BEEF CATTLE RESEARCH UPDATE

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Optimal Flake Density of Corn for Feedlot Heifers

The increasing cost of natural gas and electricity greatly increases the cost of steam flaking grains for feedlots. Energy demand for flaking is inversely related to bulk density of flaked grain; lighter, more intensely processed flakes typically require longer steaming times and greater roll pressures which increase mill production cost. A 2007 survey of consulting feedlot nutritionists reported that the average bulk density recommended for steam-flaked corn was 27 lb/bu; however the most frequently recommended bulk density was 28 lb/bu.[1] Published research indicates that flaking corn to densities less than 28 lb/bu does not further improve feedlot performance.[2,3] However, little data is available that evaluates flaking corn less intensely (heavier densities).

Recent Kansas State University evaluated feed mill efficiency and cattle performance when corn was steam flaked to densities of 28, 32, and 36 lb/bu.[4] This study used 358 heifers (initial weight of 742 lb) fed a steam flaked corn based finishing diet (diet contained 83% corn on dry matter basis) for 115 days. As would be expected, increasing flake density decreased starch availability (Table 1). It was reported that as flake density increased, mill throughput (tons/hr) increased rather dramatically. In addition, increasing flake density increased the average particle size of flakes and improved durability of the flaked corn throughout the mixing process. However, these improvements in flake integrity did not improve cattle performance (Table 2). Increasing flake density tended to decrease gains and feed efficiency. These researchers reported with an estimated feed cost of $200/ton (dry basis) that the poorer feed efficiency observed with increasing flake density increased cost of production by 1 to 2¢ per pound of gain, equating to about 3 to 8¢ per head daily. Feed conversion becomes more important to the cattle feeder as the price of grain continues to increase. Any drop in feed conversion leads to increased cost of gains. These researchers concluded that the improvements in feed mill efficiency (reduced energy usage) observed with less intensely flaked corn did not offset increased cost associated with poorer feed conversions.

Table 1. Influence of flake density on starch availability and mill efficiency.

	Flaked Density, lb/bushel			P-Value
Item	28	32	36	Linear
Starch Availability, %	46.73	39.27	34.87	<0.01
Rate, tons/hour	2.22	2.45	3.40	<0.01
Mill Efficiency, %*****	100	114	152.8	-----
Particle Size, µm	6,163	6,565	7,000	<0.01

*****Efficiency is expressed as a percentage relative to grain flaked to a density of 28 lb/bu.
Source: May et al., 2008

Table 2. Influence of flake density on growth performance of feedlot heifers.

	Flaked Density, lb/bushel			P-Value
Item	28	32	36	Linear
Initial Weight, lb	740	742	745	0.51
Final Weight, lb	1069	1065	1060	0.43
Dry Matter Intake, lb	16.82	16.91	16.98	0.52
Daily Gain, lb	2.85	2.81	2.73	0.29
Feed/Gain	5.90	6.02	6.22	0.13

Source: May et al., 2008

Influence of Round Bale Storage Method on Hay Spoilage and Nutrient Content

Recent North Carolina research used large round hay bales (4 x 5 feet, ~700 lb) to determine the influence of storage system on spoilage, and changes in nutrient concentrations during long term storage.[5] In addition, these researchers conducted an economic analysis of hay storage under the various storage systems. In this study, cool season grass hay was baled in August (40 bales tied with net wrap) and allocated to five different storage systems: 1) stored on the ground without cover; 2) stored on wooden pallets without cover; 3) stored on the ground and covered with a tarp; 4) stored on wooden pallets and covered with a tarp; and 5) stored in a barn on pallets. The bales were sampled after 7 or 15 months of storage.

The effects of storage system and storage length on the hay are shown in Tables 3 and 5. Total hay dry matter losses (shrinkage and spoilage) were greater for bales stored without cover than for covered bales or bales stored in a barn (Table 3). As would be expected, losses generally increased as the storage period was extended. Storing bales on pallets had little effect on hay losses compared with storing hay on the ground. Possibly this occurred because the bales were stored on sloping ground that was well drained. The total losses for uncovered hay averaged about 23 and 31%, respectively, after 7 and 15 months of storage. These losses were generally greater than other researchers have seen probably because the total rainfall over 15 months was 69 inches (equivalent to about to about 4 to 5 yrs rainfall in the Oklahoma panhandle). Table 4 shows typical losses as published in an OSU fact sheet.[6] This fact sheet indicates that the lower value of each range (Table 4) represents well-formed bales located in areas such as northwestern Oklahoma with low rainfall (less than 25 inches annually) and low relative humidity. The higher values are for areas such as southeastern Oklahoma with high rainfall (greater than 40 inches annually) and high relative humidity.

Table 3. Total hay losses and estimates of the effective cost of hay stored in 1 of 5 different storage systems for 7 or 15 months.

Item	Ground No Cover	Pallet No Cover	Ground Cover	Pallet Cover	Barn
Total Hay loss, %					
7 month	24.2	21.2	12.1	7.9	2.7
15 month	29.8	31.6	19.3	12.0	10.2
Usable Hay Cost, $/ton*					
7 month	143.92	156.95	126.23	131.82	146.27
15 month	160.54	175.07	140.78	133.46	174.28

*Hay cost per ton of usable DM
Adapted from Turner et al., 2007

Table 4. Percent dry matter loss of round hay bales.

	Storage Period	
Storage Method	Up to 9 months*	12 to 18 months
Exposed		
Ground	5-20	15-50
Elevated	3-15	12-35
Covered		
Ground	5-10	10-15
Elevated	2-4	5-10
Under Roof	2-5	3-10
Enclosed Barn	Less than 2	2-5

*If used before spring warm-up.
Source: Huhnke, 2003

Concentrations of crude protein (CP) and fiber components (NDF and ADF) increased with increasing time in most storage systems (Table 5). However, CP concentrations were not affected by storage systems using pallets without cover and pallets in a barn. These researchers attribute the increase in concentrations in CP to weathering and rainfall. Other research (with legume hays) has shown that nitrogen is minimally affected by rain damage (minimal to no leaching) in wilting forages[7] and may actually increase after rainfall events.[8] This research has shown that the principle forage component that is leached by rain damage is nonstructural carbohydrate. Nitrogen (crude protein) leaches from the forage at a slower rate causing the proportion of nitrogen in the hay to increase. However, the protein that is lost due to leaching is soluble protein. Thus, a greater proportion of the protein remaining in the forage may he be bound to fiber (ADF) resulting in an increased amount of acid detergent insoluble protein.[8] The increase in concentrations of NDF and ADF is due to leaching of the more soluble forage components, primarily nonstructural carbohydrates. This increase in fiber concentration in the hay will likely reduce hay intake and digestibility by cattle.

A usable hay cost was calculated for each storage system taking into account production, labor, machinery, and building and operating and ownership costs (Table 3). The most economical storage systems in this study were storing hay covered either on the ground or on pallets.

Table 5. Changes in CP, NDF, and ADF for hay stored in 1 of 5 different storage systems for 7 or 15 months.

Item	Ground No Cover	Pallet No Cover	Ground Cover	Pallet Cover	Barn
CP, % of DM					
Initial	12.6	13.3	12.7	13.6	13.5
7 month	13.3	14.3	12.9	15.0	14.0
15 month	14.4	13.5	13.0	15.0	12.9
NDF, % of DM					
Initial	60.7	61.9	60.5	62.2	59.9
7 month	67.0	64.4	64.0	66.2	61.2
15 month	68.3	67.0	64.2	64.8	63.3
ADF, % of DM					
Initial	38.4	39.5	37.5	38.0	38.8
7 month	42.8	39.6	40.2	41.0	38.1
15 month	45.0	42.1	40.9	40.6	40.8

Adapted from Turner et al., 2007

In summary, these researchers concluded that storage systems for large round hay bales should consider climatic conditions, soil type and topography. In higher rainfall climates, the use of covers and pallets can provide comparable protection to barn storage. The most cost effective system depends on many factors including the type of storage system, length of storage, initial hay cost, and the relative cost of alternative storage systems. No single system will be most economical under all scenarios.

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