

# Influence of forage inclusion level on growth performance and feeding behavior in finishing steers

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*The objectives of this study were to determine the effects of forage inclusion level on growth performance, feeding behavior and carcass characteristics in finishing steers. These results indicate that a decrease in forage inclusion from 20 to 5 percent (dry-matter [DM] basis) in a finishing diet increases dry-matter intake (DMI), average daily gain (ADG) and the gain-to-feed (G:F) ratio, as well as DMI per meal.*

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## Summary

Forty-four steers ( $994 \pm 10.1$  pounds of body weight [BW]) predominately of Angus and Simmental origin were used in a randomized block design to determine the effects of forage inclusion level on growth performance and feeding behavior in finishing steers. Steers were fed dry-rolled corn-based diets that included a mixture of hay and corn silage as the forage source. Dietary treatments were 5, 10, 15 or 20 percent forage. Diets were fed for 84 days. Feed intakes and feeding behavior were measured using the Insentec system. A visit was defined as each time the Insentec system detected a steer at a bunk. A meal was defined as eating periods, which may include short breaks separated by intervals not longer than seven minutes. Animals were weighed the first two days, then every 28 days after that and, finally, the last two days of the study. Steers were slaughtered with an average weight of 1,375 pounds. We observed a linear decrease ( $P \leq 0.02$ ) in DMI intake, ADG and G:F as forage inclusion increased. The number of visits and meals per day and eating

time per visit, per meal and per day were not affected by forage inclusion. Feed DMI per visit did not differ among treatments, but the eating rate per meal decreased linearly ( $P < 0.001$ ) with increasing forage inclusion. The eating rate (pounds/minute) responded quadratically ( $P = 0.04$ ), with the fastest eating rate observed in the 10 percent forage treatment. Hot carcass weight and dressing percentage decreased ( $P = 0.02$ ) linearly as forage inclusion increased. These results indicate that a decrease in forage inclusion in a finishing diet increases DMI, ADG and G:F, as well as DMI per meal.

## Introduction

Modern feeding strategies require careful consideration of a variety of nutritional and management factors that affect feed efficiency, feeding behavior and overall gain. One such strategy is altering the forage-to-concentrate ratio within a diet. Past research has shown that a decrease in forage level has effects on feed efficiency and feeding behavior. Feeding diets with increasing forage levels could cause increases in rumination time and more visits to the feed bunk because

rumen fill may be achieved faster (Galyean and Defoor, 2003).

Increased roughage levels also could affect feed efficiency because energy in roughages is less readily available than in concentrates (Arelovich et al., 2008). Our objectives were to determine the effects of forage inclusion level on growth performance, feeding behavior and carcass characteristics in finishing steers.

## Experimental Procedures

All procedures with animals were approved by the NDSU Animal Care and Use Committee. Forty-four steers ( $994 \pm 10.1$  pounds of BW) predominately of Angus and Simmental origin were used in a randomized block design to determine the effects of forage inclusion level on growth performance and feeding behavior in finishing steers. Steers were fed dry-rolled corn-based diets that included a mixture of hay and corn silage as the forage source (Table 1). Dietary treatments were 5, 10, 15 or 20 percent forage (DM basis; Table 1). Diets were fed for 84 days.

Feed intakes and feeding behavior were measured using the Insentec system. A visit was defined as each time the Insentec system detected a steer at a bunk (Swanson et al., 2014). A meal was defined as eating periods, which may include short breaks separated by intervals not longer than seven minutes (Swanson et al., 2014). Animals were weighed the first two days, then every 28 days after that and, finally, the last two days of the study.

Steers were slaughtered at an average weight of 1,375 pounds. Hot

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**Table 1. Diet composition (%).**

Ingredient	Forage Inclusion, % of DM			
	5	10	15	20
Dry-rolled corn	77.5	70.0	62.5	55.0
Corn distillers grains + solubles	10.0	10.0	10.0	10.0
Grass/legume hay	2.5	5.0	7.5	10.0
Corn silage	5.0	10.0	15.0	20.0
Fine ground corn	2.06	2.06	2.06	2.06
Limestone	1.50	1.50	1.50	1.50
Urea	1.00	1.00	1.00	1.00
Salt	0.20	0.20	0.20	0.20
Concentrated separator byproduct	0.15	0.15	0.15	0.15
Vitamin premix <sup>a</sup>	0.01	0.01	0.01	0.01
Trace mineral premix <sup>b</sup>	0.05	0.05	0.05	0.05
Monensin premix <sup>c</sup>	0.02	0.02	0.02	0.02
Tylosin premix <sup>d</sup>	0.01	0.01	0.01	0.01

<sup>a</sup>Contains 48,510 kIU/kg vitamin A and 4,630.5 kIU/lg vitamin D.

<sup>b</sup>Contains 36.2 g Ca/kg DM, 25.6 g Cu/kg DM, 160 g Zn/kg DM, 65 g Fe/kg DM, 40 g Mn/kg DM, 1,050 mg/kg I, and 250 mg/kg Co.

<sup>c</sup>Contains 176.4 g/kg monensin.

<sup>d</sup>Contains 88.2 g/kg tylosin.

**Table 2. Nutrient analyses of total mixed diets fed to steers.**

Componenta	Forage Inclusion, % of DM			
	5	10	15	20
DM, %	65.8	76.4	70.2	65.8
OM, % of DM	95.6	95.1	94.8	94.2
CP, % of DM	14.5	14.4	13.4	13.9
NDF, % of DM	27.6	29.8	32.5	35.1
ADF, % of DM	8.19	10.7	13.3	15.7
Ether extract, % of DM	3.86	3.62	3.31	3.20
Ca, % of DM	0.69	0.79	0.72	0.80
P, % of DM	0.39	0.38	0.35	0.35

<sup>a</sup>ADF - acid detergent fiber; NDF - neutral detergent fiber; CP - crude protein; DM - dry matter; OM - organic matter.

**Table 3. Influence of forage inclusion level on growth performance in finishing steers.**

Item	Forage Inclusion, % of DM				SEM <sup>a</sup>	Contrast P		
	5%	10%	15%	20%		Linear	Quadratic	Cubic
BW, lb.								
Initial	990	977	999	1,014	20.5	0.32	0.49	0.66
Final	1,410	1,373	1,377	1,338	26.6	0.08	0.95	0.47
Gain	420	396	378	323	15.2	<0.001	0.30	0.51
ADG, lb.	5.1	4.8	4.6	4.0	0.18	<0.001	0.41	0.68
DMI, lb.	25.5	25.3	24.6	21.6	0.73	<0.001	0.07	0.62
DMI, % of BW	2.11	2.15	2.06	1.83	0.051	<0.001	0.01	0.92
G:F	0.197	0.187	0.184	0.178	0.0054	0.02	0.70	0.65
F:G	5.11	5.42	5.47	5.67	-	-	-	-

<sup>a</sup>Standard error of the mean (n = 11).

carcass weight was measured on the day of slaughter, and carcass measurements were measured following a 24-hour chill. Measurements taken were subcutaneous fat thickness at the 12th rib; rib-eye area (REA); marbling score; and kidney, pelvic and heart fat (KPH).

## Results and Discussion

We observed a linear decrease ( $P \leq 0.02$ ) in DMI intake, ADG and G:F as forage inclusion increased (Table 3). Past research has suggested increased DMI and poorer feed efficiency with increasing forage inclusion in the diet for finishing cattle (Galyean and Defoor, 2003). Perhaps the fiber characteristics of the forage source differed from other experiments.

Steers fed the 5 percent forage diet did not appear to exhibit any signs of acidosis, indicating this level of forage inclusion resulted in adequate buffering. The number of visits and meals per day and eating time per visit, per meal and per day were not affected by forage inclusion (Table 4). Feed DMI per visit did not differ among treatments, but the eating rate per meal decreased linearly ( $P < 0.001$ ) with increasing forage inclusion (Table 3).

The eating rate (grams/minute) responded quadratically ( $P = 0.04$ ), with the fastest eating rate observed in the 10 percent forage treatment (Table 4). This may suggest that the 10 percent forage inclusion rate resulted in a more optimal rumen environment, which may result in an increased intake rate.

Hot carcass weight and dressing percentage decreased ( $P = 0.02$ ) linearly as forage inclusion increased (Table 5). This likely was because of a decreased rate of gain and final

BW observed with increasing forage inclusion and because of increased rumen fill with increasing forage inclusion, respectively. Overall, these results indicate that a decrease in forage inclusion in a finishing diet increases DMI, ADG, G:F and DMI per meal and decreases hot carcass weight and dressing percentage.

### Literature Cited

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Swanson, K.C., A. Islas, Z.E. Carlson, R.S. Goulart, T.C. Gilbery and M.L. Bauer. 2014. Influence of dry-rolled corn processing and increasing dried corn distillers grains plus solubles. J. Anim. Sci. 92:2531-2537

**Table 4. Influence of forage inclusion level on feeding behavior in finishing steers.**

Item	Forage Inclusion				SEM <sup>a</sup>	Contrast P		
	5%	10%	15%	20%		Linear	Quadratic	Cubic
Eating events, no./d								
Visits	28.5	28.1	29.2	28.2	1.99	0.99	0.88	0.69
Meals	8.30	8.52	8.48	8.96	0.344	0.21	0.71	0.62
Eating time, min.								
Per visit	3.56	3.21	3.68	3.89	0.306	0.29	0.36	0.44
Per meal	12.1	10.4	12.0	11.8	0.63	0.81	0.27	0.07
Per day	98.9	88.2	101.4	103.7	4.82	0.21	0.18	0.11
Feed DMI, lb.								
Per visit	0.912	0.925	0.885	0.808	0.0610	0.21	0.46	0.95
Per meal	3.10	2.99	2.93	2.48	0.060	0.002	0.17	0.44
Per min (eating rate)	0.262	0.295	0.247	0.218	0.0143	0.007	0.04	0.12

<sup>a</sup>Standard error of the mean (n = 11).

**Table 5. Influence of forage inclusion level on carcass characteristics in finishing steers.**

Item	Forage Inclusion				SEM <sup>a</sup>	Contrast P		
	5%	10%	15%	20%		Linear	Quadratic	Cubic
Hot carcass weight	851	832	825	790	16.9	0.02	0.64	0.55
Dress, %	60.4	60.5	59.9	59.0	0.43	0.02	0.23	0.80
REA, in <sup>2</sup>	13.9	13.6	13.7	13.5	0.43	0.53	0.89	0.72
Back fat, in	0.370	0.390	0.398	0.378	0.0283	0.80	0.58	0.93
Marbling <sup>b</sup>	460	450	433	416	27.1	0.20	0.88	0.94
KPH, %	1.75	1.68	1.81	1.77	0.051	0.45	0.79	0.10
Yield grade	2.57	2.63	2.62	2.50	0.172	0.78	0.57	0.95

<sup>a</sup>Standard error of the mean (n = 11).

<sup>b</sup>400 = Small<sup>0</sup>, 500 = Modest<sup>0</sup>.