Therefore this project is proposed to investigate the impacts of DDG cube supplementation and increased stocking rates on performance, sustainability, and subsequent finishing performance of growing steers grazing native range in western Oklahoma (Klemme Research Range, Besse Ok; KLEMME) with comparison to similar projects conducted at the Eastern Research Station near Haskell OK, which is composed primarily of bermudagrass based pastures (ERS).

Methods

Klemme Range Research Station

Grazing trial was conducted Marvin Klemme Range Research Station (Klemme), near Bessie, Oklahoma (35°25’00.4” N, 99°03’42.6” W). This site is characterized by rolling Red Shale uplands (2 – 15% slopes) dissected by deep drainages with shallow Cordell silty clay loam soils, which are shallow (25 to 36 cm) and contain numerous rocky outcrops of hard red siltstone. These Red Shale sites support mixed-grass prairie as the potential climax natural vegetation (Gillen et al., 2000). The steers grazed for 130 days from mid May to early October each year and were follwed through finishing in a commercial feedlot.

In each year, 140 steers (BW = 240 ± 21 kg in yr 1 and 255 ± 19 kg in yr 2) were randomly allocated to the 6 pastures. Pastures were allocated to 2 supplementation treatments (n = 3 pastures/treatment), 1) Positive Control (PC) - steers were stocked at 2.4 ha/steer and provided with 2.26 kg of supplemental DDGS cubes on alternate days (daily supplementation rate of 1.13 kg/steer) only during the late summer; and 2) High Supplement (HS) – stocking rate of steers were increased by 33% (1.6 ha/steer) with supplemental DDGS cubes provided at a rate of 0.75% BW/d for the entire grazing season.

Eastern Research Station

Grazing trial was conducted at the ERS station in eastern Oklahoma, the methods and results of the grazing experiment are reported in Adams et al. (2022b). Briefly, each year, crossbred steers (n = 140) were assigned to pastures, and pastures were assigned to one of three treatments (n = 3 pastures/treatment); 1) Fertilized Control (FC) - steers grazed N fertilised pastures (112 kg N/ha) with no supplementation; 2) Positive Control (PC) – steers were supplemented DDG cubes at 1.2 kg/d prorated for 3-d/wk feeding on N fertilized pastures; or 3) High Supplement (HS) – steers were supplemented DDG cubes at 0.75% of BW/d prorated for 5-d/wk feeding on unfertilized pastures.

Subsequent Finishing

Following summer grazing at KLEMME and ERS, steers were transported to a commercial finishing operation (Buffalo Feeders LLC in Buffalo Oklahoma) to evaluate the carryover effects of summer supplementation on finishing performance and efficiency. Because of the size and scale of the pens in the commercial feedlot used for finishing the steers, the steers were comingled across treatments and pastures within the commercial scale pens to remove and confounding effect of pen allocation. Steers were transitioned to high concentrate finishing diets by

providing a starter and 2 step-up diets with progressively lower concentrations of roughage for 5 days each with 2 day rations blending between each step. Steers were fed until a targeted 1.5-cm backfat was reached at the 10th rib.

Calculations

Equations from Garrett et al. (2004), Guiroy et al. (2001), and Tedeschi et al. (2004) were used to estimate composition of BW and gain and to allocate individual DM intake (DMI) to steers within pens. This allowed for determination of feed efficiency (G:F), and days on feed required to reach 28% EBF during the finishing period for individual animals. Nutrient retention and greenhouse gas emissions were calculated as well, based on NASEM (2016) and IPCC (2007) equations. Net protein retained in LWG (NPg) and Net Nitrogen (NN, g/day) were used along with estimated N inputs to calculate N use recovery. Enteric methane and emissions were calculated using equations from the Intergovernmental Panel on Climate Change (IPCC, 2006). Methane emission conversion to CO2 equivalents were made using a conversion factor of CH4 $\times 25$ and Nitrous Oxide conversion to CO2 equivalents were made using a conversion factor of N2O $\times EF \times 298$.

Statistical Methods

Performance and calculated greenhouse gas emissions were analyzed for each location separately using the mixed procedure of SAS (SAS Inst. Inc. Cary, NC). The original pasture group was used as the experimental unit in this analysis, due to the comingling of cattle in pens for finishing. The fixed effects in the model included the supplementation treatment on pasture, the year and the year by treatment interaction. The random effect included pasture within each treatment by year. Least-squares means were separated using the predicted differences statement in SAS.

Results

Grazing Performance and Calculated Greenhouse Gas Emissions

At the KLEMME site, steers grazing native range with the HS treatment gained 0.12 kg per day more than PC (0.98 vs 0.87 kg/d, respectively), even though stocking rates of the HS was increased by 33%. This led to a 75% increase in LW gain/ha for HS (84kg/ha) compared with PC (48 kg/ha), which indicates that the increased feeding rate more than offset the reduction in forage availability and reduced grazing selectivity from the increased stocking rate. The increased performance lead to an increase in protein accretion by the steers improving N use efficiency, which reduced calculated N_2O emissions. There was no difference in calculated enteric methane production per steer, but total emissions (kg CO_2 equivalents/steer) and emission intensity (CO_2 Equivalent/kg LW gain) were less for HS than PC, which is related to the increased intensity of production in the HS treatment.

At ERS, supplementing at the high rate increased overall LW gain/d (0.87, 1.10, and 1.16 kg/d for FC, FS, and HS, respectively) and LW gain/ha (360, 458, and 487 kg/ha, respectively), indicating that supplementation rates offset the use of synthetic fertilizer for beef production. Nitrogen use efficiency was greater for FC than FS and HS, which did not differ. N_2O emissions were greater for FS than FC, while HS was intermediate. Calculated ruminal enteric methane production per steer was not different, but similar to N_2O emissions, Total emissions in CO2 equivalent per steer were greater for FS than FC with HS being intermediate. Due to the higher production in HS the emission intensity was lowest for HS compared with FS and FC which did not differ.

Finishing Performance and Calculated Greenhouse Gas Emissions

Steers from HS at the KLEMME range site were 25 kg heavier than PC at entry into the feedlot (393 kg vs 368 kg, respectively). The HS steers maintained this weight advantage by the time steers were reimplanted. Liveweight gain per day (1.5 kg/d) was not different during the finishing period, but Gain:Feed was greater for HS than PC. The lack of performance difference and reduced feed efficiency in PC are indications that there was no compensatory gain from the gain reduction on pasture for the PC steers. There was no difference between treatments in liveweight at harvest, hot carcass weight, backfat thickness or carcass quality, but PC steers took 27 more days to finish than HS (192 days vs 165 days, respectively). There was no difference in N use efficiency

during finishing buy N2O emissions, enteric methane and total emissions (CO2 equivalents, kg/steer) were reduced for HS compared with PC. Emission intensity (CO_2 Equivalent/kg LW gain) tended to be less for HS than PC.

Similar to KLEMME, for steers from ERS there was no difference in liveweight at harvest or hot carcass weight, but the FC took more days on finish than FS and HS. Nitrogen use efficiency was highest for FC, but total N2O and methane emissions (and thus Total Emissions, CO_2 equivalent/steer) were greater for FC than FS and HS.

Discussion

Producers in the USA are under pressures to maximize production by increasing stocking rates which can harm range condition and animal performance. A compact and durable DDG cube produced via a novel extrusion process improves utility in pasture supplementation by reducing wind loss and soil mixing, which is common when supplementing loose DDG in pasture settings. Feeding supplemental dried distiller's grains (DDGS) has been shown to offset forage consumption (Adams et al., 2022a) by 0.55 kg for each kg of DDGS cubes fed, which may allow for increasing stocking rates without impacting range condition. This research indicates that stocking rates can effectively be increased on native range pastures in the Southern Great Plains of the USA without reducing individual animal performance, thereby increasing total production per hectare. Replacement of synthetic N fertiliser without impacting pasture carrying capacity while increasing grazing performance is also a boon to sustainable grazing systems in introduced pastures.

Many producers are wary of adding weight gain while grazing steers fearing that additional gain prior to entering the feedlot will adversely affect finishing performance. In the current experiments, there were very little if any indications of compensatory growth in the control calves. The calves fed supplemented at the high rates in both experiments retained the advantages in weight during finishing and required less days on feed to reach the targeted finishing end point.

The increased performance while grazing to offset increased stocking rates (KLEMME) or reduced synthetic fertiliser use (ERS) reduced the environmental impacts of the grazing enterprise and these benefits carried over into the finishing phase of production by reducing feed use, days on feed, and greenhouse gas emissions.

Acknowledgements

The authors would like to acknowledge Charles Worthington, Superintendent of the Klemme Range Research Station; Rodney Farris, Superintendent of the Eastern Research Station, Dusty Turner, Masterhand Milling Inc, Lexington, NE; Tom Fanning, Manager of Buffalo Feeders, LLC. for their assistance in conducting these experiments. All animals and procedures used in this experiment were approved by the Oklahoma State University Institutional Care and Use Committee (IACUC protocol numbers AG-19-4 and AG-22-16).

References

Adams JM, Robe J, Grigsby ZN, Rathert-Williams A, Major M, Lalman DL, Foote AP, Tedeschi LO, Beck PA (2022a) Effects of supplementation rate of an extruded dried distillers' grains cube fed to growing heifers on voluntary intake and digestibility of bermudagrass hay. *Journal of Animal Science* 100:1-11.

Adams JM, Farris R, Clawson S, Ward E, Beck PA (2022b) Economic feasibility of extruded dried distillers grains cube as a supplement for beef steers grazing introduced mixed-grass pastures *Applied Animal Science* 38:518-530.

Adams JM, Tedeschi LO, Beck PA (2023) Impact of pre-finishing plane of nutrition of stocker steers grazing introduced pastures on finishing performance and efficiency *Applied Animal Science* 39:400-410

Garrett WN, Hinman N, Brokken RF, Delfino JG (1978) Body composition and the energy content of the gain of Charolais steers. *Journal of Animal Science* 47 (Suppl. 1):417 (Abstr.).

Gillen RL, Eckroat JA, McCollum III FT (2000) Vegetation response to stocking rate in southern mixed-grass prairie *Journal of Range Management* 53:471-478.

Guiroy PJ, Fox DG, Tedeschi LO, Baker MJ, Cravey MD (2001) Predicting individual feed requirements of cattle fed in groups *Journal of Animal Science* 79:1983-1995

IPCC. 2006 IPCC Guidlines for National Greenhouse Gas Inventories; Eggleston, H.S., Buendia, L., Miwa, K., Ngara, T., Tanabe, K., Eds.; National Greenhouse Gas Inventories Programme: Hayama, Japan, 2006.

Reuter RR, Beck PA (2013) Carry-over effects of stocker cattle systems on feedlot performance and carcass characteristics *Journal of Animal Science* 91:508-515

Tedeschi LO, Fox DG, Guiroy PJ (2004) A decision Support system to improve individual cattle management. 1. A mechanistic, dynamic model for animal growth. Agricultural Systems 79:171-204

Wallis BD, Gunter PA, Horn GW, Reuter RR, Arnall B, Warren J, Lancaster SR, Lancaster PA (2023) Replacing fertilizer with dried distillers' grains in stocker cattle systems on Southern Great Plains Old World Bluestem, USA Animals 13, 2904. https://doi.org/10.3390/ani13182904