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ESTIMATING THE SUPPLEMENT INTAKE, HAY REPLACEMENT VALUE, AND ECONOMICS OF A CORN DISTILLER'S GRAIN LICK-TUB SUPPLEMENT WHEN FED TO PRE- AND POST-CALVING BEEF COWS

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This cow (*n* = 108) supplementation study determined cow daily intake of a chemically hardened 28% crude protein (CP) distiller's dried grain with solubles (DDGS) lick-tub supplement, which subsequently replaced alfalfa-brome grass hay based on cow daily intake. For the 90-day study, a hay control group (CON) was compared to: 1) a pre-calving treatment (PRE-SUP) that consumed supplement for the entire study, and 2) a post-calving treatment (POST-SUP) that began receiving supplement after calving. Compared to the CON and POST-SUP treatments, PRE-SUP treatment cows consumed the least hay dry matter (DM) ($P < 0.01$) and a greater amount of total supplement ($P > 0.05$). Compared to the PRE-SUP treatment, POST-SUP cows consumed 41.9% more lick-tub supplement per day ($P > 0.05$) after calving. Cow starting, calving, and ending body weight (BW), and cow calving and ending body condition score (BCS) did not differ ($P > 0.05$). Post-calving cow BW gain and average daily gain (ADG) did not differ ($P > 0.05$). Ending rib fat thickness was greater for supplemented treatments compared to CON. Breeding cycle and total percent pregnant did not differ ($P > 0.05$). Supplementation cost was determined when fed pre- and post-calving. PRE-SUP was similar to POST-SUP, but PRE-SUP had more cost.

Key words: beef cows; distiller's dried grain with solubles; economics; hay replacement; lick-tub supplement intake; supplementation timing

ПРОЦЕНА НА ДОПОЛНИТЕЛНА КОНСУМАЦИЈА И ЕКОНОМИКА ПРИ ИСХРАНА НА ТОВНИ ГОВЕДА ПРЕД И ПО ТЕЛЕЊЕ СО ЗАМЕНА НА СЕНО СО ДЕСТИЛАТ ОД ПЧЕНКАРНО ЗРНО ДОДАДЕН ВО ВИД НА БЛОКОВИ ЗА ЛИЖЕЊЕ

Во оваа студија се определува дневниот внес на 28% суров протеински (CP) додаток подготвен хемиски од суви гранули со растворувач (DDGS) додаван кон дневната исхрана на крави (*n* = 108) во вид на блокови за лижење со цел постепено да го замени сеното од луцерка и класица (Bromus inermis) во дневната консумација на храната. Во текот на 90-дневното истражување контролната група крави (CON) која беше хранета со сено е споредена со 1) група крави пред отелување (PRE-SUP), кои овој додаток кон исхраната го консумирале во текот на целиот период на истражување, и 2) група крави по отелување (POST-SUP), кои почнале додатокот на исхрана да го консумираат по отелување. Споредено са CON и POST-SUP, групата PRE-SUP консумирала најмалку сува материја од сеното (DM) ($P < 0,01$) и поголема количина од вкупниот додаток ($P > 0,05$). Во споредба со PRE-SUP, групата POST-SUP консумирала 41,9% повеќе од блоковите за лижење ($P > 0,05$) по отелувањето. Немаше разлика ($P > 0,05$) во почетната телесна тежина на кравите, тежината при отелување и крајната тежина (BW), како и во почетната и крајната телесна состојба (BCS). Немаше разлика ($P > 0,05$) во зголемувањето на телесната тежина по отелување и просечниот дневен прираст (ADG). Крајната дебелина на сало до ребрата беше поголема кај кравите третирани со додатокот на исхрана во споредба со CON. Циклусот за размножување и вкупниот процент на бременоста не се разликуваа ($P > 0,05$). Трошоците за додатоците во исхраната беа пресметани за период пред отелување и по отелување. PRE-SUP беше сличен со POST-SUP, но во PRE-SUP имаше поголеми трошоци

Клучни зборови: крави за производство на месо; суви гранули со растворувачи; економија; замена за сено; внес на додаток во исхрана преку блокови за лижење храна; временски распоред за внесување додатоци во исхраната

INTRODUCTION

Precipitation shortage in the Great Plains region of the United States (US) is common and limits hay production. Manske et al. (2010) summarized precipitation shortage in western North Dakota during the grazing season from Apr. 15 – Oct. 15 each year for the 118 year period between1892 and 2009. Thirty-nine years were identified as being mild to severe drought. Selling cows to reduce the cow herd size or purchasing additional hay are two management decisions farm managers must make when hay supplies are inadequate. An alternative is to replace purchased hay with a nutrient-dense co-product such as distillers dried grains with solubles (DDGS).

Since hay shortages can be a problem in approximately one-third of the years (Manske et al., 2010), this study was conducted to estimate the quantity of hay that could be replaced using a non-forage experimental chemically hardened 28.0% CP corn DDGS lick-tub supplement. Corn DDGS are a nutrient dense source of protein and energy with high rumen escape properties (Holt and Pritchard, 2004; Lardy and Anderson, 2003; Klopfenstein et al., 2008; NRC, 1996). Although there is a large volume of research evaluating the use of DGGS for growing and finishing cattle in the US (Depenbusch et al., 2008; Klopfenstein et al., 2008; May et al., 2010; Uwituze et al., 2010), information on the effects of DDGS in gestating and lactating beef cow diets is meager (Radunz et al., 2010; Winterholler et al., 2012).

One method for delivering DDGS to gestating and lactating beef cows is to use a voluntary lick-tub system; however, the amount of supplement cows voluntarily remove can be variable. The objective, therefore, was to determine cow voluntary intake of chemically hardened DDGS-based lick-tub supplement fed to cows pre- and post-calving to determine the amount of hay that could subsequently be replaced and to determine the economics of replacement supplementation. Our hypothesis was that the replacement supplementation would not affect cow performance, ending 12^{th} rib fat thickness, reproductive performance or calf weaning weight.

MATERIALS AND METHODS

The field experiment was conducted at the Dickinson Research Extension Center (DREC) Ranch Headquarters (14º11’40”N 102º50’23”W) located approximately 35 km north of Dickinson, North Dakota, USA, in accordance with guidelines approved by the North Dakota State University Institutional Animal Care and Use Committee (Approval Number A0808).

Experimental design and animals

To determine voluntary consumption of the lick-tub supplement and subsequent hay replacement, 108 multiparous (3–10 year old) beef cows were randomly assigned in an 90-day study to the following treatments: 1) an all hay control diet (CON), 2) hay reduction based on voluntary DDGS lick-tub supplement intake beginning 56-days pre-calving (PRE-SUP) and fed continuously to the end of the study, and 3) hay reduction based on voluntary DDGS lick-tub supplement intake beginning when the first cow calved (POST-SUP) and fed to the end of the study, a period of 34-days. Each treatment group consisted of 4 pens (weight blocks: light, medium, medium-heavy, and heavy) with 9 cows per pen; 36 cows per treatment.

Supplement and diet energy balance

The lick-tub supplement was a chemical reactive-agent hardened proprietary formulation prepared by Ridley Nutrition Solutions (Mankato, MN, USA) and was fed with unrestricted access in plastic 90.8 kg tubs according to the supplementation protocols for the PRE-SUP and POST-SUP treatments. Medium-quality, alfalfa-brome grass mixed hay (*Medicago sativa–Bromus inermis*) was fed throughout the study and the diets were calculated to contain a DM energy balance across treatments. The hay fed to each pen of cows was weighed and fed daily using a Haybuster Bale Processor (Dura Tech Industries International, Inc., Jamestown, ND, USA 58401) equipped with a Digi-Star EZ 2000 electronic scale (Digi-Star, LLC, Fort Atkinson, WI, USA 53538). Hay orts (feed not consumed) were collected and weighed weekly, and the DM content determined. The amount hay DM removed was deducted from the total DM delivered to each pen of cows to determine the net dry matter intake (DMI).

In accordance with the research objective, which was to determine the amount supplement the cows would voluntarily remove from the experimental, chemically hardened, DDGS supplement, and to respond by reducing the amount of hay DM fed to the cows accordingly, a beginning DMI level had to be established. Therefore, it was estimated that the cows would voluntarily lick and consume an average 0.272 kg of supplement/day. Using this initial DDGS lick supplement DMI and the corresponding energy value of the alfalfa-bromegrass hay, the estimated starting DMI for each pen weight block was determined using the following Nutrient Requirements of Beef Cattle (NRC, 1996) DMI formula: $DMI = (SBW^{0.75} \times (0.04997 \times NE_m^2 + 0.04361)/NE_m)$ (TEMP 1) (MUD 1) + 0.2 Yn), where $SBW^{0.75}$ is shrunk body weight (0.95 × BW, kg) and NEm of 1.15 Mcal/kg.

In the DMI formula, net energy for maintenance of 1.0 Mcal/kg of diet was arbitrarily selected as the starting energy basis and milk production, Yn, was set at 1.23 kg, which was estimated to typify the milking ability of cows used in the experiment to balance energy across treatment weight blocks. In western North Dakota, USA, mud is rarely an issue; therefore, there was no adjustment for mud, which was set at 1.0. The initial daily weight block energy was calculated to be 13.24, 13.96, 14.31, and 15.07 Mcal/cow/day for the light, medium, medium-heavy, and heavy weight blocks, respectively. Lick-tubs were weighed initially, weekly, and full lick-tubs were added weekly to ensure that the supplement was always available for voluntary consumption. After the initial DMI energy balance was established, weekly supplement consumption was the basis for adjustments to the amount of hay fed during the following week. In addition to hay adjustments for supplement consumption, the amount of hay fed was also adjusted for ambient temperature. During the experiment, the average minimum temperature ranged from 1.0 to –12.0º C and the average high temperature ranged from 15.0 to –4.0º C. Periods of very cold temperatures were encountered between January and March and ranged between –21 to –27º C. This was anticipated, therefore, dry matter intake was adjusted at the beginning of each week for temperatures based on the local weather forecast for the upcoming week. The percent adjustment to hay DMI was as follows: –12.2º C and above – no increase, –12.2º C to –15.0º C + 7% increase, –15.0º C to –17.8º C +10% increase, –17.8º C to –23.3º C +16% increase, and –23.3º C to –28.9º C +20.0% increase (NRC, 1996).

Forage and supplement composition

The bales fed were core sampled, composited weekly, and analyzed by a commercial laboratory for CP, neutral detergent fiber (NDF), acid detergent fiber (ADF), in vitro dry matter disappearance (IVDMD), in vitro organic matter disappearance (IVOMD), calcium (Ca), and phosphorus (P) (Ag-Source Soil and Forage Laboratory, Bonduel, WI, USA); (Table 1). Before the initiation of feeding, the experimental lick-tub type supplements were core sampled and analyzed for CP, NDF, ADF, IVDMD, IVOMD, Ca, and P at the North Dakota State University Nutrition Laboratory (Table 1). Samples were analyzed in duplicate according to the Association of Official Analytical Chemists (AOAC, 2010) for DM by drying at 135º C (AOAC method 930.15), CP (AOAC method 2001.11), and calcium and phosphorus (AOAC methods 968.08 and 965.17). Laboratory analysis for NDF and ADF were based on the procedure of Goering and Van Soest (1970) and IVDMD and IVOMD analysis was based on the procedure of Tilley and Terry (1963).

Table 1

Dry matter hay and 28% CP corn DDGS lick-tub supplement nutrient analysis (%)

	Alfalfa-Brome hay	28.0% CP corn DDGS lick-tub supplement
CP	13.3	27.78
TDN	58.0	80.46
NDF	58.5	12.85
ADF	39.7	2.54
IVDMD*	69.6	85.75
IVOMD**	68.4	63.39
Ca	0.95	9.62
P	0.28	1.52

*In vitro Dry Matter Disappearance.
**In vitro Organic Matter Disappearance.

Measurements

Measurements of cow performance included BW, ADG, BCS, 12th rib fat thickness, and for calf performance, birth weight, age at weaning, weaning body weight, and body weight gain/day of age was determined.

Cows in the study were bred naturally using fertility tested bulls and the subsequent breeding cycle pregnancy rate, number of non-pregnant cows, and the total number of pregnant cows within treatment was determined using transrectal ultrasound cranial width measurements taken 30 days after the end of a 45 day breeding season using an Ausonics Impact VF1 ultrasound machine (Ausonics International Inc., 2860 De La Cruz Blvd., Santa Clara, CA USA 95050) and 6.0 MHz convex rectal probe (Universal Medical Systems, Inc., 299 Adams St., Bedford Hills, NY USA 10507).

The average of two consecutive cow weights were taken at the start and end of the study. Coinciding with cow BW recording, the cows were scored for body condition (e.g., BCS: 1 = emaciated, 9 = obese; Wagner et al., 1988) at the start, calving, and at the end of the study with two evaluators, and fat thickness collected between the 12th and 13th ribs was measured at the start and end of the study using an Aloka 500 real-time ultrasound machine. The ultrasound machine was equipped with a 17 cm probe, standoff, PXC200 frame grabber, and UISC-USB-2820 Capture Technology (The National CUP Lab & Technology Center, Ames, Iowa, USA 50010).

Within 24 hours of birth, the calves were processed, which included collection of birth weight, fitting of a visual identification ear tag, navel iodine dip, and application of emasculator bands to bull calves. At seven weeks of age, the calves were vaccinated with One Shot Ultra® 7 (Zoetis 100 Campus Drive, Florham Park, NJ 07932, Tel: +1 973.822.7000).

Economic analysis

For the economic analysis in this study, a 100 cow reference herd is used to illustrate the net cost/cow when using a 28% CP corn DDGS lick-tub supplement as a replacement for hay and is expressed in U.S. dollars. In the analysis, hay was priced at $0.06615/kg, lick-tub supplement was priced at $0.6064/kg, and the supplement delivery cost was $0.0132/kg. The combined cost for supplement and delivery was $0.6196/kg.

Statistical analysis

The data was analyzed using the generalized least squares MIXED analysis procedure of SAS (SAS, 2002). Main effects included dietary treatments (fixed) and pen (random) served as the experimental unit. Cow gestation interval (days) was used as a covariate to adjust cow starting, calving, and ending BW. Calving interval (days) from calving to the end of the supplementation period was used as a covariate to adjust post-calving cow BW loss and ADG. An unequal number of bull and heifer calves were born; therefore, sex of calf within treatment groups was evaluated as a covariate and was found to be not significant with respect to rebreeding performance in the investigation. Therefore, the covariate was removed from the model. Least square means were used to partition treatment effects and differences were considered significant at $P \leq 0.05$.

RESULTS

Hay and lick-tub intake

Hay and lick-tub consumption during the 90 day experiment have been summarized in Table 2. According to the research design, the amount of daily hay provided was reduced in response to the amount of supplement the cows removed licking on the supplement surface. Supplemented cows provided access to the 28% CP corn DDGS lick-tub supplement consumed less hay DM than the CON cows ($P < 0.01$). Comparing the PRE- and POST-SUP treatments, PRE-SUP cows consumed the least amount of hay DM ($P < 0.01$) and a greater amount of supplement ($P < 0.05$). Cows in the POST-SUP treatment consumed less total supplement per cow for the entire 90 day study, but during the period after calving, when POST-SUP supplementation began, daily consumption was 42% greater ($P > 0.05$) than the PRE-SUP cows. The observed increase in consumption is an animal response resulting from no prior acclimation to the DDGS lick-tub supplement (NRC, 1996).

Table 2

Cow dry matter intake of hay and 28% CP corn DDGS lick-tub supplement (n = 36)

	Treatments[1]			
	CON	PRE-SUP	POST-SUP	SEM[2]
Dry matter intake hay (kg/cow)***	1616.4a	1539.3b	1574.7c	34.6
Hay (kg/cow/day)***	18.58a	17.68b	18.10c	0.40
DDGS-based lick-tub supplement fed (d)	–	89.5	33.5	–
Supplement (kg/cow)*	–	24.48a	12.97b	4.52
Supplement (kg/cow/day)*	–	0.2735a	0.3872b	0.072

[1]Treatments: CON = all hay; PRE-SUP = reduced hay and DDGS lick-tub for 90 days; POST-SUP = reduced hay and DDGS lick-tub for 34 days after calving.

[2]SEM pooled standard error of the mean.

*Means with unlike superscripts in a line are statistically different at ($P < 0.05$).

***Means with unlike superscripts in a line are statistically different at ($P < 0.01$).

Animal performance

Cow, calf, and reproductive performance have been summarized in Table 3. Covariate analysis of cow starting, calving, and ending BW did not differ ($P > 0.05$) among treatments. However, when considering cow weight change between calving and the end of the supplementation period, cow BW declined, but the treatment difference was not significant ($P > 0.10$). Beginning, calving, and ending BCS also did not differ ($P > 0.10$) among treatments. Ending external fat thickness over the 12th rib was greater for the supplemented treatments than for CON ($P < 0.05$). When comparing the average fat thickness of the supplemented cows with that of the CON cows, fat thickness of the CON cows was 41.0% less.

T a b l e 3

Pre- and post-calving cow, calf, and reproductive performance following hay replacement with a voluntary intake 28% CP corn DDGS lick-tub supplement (n = 36)

	Treatments[1]			
	CON	PRE-SUP	POST-SUP	SEM[2]
Cow performance				
Gestation interval (d)	218.1	220.6	224.1	2.13
Start BW (± SE kg)	690.0±25.90	685.3±25.87	677.4±25.93	
Calving BW (± SE kg)	673.8±28.77	682.7±28.44	676.9±28.84	
End BW (± SE kg)	630.7±23.19	640.0±22.95	640.9±23.24	
Calving interval (d)	27.8	28.6	29.8	2.07
Post-calving cow gain (± SE kg)	–42.0±10.01	–44.0±9.89	–43.5±10.06	
Post–calving cow ADG (± SE kg)	–1.55±0.409	–1.74±0.405	–1.41±0.411	
Cow BCS[3]				
Start	6.39	6.42	6.39	0.233
Calving	6.39	6.47	6.47	0.223
End	5.75	6.06	5.83	0.317
Cow BCS Change	–0.64	–0.36	–0.56	0.133
12th Rib Fat thickness (mm)				
Start rib fat thickness (mm)	5.86	5.91	6.03	0.702
End rib fat thickness (mm)*	3.58a	5.09b	5.00b	0.867
Calf performance:				
Birth BW (kg)	44.6	43.1	43.0	1.06
May turnout BW (kg)	77.3	79.4	79.4	3.17
Age at weaning (d)***	187.8a	190.6b	193.2c	2.44
Weaning BW (kg)	292.6	292.2	290.6	6.21
BW gain/d of age (kg)	1.32	1.31	1.28	0.023
Reproductive performance (%)				
1st Breeding cycle	52.8	38.9	55.1	11.14
2nd Breeding cycle	23.4	38.9	24.9	5.83
3rd Breeding cycle	21.3	19.4	13.4	7.85
Non-pregnant	2.8	2.8	6.7	3.19
Overall pregnancy	97.2	97.2	93.6	3.13

[1]Treatments: CON = all hay; PRE-SUP = reduced hay and DDGS lick-tub for 90 days; POST-SUP = reduced hay and DDGS lick-tub for 34 days after calving.
[2]SEM_pooled standard error of the mean.
[3]Body condition score (1–9 scoring system)
*Means with unlike superscripts in a line are statistically different at ($P < 0.05$).
***Means with unlike superscripts in a line are statistically different at ($P < 0.01$).

Hay and lick-tub supplement feeding was terminated the first week of May when the cows and their calves were combined into a single group and moved to crested wheatgrass pasture, and subsequently to native range pastures the 3rd week of June. Calf birth weight (P > 0.10), calf BW at May turnout (P > 0.10), and weaning BW (P > 0.10) did not differ; however, calf age at weaning was greater for the POST-SUP treatment (P < 0.001).

There was an unequal number of steer and heifer calves in the treatment groups after calving (CON: 23 bull, 13 heifer; PRE-SUP: 19 bull, 17 heifer; POST-SUP: 12 bull, 24 heifer). Therefore, treatment sex of calf was evaluated as a covariate and found to be non-significant with respect to cow rebreeding performance. First (P > 0.10), second (P > 0.10), and third (P > 0.10) breeding cycle pregnancy rates did not differ (Table 3). The number of non-pregnant cows (P > 0.10) and the total percent pregnant (P > 0.10) did not differ between CON and supplemented treatments.

Economic analysis for the supplementation strategies compared in the study has been summarized in Table 4. Using the local hay price of $0.06615/kg for hay and $0.6196/kg as the delivered price for the 28% CP corn DDGS lick-tub supplement, the ingredient cost of the supplement was 9.4 times more expensive than hay, which is common for nutrient-dense protein-energy self-fed lick-tub supplements. For a 100 head cow herd, feeding the 28% CP corn DDGS supplement for the full 90 day feeding period cost $1,006.76 for the PRE-SUP treatment compared to $527.78 for the POST-SUP treatment; an additional cost of $478.98, or $4.78/cow.

Table 4

Treatment economic analysis for a 100 cow reference herd[1]

	Treatments[2]		
	CON	PRE-SUP	POST-SUP
Hay intake/cow (kg)	1616.4	1539.3	1574.7
Hay intake/100 cows (kg)	161640	153930	157470
Hay cost/cow ($)*	106.92	101.82	104.17
Hay cost/100 cows ($)*	10,692.49	10,182.47	10,416.64
Supplement intake/cow (kg)	–	24.48	12.97
Supplement intake/100 cows (kg)	–	2448	1297
Supplement cost/cow ($)**	–	15.17	8.04
Supplement cost/100 cows ($)**	–	1,516.78	803.62
Total cost/100 cows ($)	10,692.49	11,699.25	11,220.26
Difference compared to CON ($)	–	1,006.76	527.78
Cost difference (%)	–	+9.4	+4.9

[1]All values are U.S. dollars
[2]Treatments: CON = all hay; PRE-SUP = reduce hay and DDGS lick-tub for 90 days; POST-SUP = reduced hay and DDGS lick-tub for 34 days after calving.
*Hay cost $0.06615/kg
**Supplement cost = $0.6064/kg, delivery cost $0.0132/kg

DISCUSSION

Multiparous third trimester gestating beef cows that voluntarily consumed the lick-tub supplement, for either the full 90 day period or for 34 days after calving, received an energy balance across treatments that was similar, as evidenced by cow calving BW, ending BW, and ending BCS. However, ending ultrasound fat thickness would indicate that the supplemented cows received a greater amount of energy, which was not detected with our visual BCS.

Body condition scoring has been used extensively in the beef cattle industry as a tool to ensure cows are in the best possible condition at the start of the breeding season (Houghton et al., 1990). Research has shown that body reserves at calving affect the postpartum interval (Wiltbank et al., 1961) and the interval from calving to first estrus and pregnancy rates are directly affected by cow BCS at calving and at breeding (Richards et al., 1986; Selk et al., 1988). Richards et al. (1986) evaluated BCS and suggested that a moderate BCS of 5 (e.g. BCS: 1 = emaciated, 9 = obese; Wagner et al., 1988) would be the most functional target BCS for mature beef cows at calving. Morrison et al. (1999) evaluated the effect on postpartum interval when low and high BCS cows were fed to either gain or lose BW to attain BCS of 5 at calving and concluded that large prepartum body reserve changes during the third trimester did not negatively affect reproductive performance. In the present study, ending BCS was 5.75, 6.06, and 5.83 for CON, PRE-SUP, and POST-SUP treatments, respectively, which would be supportive for subsequent reproductive performance and agrees with the work of Morrrison et al. (1999). The quantitative and significant ultrasound ending rib fat thickness difference, that was identified between the CON and supplemented cows, did not have a negative influence on pregnancy rate as evidenced by the reproductive performance of the CON cows compared to the supplemented cows (Table 3). Body reserves, as indicated by BCS across treatments that was greater than 5, suggest that voluntary PRE-SUP and POST-SUP intake of the DDGS lick-tub supplement supplied adequate energy for hay replacement leaving the cows in moderate BCS and well prepared for postpartum uterine involution and subsequent rebreeding performance.

Engel et al. (2008), in a 2 year experiment in western South Dakota, fed beef heifers a mixed grass hay (crested wheatgrass, western wheatgrass, and alfalfa) diet and 3.80 (year 1) and 2.80 (year 2) kg/heifer/day of DDGS or a soybean hull control diet and evaluated the effects on animal and reproductive performance and on blood plasma concentrations of GH, IGF-I, and NEFA. The yearly DDGS diets were formulated to contain greater ether extract (3.6% in year 1, 2.1% in year 2) and undegradable intake protein (4.6% in year 1, 3.7% in year 2) than the soybean hull control supplemented diet. Both treatments influenced BW gain positively, but heifers receiving DDGS had greater positive BW improvement during the feeding period, and 10% greater pregnancy. The heifers used to evaluate DDGS supplementation during gestation by Engle et al. (2008), subsequently became primiparous lactating cows and the effect of DDGS positively influenced reproductive performance. In the current study, our data agrees with the findings of Engle et al. (2008). Although the lick-tub supplement provided a much smaller amount of DDGS/cow/day, maintaining balanced energy across treatments with the combination of corn DDGS from the lick-tub supplement and hay supported similar reproductive performance among CON, PRE-SUP AND POST-SUP treatments.

Providing least-cost balanced diets for gestating and lactating cows under all conditions is the underlying goal of the cattle producer. Our economic analysis of the supplementation strategies compared in this study show that late gestation and early lactating beef cows can be provided an energy balanced nutritional regimen after calving that will be as effective as feeding the supplement for the entire 90 day feeding period. However, under conditions when precipitation shortages severely limit hay production, the lick-tub system restricts the amount of supplement that can be fed and subsequently the amount of hay that can be reduced. Therefore, a supplementation strategy that not only provides an energy balanced diet, but can also replace a large quantity of winter forage would be a better option than using a lick-tub strategy based on the amount of supplement cows will remove by licking. Compared to the current lick-tub supplement study in which the amount of supplement available to the cows was dependent the cow's licking action on the tub surface, Senturklu et al. (2013, in review) investigated replacing large quantities of winter forage with a pelleted, nutrient dense, protein-energy supplement (field pea-DDGS-barley malt sprout). In the study, it was determined that 1 kg of supplement would replace 2.9 kg of forage without affecting subsequent cow reproductive performance. Moreover, while lick-tub supplements can effectively replace forage, as has been shown in the current study, lick-tubs become woefully inadequate when large quantities of forage must be replaced.

CONCLUSION

The experimental chemically hardened 28% CP corn DDGS lick-tub supplement was found to effectively replace hay up to the nutritionally equivalent amount of supplement that was removed by the cow's licking action on the tub surface without effecting cow ending BCS, rebreeding performance or calf weaning weight, and was more expensive than feeding an all hay diet. These data also suggest that when large quantities of forge must be replaced, due to limited forage resources, a lick-tub supplementation system will be inadequate; limiting the amount hay that can be replaced.

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