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Dry and High-Moisture Corn as Affected by Processing and Type of Diet

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(A Summary of Research at South Dakota State University)

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High-moisture grains have received considerable emphasis in cattle feeding research and by feedlot operators during recent years. Large quantities of grain are harvested at high-moisture contents because of harvesting and other advantages associated with the high-moisture content or because of unfavorable natural drying conditions. Drying grain is expensive, and it would appear that first consideration should be given to storing and using the grain in the high-moisture form if it is to be fed to livestock.

Research with high-moisture grains has shown that high-moisture grain may be one of the more economical and efficient ways of utilizing grain for feeding. Similar results appear to be obtained whether grain is harvested at a high-moisture content or water added to dry grain at time of storage. Research has also indicated some interrelationships between moisture content of grain, grain processing methods, levels of roughage and moisture content of the roughage.

It has become quite apparent that results obtained from various ways of processing grain are not the same for all grains and under all conditions. It appears that both animals and feed factors and also climatic environment are involved. If so, research on grain processing needs to be conducted under a number of variables as to animals, feeds and climatic environment.

In view of the large percentage of the total cost of growing and finishing cattle represented by feed costs, relatively small improvements in feed efficiency can result in substantial savings if not offset by the cost of the processing method. Since corn grain is a highly palatable and digestible feed, investment for various methods of processing that will provide an economical return may be limited. However, this may vary somewhat for a commercial feeder purchasing all feeds or a farmer growing corn and also feeding cattle. A more logical approach by the latter might be the selection of a processing and storage system that results in the least cost in relation to the production obtained.

Since corn grain is the major cattle feed grain in this area and much of it will be harvested at a high-moisture content on purpose or because of no choice, we decided to devote most of our attention in the area of feed processing to high-moisture corn. Several experiments with dry and high-moisture corn fed whole or rolled were conducted under various conditions of types, levels and moisture content of roughage and are summarized here. The high-moisture grain used in the experiments was reconstituted from dry grain. This procedure allowed better use of the storage facilities available, provided more flexibility as to when the experiments could be conducted, and permitted more uniformity between the source of corn in dry and high-moisture comparisons. Reconstituted high-moisture corn fed in these experiments was stored as whole grain in an oxygen-

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A summary of the presentation given at Cattle Feeders Day, October 1, 1971.

limiting silo (Harvestore). Both dry and high-moisture grains were from the same source, and they were rolled just prior to feeding. Dry grain was rolled to a medium degree of fineness, and the high-moisture grain was rolled to produce a flattened kernel with a minimum amount of fine material. Moisture content of the feeds was determined by oven drying which may have resulted in the dry matter intake calculated from these values being less than the actual consumption thus favoring the high-moisture fermented feeds.

The cattle were fed in pens which were paved with concrete but without access to shade or shelter. All diets were considered to be supplemented with adequate levels of protein, minerals and vitamin A. Diethylstilbestrol was fed at 10 mg. per head daily or implanted with 36 mg. initially and again after about 4 months if the experiments were much over 5 months in length. Carcass characteristics did not appear to be affected by diets fed other than reflections of differences in weight gains and carcass weights. Therefore, carcass data are not shown in the tables giving results of the various experiments.

Dry and High-Moisture Corn With Haylage

Dry and high-moisture corn was compared when fed rolled and with a limited feed of alfalfa-brome haylage. The high-moisture corn was reconstituted to 29% moisture. Alfalfa-brome hay was chopped, reconstituted to 46% moisture and stored in a silo. Each type of corn was fed once or twice daily in amounts that would be nearly consumed by the next feeding. Data from this experiment are summarized in table 1. Feed data shown in the table have been adjusted to a 12% moisture basis to facilitate comparisons between diets.

When fed once daily, steers fed high-moisture corn consumed slightly more grain dry matter and gained 0.24 lb. (8.9%) more daily with 5.4% lower feed requirements.

Table 1. Dry and High-Moisture Corn Fed Once or Twice Daily with Haylage (December 29 to June 27 - 159 Days)

	Dry corn		HM corn[a]	
	Fed once daily	Fed twice daily	Fed once daily	Fed twice daily
Number of steers	17	18	17	18
Init. shrunk wt., lb.	698	699	692	700
Final shrunk wt., lb.	1129	1151	1161	1161
Avg. daily gain, lb.	2.71	2.84	2.95	2.90
Avg. daily feed, lb.				
Alfalfa-brome[b]	4.0	4.0	4.0	4.0
Corn, as fed	17.5	17.6	21.6	21.9
Corn, air-dry[c]	17.0	17.1	17.5	17.7
Protein supplement	1.0	1.0	1.0	1.0
Total, air-dry[c]	22.0	22.1	22.5	22.7
Feed/100 lb. gain, air-dry, lb.				
Alfalfa-brome	145	142	136	138
Corn	628	602	595	611
Protein supplement	36	35	34	34
Total	809	779	765	783

[a] Water added and stored at about 29% moisture.
[b] Fed as reconstituted haylage with about 46% moisture.
[c] Converted to 12% moisture basis.

Feeding twice daily resulted in a slight improvement in rate of gain (4.9%) and feed efficiency (3.7%) for dry corn but not for the high-moisture corn. However, steers fed high-moisture corn once daily were still slightly ahead of those fed dry corn twice daily on rate of gain (3.9%) with about the same feed requirements.

Dry and High-Moisture Corn With and Without Roughage

In this experiment, dry or high-moisture corn was fed in all-concentrate diets and with 15 lb. per head daily of corn silage. High-moisture corn was reconstituted from dry corn and stored at a moisture content of about 28%. Each kind of corn was fed once or twice daily in amounts that would be nearly consumed by the next feeding.

Table 2. Dry and High-Moisture Corn Fed Once or Twice Daily With Corn Silage (June 23 to November 8 - 139 Days)

	Dry corn		HM corn[a]	
	Fed once daily	Fed twice daily	Fed once daily	Fed twice daily
Number of steers	18	17	17	18
Init. shrunk wt., lb.	772	774	773	771
Final shrunk wt., lb.	1150	1179	1164	1174
Avg. daily gain, lb.	2.73	2.90	2.82	2.91
Avg. daily feed, lb.				
Corn silage	14.6	14.4	14.9	14.4
Corn grain, as fed	16.8	17.3	19.0	19.6
Corn grain, air-dry[b]	16.8	17.3	15.3	15.8
Protein supplement	1.9	1.9	1.9	1.9
Total, air-dry[b]	24.3	24.7	22.9	23.3
Feed/100 lb. gain, air-dry, lb.[b]				
Corn silage	206	189	202	191
Corn grain	613	591	543	546
Protein supplement	70	65	67	66
Total	889	845	812	803

[a] Water added and stored at about 28% moisture.
[b] Converted to 12% moisture basis.

Results of the experiment with corn silage at 15 lb. per head daily are shown in table 2. These diets are high in concentrates when one considers that the corn silage was about 65% moisture and that 35 to 40% of the dry matter is grain.

When fed once daily, rate of gain was slightly (3.3%) in favor of high-moisture over dry corn. Improvement in feed efficiency amounted to 8.7% for the high-moisture corn group. Feed intake and rate of gain were improved by feeding twice daily for both dry and high-moisture corn. Improvement in daily gain was greater for the dry corn, resulting in about the same rate of gain for dry and high-moisture corn, but feed requirements were 5% less for the high-moisture grain.

Table 3. Dry and High-Moisture Corn Fed Once and Twice Daily Without Roughage (June 23 to November 8 - 139 Days)

	Dry corn		HM corn[a]	
	Fed once daily	Fed twice daily	Fed once daily	Fed twice daily
Number of steers	18	17	18	18
Init. shrunk wt., lb.	770	769	774	778
Final shrunk wt., lb.	1179	1197	1171	1205
Avg. daily gain, lb.	2.94	3.09	2.86	3.08
Avg. daily feed, lb.				
Corn grain, as fed	18.4	18.9	22.4	23.2
Corn grain, air-dry[b]	18.4	18.9	18.1	18.7
Protein supplement	1.9	1.9	1.9	1.9
Total, air-dry[c]	20.8	21.3	20.5	21.1
Feed/100 lb. gain, air-dry, lb.				
Corn grain	626	611	632	606
Protein supplement	64	62	66	62
Total[c]	706	688	714	684

[a] Water added and stored at about 28% moisture.
[b] Converted to 12% moisture basis.
[c] Corn silage fed during first 4 weeks while increasing to full feed amounted to average of 0.5 lb. daily of air-dry matter for the experiment.

Results obtained when feeding the dry and high-moisture grain in all-concentrate diets are shown in table 3. There were only small differences between dry and high-moisture corn in dry matter consumed, rate of gain and feed efficiency. Feeding twice daily brought about slight improvements in gain and feed efficiency with the advantage over once daily being slightly greater for the high-moisture corn.

Comparisons of the diets with and without roughage and dry corn are shown in table 4. The 15 lb. of corn silage reduced rate of gain and resulted in essentially no saving in total concentrates per 100 lb. of gain in comparison to the all-concentrate diet. The effect was similar for once or twice daily feeding, with slightly less reduction for twice daily.

The comparisons for diets with and without roughage and high-moisture corn are shown in table 5. Rate of gain was not affected by including 15 lb. corn silage when fed once daily but was reduced when fed twice daily. These results differ from those obtained with dry corn mainly in that, while total feed requirements were increased by feeding the corn silage, there was some reduction in amount of concentrates required. The savings in concentrates per 100 lb. of air-dry corn silage amounted to 43.6 and 29.3 lb., respectively, for once and twice daily feeding. These results would indicate that high-moisture corn has more advantage over dry corn when fed with roughage than when fed in all-concentrate diets.

Table 4. Dry Corn Fed Once and Twice Daily With and Without Roughage (June 23 to November 8 - 139 Days)

	All-concentrate		15 lb. corn silage	
	1x daily	2x daily	1x daily	2x daily
Number of steers	18	17	18	17
Init. shrunk wt., lb.	770	769	772	774
Final shrunk wt., lb.	1179	1197	1150	1179
Avg. daily gain, lb.	2.94	3.09	2.73	2.92
Avg. daily feed, lb.				
Corn grain, air-dry	18.4	18.9	16.8	17.3
Protein supplement	1.9	1.9	1.9	1.9
Corn silage	--	--	14.6	14.4
Total, air-dry[a]	20.8	21.3	24.3	24.7
Feed/100 lb. gain, air-dry, lb.				
Corn grain	626	611	613	591
Protein supplement	64	62	70	65
Corn silage	--	--	206	189
Total[a]	706	688	889	845

[a] Corn silage fed during first 4 weeks while increasing to full feed amounted to an average of 0.5 lb. daily for the experiment.

Table 5. High-Moisture Corn Fed Once and Twice Daily With and Without Roughage (June 23 to November 8 - 139 Days)

	All-concentrate		15 lb. corn silage	
	1x daily	2x daily	1x daily	2x daily
Number of steers	18	18	17	18
Init. shrunk wt., lb.	774	778	773	771
Final shrunk wt., lb.	1171	1205	1164	1174
Avg. daily gain, lb.	2.86	3.08	2.82	2.91
Avg. daily feed, lb.				
Corn grain, air-dry[a]	18.1	18.7	15.3	15.8
Protein supplement	1.9	1.9	1.9	1.9
Corn silage	--	--	14.9	14.4
Total, air-dry[b]	20.5	21.1	22.9	23.3
Feed/100 lb. gain, air-dry, lb.				
Corn grain	632	606	543	546
Protein supplement	66	62	67	66
Corn silage	--	--	202	191
Total[b]	714	684	812	803

[a] Converted to 12% moisture basis.

[b] Corn silage fed during first 4 weeks to all-concentrate groups while increasing to full feed amounted to an average of 0.5 lb. daily for the experiment.

Dry and High-Moisture Corn Fed Whole or Rolled in High-Concentrate Diets

Methods of processing were compared for dry and high-moisture corn in this experiment. Water was added to the reconstituted high-moisture corn for an average of 27.4% moisture. All diets contained 2 lb. of alfalfa-brome hay. Results of this experiment are shown in table 6.

Table 6. Dry and High-Moisture Corn Fed Whole and Rolled in a High Concentrate Diet (September 10 to December 30 - 111 Days)

	Dry corn		HM corn[a]	
	Whole	Rolled	Whole	Rolled
Number of steers	24	24	24	24
Init. shrunk wt., lb.	841	844	847	846
Final shrunk wt., lb.	1136	1128	1117	1098
Avg. daily gain, lb.				
85 days, filled	3.20	3.13	3.17	3.07
111 days, shrunk	2.66	2.55	2.44	2.27
Avg. days feed, air-dry, lb.[b]				
85 days	22.8	21.9	21.8	21.1
111 days	23.2	22.0	21.7	21.1
Feed/100 lb. gain, air-dry, lb.[b]				
85 days, filled	714	699	689	689
111 days, shrunk	874	863	890	929

[a] Water added and stored at 27.4% moisture.
[b] Converted to 12% moisture basis.

A considerable amount of snow and low temperatures with high winds were encountered the last 3 weeks of the experiment. Weight gain and feed efficiency data show some major difference between the 85-day weigh period and the one at 111 days when the experiment was terminated. Since differences in treatment at these two times probably can be attributed to weather conditions, weight and feed data are shown for the 85-day period as well as at 111 days.

At 85 days, feed intake and rate of gain were slightly higher for dry corn fed whole or rolled. Steers fed whole corn, dry or high-moisture, consumed more feed and gained at a slightly faster rate (2.2 to 3.2%) than those fed rolled corn. Feed efficiency favored high-moisture corn by 3.5% when fed whole, but it was about equal for dry and high-moisture corn when rolled.

Performance at 111 days was considerable less than at 85 days. The main difference appeared to be a greater effect of adverse weather conditions on steers fed the high-moisture corn.

Dry and High-Moisture Corn Fed Whole and Rolled With Two Levels of Haylage

Diets for this experiment consisted of dry or reconstituted high-moisture (29.7%) corn fed whole or rolled with 2 or 8 lb. of alfalfa-brome haylage. The forage was field chopped at 39.4% average moisture.

Table 7. Dry and High-Moisture Corn Fed Whole or Rolled With Two Pounds of Alfalfa-Brome Haylage (June 10 to October 30 - 142 Days)

	Dry corn		HM corn[a]	
	Whole	Rolled	Whole	Rolled
Number of steers	16	16	16	16
Init. shrunk wt., lb.	652	646	654	644
Final shrunk wt., lb.	1154	1151	1123	1085
Avg. daily gain, lb.	3.54	3.55	3.30	3.10
Avg. daily feed, air-dry, lb.[b]				
Corn	19.1	19.5	17.8	16.8
Haylage	1.4	1.4	1.4	1.4
Supplement	1.9	1.9	1.9	1.9
Total	22.4	22.8	21.1	20.1
Feed/100 lb. gain, air-dry, lb.[b]				
Corn	540	549	539	540
Haylage	39	39	42	45
Supplement	54	53	57	61
Total	633	641	638	646

[a] Water added and stored at 29.7% moisture.
[b] Converted to 12% moisture basis.

When fed with 2 lb. haylage (table 7), steers fed dry corn consumed more grain dry matter and gained 0.24 lb. (7.3%) more daily for whole grain and 0.45 lb. (14.5%) for rolled grain than those fed the high-moisture grain. However, feed efficiency was about the same between dry and high-moisture grain when fed whole or rolled.

Results obtained with dry and high-moisture grain and from rolling appeared somewhat different when diets contained 8 lb. haylage (table 8). Here gains were greater for dry corn when fed whole (0.23 lb. or 7.3%) but greater for high-moisture corn when rolled (0.17 lb. or 5.4%). Feed requirements were 2.7% less for dry corn fed whole but 9.1% less for high-moisture corn fed rolled.

Feeding 8 lb. haylage in comparison to 2 lb. with dry corn resulted in a greater total feed intake but less corn (table 9). Rate of gain was reduced and to a greater extent with the rolled grain. The greater amount of haylage had a rather small effect on the total concentrates per 100 lb. of gain, especially with rolled corn.

Table 8. Dry and High-Moisture Corn Fed Whole or Rolled With Eight Pounds Alfalfa-Brome Haylage (June 10 to October 30 - 142 Days)

	Dry corn		HM corn[a]	
	Whole	Rolled	Whole	Rolled
Number of steers	16	14	16	16
Init. shrunk wt., lb.	654	646	641	657
Final shrunk wt., lb.	1136	1095	1091	1129
Avg. daily gain, lb.	3.39	3.16	3.16	3.33
Avg. daily feed, air-dry, lb.[b]				
Corn	17.9	17.6	17.2	16.7
Haylage	5.5	5.7	5.5	5.5
Supplement	0.9	1.0	0.9	0.9
Total	24.3	24.3	23.6	23.1
Feed/100 lb. gain, air-dry, lb.				
Corn	528	555	535	502
Haylage	163	180	174	166
Supplement	28	31	30	28
Total	719	766	739	696

[a] Water added and stored at 29.7% moisture.
[b] Converted to 12% moisture basis.

Table 9. Two vs. Eight Pounds Haylage With Dry Corn

	Whole corn		Rolled corn	
	Haylage		Haylage	
	2 lb.	8 lb.	2 lb.	8 lb.
Avg. daily gain, lb.	3.54	3.39	3.55	3.16
Avg. daily feed, air-dry, lb.				
Corn	19.1	17.9	19.5	17.6
Haylage	1.4	5.5	1.4	5.7
Supplement	1.9	0.9	1.9	1.0
Total	22.4	24.3	22.8	24.3
Feed/100 lb. gain, air-dry, lb.				
Corn	540	528	549	555
Haylage	39	163	39	180
Supplement	53	28	53	31
Total	632	719	641	766

Effects of the higher level of haylage fed with whole high-moisture corn were similar as with dry corn (table 10). However, when the steers were fed 8 lb. of haylage and high-moisture rolled corn, they consumed about the same amount of corn as those fed only 2 lb. of haylage. Rate of gain was 0.23 lb. (7.4%) more with the higher level of haylage. When compared to the best dry corn treatment of whole grain and 2 lb. haylage, steers fed high-moisture rolled corn and 8 lb. haylage gained at a lower rate and had higher total feed requirements but with less concentrates. Haylage replaced corn and supplement at a rate of 50 lb. per 100 lb. of air-dry haylage.

Table 10. Two vs. Eight Pounds Haylage With High-Moisture Corn

	Whole corn		Rolled corn	
	Haylage		Haylage	
	2 lb.	8 lb.	2 lb.	8 lb.
Avg. daily gain, lb.	3.30	3.16	3.10	3.33
Avg. daily feed, air-dry, lb.				
Corn	17.8	17.2	16.8	16.7
Haylage	1.4	5.5	1.4	5.5
Supplement	1.9	0.9	1.9	0.9
Total	21.1	23.6	20.1	23.1
Feed/100 lb. gain, air-dry, lb.				
Corn	539	535	540	502
Haylage	42	174	45	166
Supplement	57	30	61	28
Total	638	739	646	696

Dry and High-Moisture Corn Fed Whole or Rolled With Hay or Haylage in High-Roughage Diets

This experiment was conducted to compare dry and high-moisture corn fed whole or rolled in limited grain diets fed to calves from weights of about 500 lb. to about 800 lb. High-moisture corn was reconstituted to 28.0% moisture. Grain was fed at 1 lb. of air-dry matter per 100 lb. of body weight with adjustments being made every 4 weeks. Alfalfa-brome hay or haylage was fed to appetite. No protein supplement was considered necessary in the diets and the cattle were implanted with diethylstilbestrol. Forage dry matter made up about 65% of the diets.

When fed with hay, rate of gain was improved by rolling either grain (table 11). However, effects of rolling on either rate of gain or feed efficiency were small. Rate of gain was 8.6% greater for high-moisture corn with 8.0% lower feed requirements when fed whole. When rolled, gain and feed efficiency favored high-moisture corn by 7.3 and 6.1%.

Table 11. Dry and High-Moisture Corn in High Hay Diets
(February 4 to July 16 - 161 Days)

	Dry corn		HM corn[a]	
	Whole	Rolled	Whole	Rolled
Number of steers	16	16	16	16
Init. shrunk wt., lb.	505	508	509	504
Final shrunk wt., lb.	803	818	833	836
Avg. daily gain, lb.	1.85	1.92	2.01	2.06
Avg. daily feed, air-dry, lb.				
Corn	6.8	7.0	7.0	7.0
Hay	11.9	12.0	11.7	11.9
Total	18.7	19.0	18.7	18.9
Feed/100 lb. gain, air-dry, lb.				
Corn	367	361	348	342
Hay	643	619	581	578
Total	1010	980	929	920

[a] Water added and stored at 28% moisture.

Table 12. Dry and High-Moisture Corn in High Haylage Diets
(February 4 to July 16 - 161 Days)

	Dry corn		HM corn[a]	
	Whole	Rolled	Whole	Rolled
Number of steers	16	16	16	16
Init. shrunk wt., lb.	511	509	508	504
Final shrunk wt., lb.	836	835	844	871
Avg. daily gain, lb.	2.01	2.03	2.08	2.28
Avg. daily feed, air-dry, lb.				
Corn	7.0	7.0	7.0	7.2
Haylage	13.2	13.7	13.4	13.8
Total	20.2	20.7	20.4	21.0
Feed/100 lb. gain, air-dry, lb.				
Corn	349	347	338	317
Haylage	656	675	641	605
Total	1005	1022	979	922

[a] Water added and stored at 28% moisture.

When fed with haylage (table 12), rate of gain and feed efficiency were also in favor of the high-moisture corn. While differences were small for whole corn, there was a 12.3% greater gain with 9.8% improvement in feed efficiency for high-moisture rolled corn over dry rolled corn.

Table 13. Hay vs. Haylage With Dry Corn

	Whole corn		Rolled corn	
	Hay	Haylage	Hay	Haylage
Avg. daily gain, lb.	1.85	2.01	1.92	2.03
Avg. daily feed, air-dry, lb.				
Corn	6.8	7.0	7.0	7.0
Hay or haylage	11.9	13.2	11.9	13.7
Total	18.7	20.2	18.9	20.7
Feed/100 lb. gain, air-dry, lb.				
Corn	367	349	361	347
Hay or haylage	643	656	619	675
Total	1010	1005	980	1022

A comparison of hay and haylage with dry corn is shown in table 13. Steers fed haylage consumed more forage dry matter and gained at a faster rate. There appeared to be more advantage for haylage over hay when the dry corn was fed whole. Forage dry matter requirement per 100 lb. of gain was 13 lb. more for haylage but grain required was 18 lb. less. This represents a good return for the larger amount of forage consumed as haylage. The higher consumption of forage had less effect on grain requirements when the dry corn was rolled.

Table 14. Hay vs. Haylage With High-Moisture Corn

	Whole corn		Rolled corn	
	Hay	Haylage	Hay	Haylage
Avg. daily gain, lb.	2.01	2.08	2.06	2.28
Avg. daily feed, air-dry, lb.				
Corn	7.0	7.0	7.0	7.2
Hay or haylage	11.7	13.4	11.9	13.8
Total	18.7	20.4	18.9	21.0
Feed/100 lb. gain, air-dry, lb.				
Corn	348	338	342	317
Hay or haylage	581	641	578	605
Total	929	979	920	922

With high-moisture grain (table 14), the advantage for haylage over hay appeared to be with rolled grain. Rate of gain was 0.22 lb. (10.7%) more with haylage. Total feed requirements were about the same. While 27 lb. more forage air-dry matter was required per 100 lb. of gain, corn requirement was reduced by 25 lb., resulting in a very favorable return for the higher forage intake from the haylage.

Dry and High-Moisture Corn Fed Whole or Rolled with Hay or Haylage in High-Concentrate Finishing Diets

The cattle fed the high-roughage diets with hay or haylage (tables 11 to 14) were used in a finishing experiment following the growing experiment. Dietary treatments were the same as in the high-roughage experiment, but forage dry matter was limited to 1.5 lb. per head daily after a gradual change to a full feed of the high-concentrate diets. Each of the eight treatments was replicated two times with eight steers per pen.

The dry corn contained an average of 12.0% moisture and the reconstituted high-moisture corn averaged 21.9% moisture. The hay was a baled alfalfa-brome mixture (13.0% moisture) chopped with a forage harvester. The haylage was reconstituted from the baled hay and stored in an oxygen-limiting silo at an average moisture of 48.4%.

Table 15. Dry and High-Moisture Corn in High-Concentrate Diets With Hay (July 16 to October 29 - 105 Days)

	Dry corn		HM corn[a]	
	Whole	Rolled	Whole	Rolled
Number of steers	16	16	16	16
Init. shrunk wt., lb.	828	823	829	817
Final shrunk wt., lb.	1109	1094	1105	1096
Avg. daily gain, lb.	2.66	2.58	2.62	2.65
Avg. daily feed, air-dry, lb.				
Corn	20.12	18.55	18.96	18.62
Hay	2.67	2.64	2.62	2.60
Supplement	2.02	2.02	2.02	2.02
Total	24.81	23.21	23.60	23.24
Feed/100 lb. gain, air-dry, lb.				
Corn	754	718	722	702
Hay	100	102	99	98
Supplement	76	78	77	76
Total	930	898	898	876

[a] Water added and stored at 21.9% moisture.

When fed with hay, rate of gain varied only slightly between dry and high-moisture corn (table 15). Dry matter consumption was slightly higher for dry corn fed whole, resulting in small increases in feed requirements in comparison to dry rolled corn or the whole high-moisture corn, 3.44 and 2.45%, respectively.

Effects of rolling either dry or high-moisture corn on basis of weight gain or feed efficiency were small in this experiment with high-concentrate diets. Feed consumption was slightly lower for diets with rolled corn with feed requirements being 3.44 and 2.45% less for the dry and high-moisture grain.

Table 16. Dry and High-Moisture Corn in High-Concentrate Diets With Haylage
(July 16 to October 29 - 105 Days)

	Dry corn		HM corn[a]	
	Whole	Rolled	Whole	Rolled
Number of steers	16	16	16	16
Init. shrunk wt., lb.	818	819	821	818
Final shrunk wt., lb.	1087	1111	1103	1107
Avg. daily gain, lb.	2.55	2.78	2.68	2.75
Avg. daily feed, air-dry, lb.				
Corn	18.99	19.14	18.97	18.73
Haylage	2.34	2.44	2.35	2.41
Supplement	2.02	2.02	2.02	2.02
Total	23.35	23.60	23.34	23.16
Feed/100 lb. gain, air-dry, lb.				
Corn	744	689	706	680
Haylage	91	87	91	88
Supplement	79	72	75	73
Total	914	848	872	841

[a] Water added and stored at 21.9% moisture.

When fed with haylage (table 16), rate of gain was higher (5.1%) with lower feed requirements (4.6%) for high-moisture corn when fed whole, but performance was about the same as for dry corn when both were rolled. Steers fed rolled corn gained at a faster rate and with lower feed requirements with either dry (9.0% more gain with 7.2% less feed) or high-moisture corn (2.6% more gain with 3.6% less feed). This would indicate that the advantage for rolling was greater with haylage than with hay. This is in agreement with other experiments summarized using higher levels of roughage. However, this experiment showed more advantage for rolling the grain with the low level of roughage.

The comparison between hay and haylage with dry corn is shown in table 17. The comparative value of hay and haylage appeared to vary between whole and rolled corn. Gain was less (4.1%) for haylage with whole corn but greater (7.8%) with high-moisture corn. There was also some reduction (5.6%) in feed requirements with haylage and rolled corn in comparison to hay.

The comparison between hay and haylage and high-moisture corn is shown in table 18. The advantage in rate of gain and feed efficiency was for haylage, but it was small. However, these effects represent those from the total diet of which the haylage comprised approximately 10%. In view of this, haylage appeared to have a substantial advantage over hay as used in this experiment.

Table 17. Hay vs. Haylage With Dry Corn
(July 16 to October 29 - 105 Days)

	Whole corn		Rolled corn	
	Hay	Haylage	Hay	Haylage
Avg. daily gain, lb.	2.66	2.55	2.58	2.78
Avg. daily feed, air-dry, lb.				
Corn	20.12	18.99	18.55	19.14
Hay or haylage	2.67	2.34	2.64	2.44
Supplement	2.02	2.02	2.02	2.02
Total	24.81	23.35	23.21	23.60
Feed/100 lb. gain, air-dry, lb.				
Corn	754	744	718	698
Hay or haylage	100	91	102	87
Supplement	76	79	78	72
Total	930	914	898	848

Table 18. Hay vs. Haylage With High-Moisture Corn
(July 16 to October 29 - 105 Days)

	Whole corn		Rolled corn	
	Hay	Haylage	Hay	Haylage
Avg. daily gain, lb.	2.62	2.68	2.65	2.75
Avg. daily feed, air-dry, lb.				
Corn	18.96	18.97	18.62	18.73
Hay or haylage	2.62	2.35	2.60	2.41
Supplement	2.02	2.02	2.02	2.02
Total	23.60	23.34	23.24	23.16
Feed/100 lb. gain, air-dry, lb.				
Corn	722	706	702	680
Hay or haylage	99	91	98	88
Supplement	77	75	76	73
Total	898	872	876	841

Dry and High-Moisture Corn Fed Whole or Rolled With Corn Silage

Dietary treatments in this experiment were dry or high-moisture corn fed whole or rolled with 20 lb. of good quality corn silage for 147 days and then 10 lb. of heat damaged corn silage for the remainder of the 230-day experiment. Each of four grain treatments was fed with urea or soybean meal as the major supplemental protein. There appeared to be no interaction between the supplement and grain treatments. Results are shown by grain treatments in table 19.

Table 19. Dry and High-Moisture Corn With Corn Silage
(January 7 to August 25 - 230 Days)

	Dry corn		HM corn[a]	
	Whole	Rolled	Whole	Rolled
Number of steers	30[b]	32	32	32
Init. shrunk wt., lb.	508	506	508	504
Final shrunk wt., lb.	1141	1116	1129	1126
Avg. daily gain, lb.	2.75	2.65	2.70	2.70
Avg. daily feed, air-dry, lb.				
Corn silage	8.26	8.21	8.22	8.23
Corn grain	13.18	12.50	12.41	11.83
Supplement	1.48	1.48	1.48	1.48
Total	22.92	22.19	22.11	21.54
Feed/100 lb. gain, air-dry, lb.				
Corn silage	300	310	305	304
Corn grain	478	472	460	437
Supplement	53	56	54	55
Total	831	838	819	796

[a] Water added and stored at 25.7% moisture.
[b] Two steers died from pneumonia.

Average daily gains for all cattle fed dry or high-moisture corn were the same (2.70 lb.). When the dry corn was rolled, rate of gain was 0.10 lb. less daily (3.6%) than for steers fed whole corn. Feed consumption was also slightly less for the steers fed rolled dry corn, resulting in similar feed efficiency between whole and rolled dry grain.

Rolling of the high-moisture corn did not change the rate of gain in comparison to the whole grain. However, slightly less air-dry matter was consumed with rolled corn resulting in a small reduction in feed requirements (2.8%).

Summary

Comparative value of dry and high-moisture corn grain and the value of rolling in comparison to feeding whole appear to be influenced by the roughage level in the diet, moisture content of the roughage, frequency of feeding and environmental temperature. Results of these several experiments appear to support the following conclusions:

1. The difference between high-moisture and dry corn when fed with low levels of roughage (about 10% or less of diet dry matter) was small or frequently was in favor of dry grain on basis of rate of gain. There were also small differences in feed efficiency under these conditions, frequently favoring the high-moisture corn.

2. At higher levels of roughage (20% or more of diet dry matter), the value of high-moisture corn in comparison to dry corn appeared to improve, especially when fed with haylage and with rolled grain.

3. There seemed to be no consistent difference on basis of rate of gain between rolled and whole dry corn grain with roughage levels up to about 20% of the diet dry matter. Rolled grain was generally consumed at a lower level but with about the same or a slight improvement in feed efficiency in comparison to the whole grain. Apparently, the whole grain is utilized efficiently even though apparent whole kernels appear in the feces. Dry matter of the feces is largely undigested feed which would be mostly corn even where the grain is finely ground or rolled. Even with roughage levels as much as 60 to 65% of the dry diet, the advantage for rolling the corn was small for steers from weights of 500 to 800 lb.

4. With high-moisture corn and low levels of roughage, there also appeared to be little, if any, advantage for rolling the grain in comparison to feeding in the whole form. At higher levels of roughage (20% or more of diet dry matter), there appeared to be more advantage for rolling high-moisture grain than for rolling dry grain. The advantage for rolling the high-moisture grain appeared to be greater with haylage than with hay. The grain replacement value of forage increased with higher levels of forage in the diet. This increase was more for haylage than for hay and more with rolled corn.

5. Differences in value of dry and high-moisture corn were small when fed in diets with limited amount of corn silage (10 to 20 lb. daily). There was also little difference between whole and rolled corn under these conditions.

6. Incidence of abscessed livers did not appear to be affected by moisture content of grain. However, there was a greater incidence when the corn was rolled. Forty-six livers were abscessed out of 382 head of cattle (12.0%) where livers were examined with one-half of the cattle being fed whole corn and the other one-half fed rolled corn. Fifteen (7.8%) of the abscessed livers were from cattle fed whole corn and 31 (16.2%) were from cattle fed rolled corn.