EXTENSION
BEEF CATTLE RESEARCH UPDATE
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Evaluation of the Effects of Corn Silage Maturity and Kernel Processing on Steer Growth Performance and Carcass Traits

Management decisions, such as silage harvest maturity, can affect the quality and yield of corn silage and impact performance in growing and finishing cattle. As silage harvest is delayed whole-plant yield and total digestible nutrients (TDN) in tons/acre increase. The increase in energy occurs because of grain development. The total amount of starch increases as the plant matures and since starch provides more than 50% of the energy in corn silage, this increase in starch content represents a large increase in total energy yield by harvesting corn silage with more maturity. However, as corn silage is harvested later in the harvest season with advanced maturity, whole plant neutral detergent fiber (NDF) decreases as well as NDF digestibility.

Corn silage is typically harvested between 65 to 70% moisture (30 to 35% dry matter, DM) which coincides with 1/2 to 2/3 milk line, or the point which starch has progressed 1/2 to 2/3 down the corn kernel. University of Nebraska research evaluated the effect of delaying corn silage harvest on performance and nutrient digestibility in growing and finishing feedlot diets.[1] In this research, corn silage was either harvested to mimic traditional corn silage harvested at 37% DM (~3/4 milk line) or a delayed harvest at 43% DM (black layer, 100% milk line). This research suggested delaying corn silage harvest increased corn silage yield and maximized grain yield and did not affect performance of finishing cattle. However, delayed silage harvest in growing cattle resulted in lower gains and efficiency, possibly due to increased starch or maturity leading to decreased NDF digestibility. Furthermore, delaying harvest maturity of corn silage can lead to packing density challenges, resulting in poorer aerobic stability.[2] This occurs because dryer corn does not pack well, producing more air pockets during packing. This may lead to poor fermentation causing higher DM losses (shrinkage), greater spoilage and poor bunk life.

Kernel processing of corn silage is a mechanical processing method used at the time of harvest to increase surface area to allow rumen microbes to act on the starch. Kernel processing serves to disrupt the tough pericarp structure to expose starch and lipids, as well as break up cobs and stems.[3] Research evaluating kernel processing effects on diet digestibility and growth performance has yielded inconsistent results with beef cattle.

Limited research has investigated the effects of corn silage harvest maturity in growing cattle diets and the interaction of harvest maturity and kernel processing of corn silage in finishing diets of feedlot cattle. Therefore, South Dakota State University conducted two experiments to investigate the effects of feeding kernel processed corn silage to growing calves (Experiment 1) and finishing beef steers (Experiment 2).[4]

In Experiment 1, 184 steers (initial shrunk body weight 856 lb) were used to evaluate the influence that kernel processing of corn silage has on production responses when fed at 65% diet inclusion (DM basis) during a 46-day growing period. Treatments were based upon corn silage that was either kernel processed or not. In this experiment, average daily gain and DM intake were increased ($P \leq 0.04$) by 6% (3.40 vs. 3.20 lb/day) and 2% (21.72 vs. 21.23 lb/day), respectively, in steers fed kernel processed corn silage compared to controls (Table 1). However, gain efficiency was not appreciably influenced by treatment ($P = 0.15$, 0.156 vs 0.151 for processed vs. controls).

Table 1. Growth performance responses for growing steer experiment[1].

	Kernel Processing		
Item[2]	No	Yes	P-value
Initial BW[3], lb	856	856	0.48
Final BW[3], lb	1005	1012	0.07
ADG, lb	3.20	3.40	0.04
DMI, lb	21.23	21.72	0.04
Gain:Feed	0.151	0.156	0.15

[1]Corn silage included in growing diet at 65% (dry matter basis) for 46-day growing trial.
[2]BW, body weight; ADG, average daily gain; DMI, dry matter intake.
[3]All body weight measures were shrunk 4% to account for digestive tract fill.
Adapted from Francis et al., 2023.

In Experiment 2, 192 steers (initial shrunk body weight = 981 lb) were used in a 112-day finishing experiment. Treatments were grouped in a 2 × 2 factorial arrangement to evaluate corn silage harvest maturity (1/2 to 2/3 milk line or black layer) and kernel processing (processed or not) at time of corn silage harvest on finishing steer growth performance and carcass traits when corn silage was fed at a dietary DM inclusion of 20%.

No interactions between harvest maturity and kernel processing were reported (P ≥ 0.12) for growth performance (Table 2). DM concentration of corn silage increased 14.2% as harvest maturity was delayed from 1/2 to 2/3 milk line to black layer (43.1 vs. 49.2%). No differences in growth performance or carcass traits due to harvest maturity were noted (Table 1). In addition, kernel processing of corn silage had minimal effects on animal growth performance and carcass traits and carcass traits in finishing steers.

Table 2. Growth performance and carcass trait responses for finishing steer experiment[1].

	Harvest Time[2]		Kernel Processing		P-values		
Item[3]	ML	BL	No	Yes	HT	KP[2]	Interaction
Growth Performance:							
Initial BW[4], lb	981	981	981	981	0.53	0.95	0.35
Final BW[5], lb	1572	1568	1581	1561	0.66	0.14	0.63
ADG, lb	5.29	5.23	5.34	5.16	0.60	0.12	0.55
DMI, lb	31.62	31.20	31.62	31.20	0.23	0.22	0.28
Gain:Feed	0.167	0.168	0.169	0.166	0.93	0.21	0.16
Carcass Traits:							
HCW, lb	983	979	988	975	0.66	0.14	0.63
Dressing, %	62.16	62.24	62.15	62.25	0.84	0.78	0.40
Rib fat, cm	0.61	0.64	0.64	0.61	0.22	0.25	0.43
Ribeye area, in^2	14.79	14.80	14.72	14.88	0.99	0.30	0.18
Marbling score[6]	541	564	554	551	0.17	0.84	0.98
Yield Grade	3.53	3.58	3.63	3.47	0.55	0.08	0.28

[1]Corn silage included in the finishing diet at 20% (dry matter basis) for 112-day finishing trial.
[2]HT, harvest time; ML, silage harvested at 1/2 to 2/3 milk line, BL, silage harvested at black layer; KP, kernel processing
[3]BW, body weight; ADG, average daily gain; DMI, dry matter intake; HCW, hot carcass weight
[4]Average of day -3 and day 1 BW; a 4% pencil shrink was applied to account for digestive tract fill.
[5]Final BW, HCW/0.625.
[6]Marbling score: 400 = Small^{00} (Minimum for USDA Choice)
Adapted from Francis et al., 2023.

In conclusion, the results showed that kernel processing of corn silage increased growth performance in growing steers at 65% dietary inclusion (DM basis). Thus, these researchers suggested that "by kernel processing corn silage, producers that feed diets with a high proportion of silage may realize increased growth performance over unprocessed corn silage". In contrast, corn silage maturity and kernel processing had minimal effects on finishing feedlot steer growth performance and carcass traits at 20% dietary DM inclusion.

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[3] Kozakai, K., T. Nakamura, Y. Kobayashi, T. Tanigawa, I. Osaka, S. Kawamoto, and S. Hara. 2007. Effect of mechanical processing of corn silage on in vitro ruminal fermentation, and in situ bacterial colonization and dry matter degradation. Can. J. Anim. Sci. 87:259–267.

[4] Francis, F. L., E. R. Gubbels, T. G. Hamilton, J. A. Walker, W. C. Rusche and Z. K. Smith. 2023. Evaluation of the effects of corn silage maturity and kernel processing on steer growth performance and carcass traits. J. Anim. Sci. 101. Available at: https://doi.org/10.1093/jas/skac321.