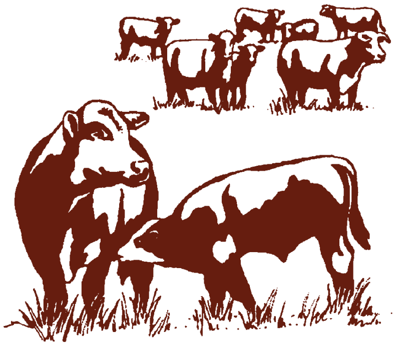

Beef Cattle Handbook

BCH-5112 Product of Extension Beef Cattle Resource Committee

Feeding Wheat to Finishing Cattle

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The price competitiveness of wheat as a feed grain is cyclical, and is historically dependent on factors affecting world supply and demand for wheat as a human foodstuff. Wheat generally becomes economically feasible to feed when the price per bushel is 108–115% that of corn, as a result of higher bushel weight and protein concentration. This generalized value is somewhat of a "moving target" as numerous factors affect the ability to utilize wheat in a specific feeding operation. Previously, it has been recommended that wheat not exceed 40–60% of the grain in finishing diets. This is because wheat has a very rapid rate of ruminal starch digestion (Table 1), which often results in low and erratic consumption patterns, reduced performance, and increased incidences of digestive disturbances compared to corn or sorghum grain. However, with proper management, wheat has been fed successfully at up to 100% of the grain in high concentrate rations in numerous research and commercial feedlot situations. Important factors to consider for successfully feeding high levels of wheat include processing methods, bunk management, and use of feed additives (ionophores, buffers, fat). Further, agronomic effects of wheat variety, growing conditions, test weight and kernel damage (sprouting) may affect feeding value.

Wheat Processing

Wheat must be properly processed to realize maximum feeding value. The unacceptability of feeding whole, unprocessed wheat was illustrated by Kansas workers (Table 2). Replacing 42% dry rolled wheat with whole wheat increased feed intake 18.2% and feed required per lb gain by 15.8%. Similar results were found in South Dakota and Tennessee studies (Burkhardt and Embry, 1970; Backus et al., 1980). These trials demonstrated that some destruction of the seed coat through processing must occur to allow ruminal and small intestinal digestive enzymes access to wheat starch and protein.

Although the kernel must be cracked or broken to allow maximum utilization, overprocessing with the attendant production of many fine particles is highly undesirable. If wheat is dry rolled, it should be rolled as coarsely as possible while still breaking essentially all of the kernels. Extensive processing increases the amount of fines or "flour" in the feedbunk, resulting in lower and more erratic feed consumption, and slower and less efficient gains. Grinding wheat in a hammermill for cattle should be avoided, if possible, because of excessive fines and dust. Tempering grain prior to dry rolling, or adding moisture, molasses, or fat on the feed truck or mixer wagon (particularly when dry roughages are fed) may help bind fines to roughage particles and aid in ration conditioning.

Table 1. In Vitro Starch Digestion Rate of Wheat and Corn (Kreikemeier, 1986)

	Trial A		Trial B	
	Wheat	Corn	Wheat	Corn
Digestion rate, %/hour[ab]	19.37	13.85	15.81	12.21

[a] *Wheat vs corn (P<.01).*
b Wheat, trial A vs trial B (P<.01)

Table 2. Wheat Processing Method and Finishing Steer Performance (Arnett, 1971)

Item	Processing Method				
	Dry Roll	Extruded	Whole	Flake	High Moisture
Daily gain, lb	2.92	2.86	2.98	2.94	2.91
Daily feed, lb[a]	21.4	22.0	25.3	21.9	21.5
Feed/gain	7.34	7.71	8.50	7.45	7.39

[a] *Air-dry basis. Rations contained 42% wheat, 42% flaked milo.*

Other processing options, including high moisture ensiling, reconstitution, extrusion and roasting, have shown no consistent nutritional benefit in Oklahoma and Kansas trials.

Numerous early studies have shown that steam-flaking wheat will not improve its feeding value since the starch is readily available, and requires no further gelatinazation or destruction of the minimal protein-starch matrix. Further, as with dry rolling, over processing by steam-flaking can increase ration fines with obvious negative consequences. However, recent Kansas research has suggested that steam-rolling wheat is beneficial (Table 3). Compared to dry rolled wheat, finishing heifers fed steam rolled wheat ate 3% more dry matter, resulting in daily gain and feed efficiency improvements of 8 and 4.8%, respectively. In a subsequent study, the rate of starch digestion for steam rolled wheat was greatly reduced compared to dry rolled wheat. Steam rolled wheat in these studies had a bulk density of 37– 40 lb/bushel, resulting in a thick, durable, crimped product rather than a true flake. It appears that cracking the wheat seedcoat without creating fines allows starch digestion to occur at a slower rate, thereby increasing performance while minimizing the incidence of subacute acidosis and other digestive disorders. Whatever processing method is used, the goal should be to maximize particle size while minimizing fines.

Table 3. Comparison of Steam Rolled (39-40 lb/bu) vs Dry Rolled Wheat on Animal Performance[a] and Rate of Starch Digestion[b]

Item	Dry Rolled	Steam Rolled	% Benefit
No. pens	8	8	
No. heifers	56	56	
In wt, lb	716	716	
Daily gain, lb	2.86	3.09	8.0
Daily feed, lb DM	18.25	18.79	3.0
Feed/gain	6.42	6.11	4.8
Rate of wheat starch digestion, %/h	21.3	6.1	

[a] *Brandt et al., 1988. Diets contained 81% wheat (dry basis).*
[b] *Kriekemeier et al., 1990. Measured using in situ techniques.*

Blends of Wheat and Other Feed Grains

Because of wheat's rapid rate of ruminal starch digestion, there has been considerable interest in blending it with more slowly fermented feed grains to optimize utilization and cattle performance. Fort Hays Station research (Brethour, 1966 and 1985) demonstrated that the feeding value of wheat was improved when fed in a 50:50 blend with corn or milo, but not with barley, whose starch is also rapidly degraded in the rumen. The average complimentary or "positive associative" effect for wheat blends was greater in milo than corn rations. Trials in several states have confirmed that the improvement in feeding value of wheat when fed in combination with more slowly fermented grains is modest, yet consistent. This probably reflects a reduction in the incidence of subacute acidosis more than improved grain utilization, although some studies with blends of milo and wheat (Axe et al., 1987) have shown slight improvements in starch digestibility. In a Kansas trial with flaked wheat and flaked milo (Brandt et al., 1986), a 50:50 blend of wheat and milo slightly improved intake and daily gain, but did not alter feed conversion compared to the flaked grains fed individually.

Dry-rolled wheat has also been fed successfully with bunker-ensiled high moisture corn, (Bock et al., 1991; Table 4), another grain with a very rapid rate of starch digestion. Positive associative effects on intake and gain for a 25% wheat blend was observed, and may be related to increased rumen fermentative efficiency, NPN utilization, and/or optimization of ration moisture content compared to the two grains fed singly. The negative effects of 50 and 75% wheat additions in this study were unclear, although cattle had more opportunity to sort these rations in the bunk.

Ionophores, Buffers and Fat in Wheat Rations

Ionophores are excellent management tools in all finishing programs to help prevent acidosis, bloat, and related digestion disturbances resulting from overconsumption of readily available carbohydrate. Kansas workers (Anderson et al., 1987) reported that Rumensin® plus Tylan® improved feed efficiency of steers fed rolled wheat diets by 7.1%, compared to a 3.1% improvement for steers fed rolled corn (Table 5). Responses by cattle to ionophores in high wheat rations are likely a combined effect of intake modulation (reduction in wide

Table 4. Associative Effects of High Moisture Corn (HMC): Dry Rolled Wheat (DRW) Combinations (Bock et al., 1991)

Item	100 HMC	75HMC: 25DRW	50HMC: 50DRW	25HMC: 75DRW	100 DRW
Daily gain, lb					
Observed[a]	3.58	3.82	3.14	3.07	3.30
Predicted[b]		3.52	3.44	3.38	
Assoc. effect[c]		.30	-.30	-.31	
Daily feed, lb DM					
Observed[a]	22.17	23.55	20.84	20.96	21.39
Predicted[b]		21.98	21.79	21.58	
Assoc. effect[c]		1.57	-.95	-.62	

[a] *Cubic effect (P<.05).*
[b] *Weighted mean of HMC and DRW fed singly.*
[c] *Observed - predicted.*

Table 5. Effect of an Ionophore or Buffer on Steers Fed Rolled Corn or Rolled Wheat Diets (Anderson et al., 1987)

	Corn diet				Wheat diet			
Item	Control	SS[a]	MT[b]	SS+MT	Control	SS[a]	MT[b]	SS+MT
Daily gain, lb[cd]	3.53	3.28	3.48	3.40	3.22	3.18	3.30	3.15
Daily feed, lb DM[cde]	20.7	19.8	20.1	19.4	18.5	17.6	17.8	17.0
Feed/gain[ce]	5.87	6.11	5.69	5.72	5.74	5.59	5.33	5.39
% improvement		-3.9	3.1	2.6		2.6	7.1	6.1

[a] *Sodium sesquicarbonate, 1% of diet dry matter.*
[b] *Monensin (25 g/ton) plus tylosin (10 g/ton).*
[c] *Corn vs wheat (P<.01).*
[d] *SS effect (P<.05).*
[e] *MT effect (P<.05).*

daily fluctuations) and improved rumen fermentation efficiency.

Buffers have also been evaluated for their ability to enhance cattle performance on high wheat diets. A summary of nine comparisons at the Fort Hays Station (Brethour, 1973) showed a 3% intake and 4% gain increase with sodium bicarbonate addition. Brethour (1986) found improvements of 13.3% in daily gain and 6.8% in feed efficiency from addition of 100g sodium bicarbonate in wheat and milo rations. However, Anderson et al. (Table 5) showed no response to sodium sesquicarbonate (Alkaten®) in wheat or corn rations. It appears that the use of ionophores, proper grain processing and bunk management are generally more important than buffers in managing cattle on high wheat diets. However, buffers can be very useful where unavoidable problems with grain processing or feeding management exist.

Fat addition to wheat diets appears to be beneficial for a number of reasons. Wheat contains only about 2% natural lipid, about half that of corn. Feeding fat increases the net energy content of the diet, since fat contains about 2.5 times more energy than grain. This may be important to counteract lower intakes, particularly in the summer, when wheat is typically fed. Fat also serves as an excellent ration-conditioning agent to minimize fines and dust. Recent work at Kansas State (Clary, 1991) also indicates that fat feeding results in a slight, but consistent reduction in the rate of ruminal starch digestion. The net result is greater intake of a diet higher in net energy concentration. A six-trial Kansas summary (Table 6) shows that addition of 3 to 4% fat (dry basis) increased feed intake 3.3%, which led to average improvements in daily gain and feed efficiency of 12.4 and 10.7%, respectively. The optimal level of supplemental fat appears to be in the range of .8–1.1 lb/head daily, or approximately 4–5% of the diet dry matter for yearlings, or 6 to 8% of the diet for calf-fed animals. It is cautioned that animals should be adapted or “stepped up” to diets containing greater than 2% added fat. Further, these suggested fat levels should be reduceD if dietary roughage exceeds 15–20% (dry basis), since fat has a negative effect on fiber digestion. Type of fat fed with wheat does not appear to affect animal response, provided that basic quality is high and consistent (low in moisture, impurities, and unsaponifiable matter; not

Table 6. Effect of Fat Addition to Wheat-Based Diets on Finishing Performance

Source	Fat Level and type[a]	Response relative to no-fat control, % ADG	DMI	F/G
Brethour, 1986[b]	3% A-V	14.8	3.5	11.9
Brandt et al., 1988	4%YG	15.1	1.0	14.0
Bock et al., 1991	3.5% SBSS or TAL	8.1	4.9	2.8
6-trial average		12.4	3.3	10.7

[a] *A-V = animal - vegetable blend, YG = yellow grease, SBSS = acidulated soybean soapstock, TAL = tallow.*
[b] *Average of four trials.*

rancid; free of toxic compounds). Implementation of a good fat sampling program at the feedyard is recommended to maintain quality control of fat shipments.

Wheat Type, Variety, and Environmental Influences

There are six major classes of wheat for marketing purposes: Hard red winter, hard red spring, soft red winter, soft white winter, durum, and mixed. Recently, varieties of hard white winter wheat also have been developed. All of these wheat types belong to the plant species Triticum aestivum, except durum, which is a distinct species (Triticum durum).

The typical nutritional composition of the major wheat grain types and two common wheat byproducts is shown in Table 7. Compared to corn and milo, the wheats are notably higher in crude protein, except for soft white winter. The wheats are also significantly higher in phosphorus and lower in moisture. To obtain maximum value from feeding wheat, these nutritional attributes should be considered in least cost ration formulation. Note that because wheat milling laboratories use different nitrogen to protein conversion factors than feed labs (5.7 vs. 6.25), the protein content of wheat is usually understated by about 1%. Moreover, milling labs report wheat protein values at a 12% standard moisture content rather than on a dry matter basis. Generally, when 40 to 50% of the finishing ration is red wheat, little or no supplemental protein is needed. Wheat protein is highly digestible, with about 80% degraded in the rumen. The rapid starch digestion pattern of wheat is also beneficial for efficient utilization of urea-based supplements, especially on higher roughage rations (Brethour, 1970).

Numerous research studies in several states have attempted to determine the relative feeding value of hard and soft wheats, with conflicting results. Earlier trials generally indicated that soft wheats had superior energy value, while later research generally found more variability across varieties than between hard and soft classes. Nebraska researchers (Fulton et al., 1973 and 1974) found that rate of starch fermentation and lactic acid production varied substantially among varieties, and there was some correlation between kernel hardness and lactic acid production. Brethour (1972 and 1973) suggested that strong gluten (bread) wheats have slightly higher net energy values, while weak gluten wheats seem less likely to cause acidosis, especially at high levels of wheat in the ration. Soft wheats are typically more palatable, but contain less protein and tend to flour more during dry processing. Overall, the relative feeding value of soft vs. hard wheat classes is very similar, and depends greatly on the specific variety fed and growing conditions.

Over 90% of durum wheat is grown in the Durum Triangle of North Dakota. High quality durum is in strong demand for pasta production, so it is seldom fed to livestock. However, durum is more prone to field sprouting, in which case it becomes a feed grain. According to North Dakota researchers (Dinusson, 1977; Johnson, 1993), cattle fed durum are considerably more difficult to keep on feed than other hard red wheats. Rolled or cracked durum becomes sticky and pasty when eaten by cattle, a condition related to its gluten strength. However, California research (Lofgren, 1974) found no difference in finishing performance of cattle

Table 7. Nutritional Dry Matter Composition of Wheat Grain and Byproducts[a]

Nutrient	Hard Red Winter	Hard Red Spring	Soft Red Winter	Soft White Winter	Durum	Grain Screenings	Wheat Midds
% Dry matter	88	88	88	89	88	89	89
% Crude protein	14.4	17.2	13.0	11.3	15.9	15.8	18.4
% Crude fiber	2.8	2.9	2.4	2.6	2.5	7.7	8.2
% Crude fat	1.8	2.0	1.8	1.9	2.0	3.9	4.9
% Ash	1.9	1.8	2.1	1.8	1.8	6.1	5.2
% Calcium	.05	.04	.05	.07	.10	.15	.13
% Phosphorus	.43	.43	.43	.39	.41	.39	.99
% TDN	88	89	89	89	85	71	69
NEg (Mcal/lb)	.69	.69	.69	.69	.62	.48	.45

[a] *NRC Nutrient Requirements of Beef Cattle, 1984 and NRC United States -Canadian Tables of Feed Composition, 1982.*

fed rations containing 62.5% steam-flaked durum or Anza, a common feed wheat. However, Pacific durum is much softer than northern durum wheat.

While varietal differences are important, growing conditions and agronomic practices such as fertilization and irrigation appear to play an even greater role in the feeding value of wheat. A Kansas study (Goldy et al., 1986; Table 8) showed that test weight, kernel hardness, and crude protein content were more variable among the 11 growing locations, than among the 15 standard varieties tested. Wheat from irrigated plots had higher yields and crude protein values, but lower test weights and hardness scores than dryland grain. Oklahoma research (1989) also found substantial location differences in dry matter, crude protein and amino acid composition of nine varieties grown at four locations across the state.

Vomitoxin in Wheat

Wheat scab or head blight results from the attack of wheat florets by Fusarium graminearum fungus. This disease occurs when wet weather persists during wheat development from bloom to maturity. Infection of a partially-developed kernel stops its growth and causes it to shrivel. If a more mature kernel is invaded, it turns a chalky color and may be covered with pink fungus. Infected kernels in harvested wheat are shriveled and pink to white and chalky in appearance.

Fusarium fungus can produce the mycotoxins deoxynivalenol (vomitoxin) and zearalenone (an estrogenic compound) in scab-damaged wheat grain and forage. Nebraska research (Nelson et al., 1984) indicated that consumption by cattle of diets containing up to 10 ppm vomitoxin for 18 weeks produced no negative effects on performance or pathological or toxicological manifestations. Suspect wheat or screenings should be tested and blended with other feeds if high levels of vomitoxin exist.

Table 8. Variety and Location Effects on Selected Criteria for Kansas Wheat (Goldy et al., 1986)

Item	Average	Variety[a] Range	Location[b] Range
Yield, bu	61.1	56.6 - 71.3	44.8 - 92.0
Test wt, lb/bu	58.0	56.0 - 59.2	53.2 - 62.4
Kernel wt[c], g	24.7	22.3 - 26.7	18.5 - 28.0
IVDMD, %	79.0	77.5 - 80.1	76.1 - 81.4
Protein, %	12.3	11.8 - 12.8	10.7 - 14.8

[a] *15 varieties*
[b] *14 locations*
[c] *Weight of 100 kernels*

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This publication was prepared in cooperation with the Extension Beef Cattle Resource Committee and its member states and produced in an electronic format by the University of Wisconsin-Extension, Cooperative Extension. Issued in furtherance of Cooperative Extension work, ACTS of May 8 and June 30, 1914.

BCH-5112 Feeding Wheat to Finishing Cattle