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Use Of High-Moisture Corn
For Dairy Cattle

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High-moisture corn is mature grain that is not dry enough for conventional storage. It may be ear corn or shelled corn. High-moisture ear corn ranges from 28-40 percent moisture content; and high-moisture shelled corn ranges from 25-35 percent moisture content.

High-moisture corn may be preserved by propionic acid treatment for storage in conventional structures, or it may be stored in silos without this treatment. If ensiled, it undergoes fermentation. Lactic acid, other organic acids, and ethyl alcohol created by the fermentation process will help preserve the corn and prevent spoilage.

Structures for storing high-moisture corn. Silos for high-moisture corn may be oxygen limiting structures or concrete stave towers. When exceptionally large amounts of corn are used, bunker silos have proved satisfactory. Silo size depends upon the amount needed and the removal rate per day. Some silos may need reinforcement for high-moisture corn. Table 1 gives the capacity of tower silos for high-moisture ground ear corn or shelled corn.

Table 1. Capacities of tower silos.

Settled depth	High-moisture ground ear corn or high-moisture whole shelled corn						
	Inside diameter in feet						
	10	12	14	16	18	20	22
Feet	Tons						
20	37						
25	47	68					
30	56	81	111	144	183	226	272
35	65	95	129	168	213	264	318
40	75	108	147	192	243	302	363
45	84	122	166	216	274	339	409
50		135	184	240	304	377	454
55			203	264	335	415	499
60				288	365	452	545

Source: Dum et. al. 1971. Special Circular 143. Penn. State Univ., College of Agriculture, Extension Service, University Park.

To minimize spoilage, the silo must be in good repair. During ensiling, the silo should be sealed to allow minimal air entrance. Use of plastic around the doors and proper door caulking will help prevent spoilage and molding. The top may be covered with plastic sheeting. Good packing and correct moisture level will assure proper fermentation and help minimize spoilage.

Removal rate is an important consideration in selecting the correct silo size. When the silo is first opened, about 4 inches a day should be removed the first several days. Removal of 2 to 3 inches per day is sufficient for winter feeding, while 4 to 6 inches should be removed during warm weather. Table 2 gives the pounds of corn per inch of height for silos of different diameters. The table can help determine the correct silo diameter for a given feeding operation. As an example, for a 16 foot diameter silo, 4 inches would equal 3200 pounds of high-moisture whole shelled corn (800 lbs. per inch x 4

inches). At this removal rate, about 1 1/2 tons of high-moisture corn should be fed each day.

Table 2. Pounds of corn per inch of height for silos of different diameters.

Inside diameter of silo (feet)	Pounds per inch of height
10	313
12	451
14	614
16	801
18	1014
20	1256
22	1513

Source: 1970 Structures and Environment Handbook, Midwest Plan Service, Iowa State University.

Harvesting corn for ensiling. Corn to be ensiled may be shelled or left on the ear. For maximum grain yield, the corn should be mature. Corn maturity occurs when kernels contain about 25-35 percent moisture. When a physiologically mature kernel is split, a black layer is visible across its tip. For good ensiling, shelled corn should contain 25-30 percent moisture, and ear corn should contain 30-35 percent moisture. Moisture content can be determined with a moisture tester or by taking samples to a local elevator. From 25 to 30 percent moisture is ideal for shelled corn, and 30-35 percent is recommended for ear corn.

Feeding value of high-moisture corn. High-moisture corn for dairy cows should be ground or rolled. When whole kernels are fed, a large percentage of the kernels pass through the animal undigested. Undigested kernel corn may reach 10-20 percent of the total weight fed.

Generally, the nutrient content of dry matter in high-moisture corn is similar to the nutrient content in dry corn. Differences in production have been reported in a few instances, but these usually result from differences in dry matter intake rather than in the corn's nutrient content. The higher moisture content must be recognized. More total pounds of high-moisture grain must be fed to equal nutrient intake from dry corn. Table 3 shows the required amount of corn at different dry matter contents to equal the dry matter in dry grain. Some dairymen have experienced lower production with high-moisture corn because less total dry matter was being fed.

Table 3. Amounts of high-moisture corn of various dry matter levels required to equal the dry matter in air-dry corn.

Air-dry ¹ (lb.)	Percent of dry matter		
	75 (lb.)	70 (lb.)	65 (lb.)
10	12	12	13
15	17	18	20
20	23	25	26
25	29	31	33
30	35	37	40
35	40	43	46
40	46	49	53

¹ Air-dry = 86 percent dry matter basis.

Shelled corn vs. ear corn. The choice between shelled and ear corn will depend on available harvesting and handling

equipment. Both shelled and ear corn can be successfully used in a feeding program. Shelled corn is higher in energy and crude protein than is ear corn.

High moisture ear corn should be ground before ensiling to insure fermentation, exclude air, and prevent spoilage. Shelled corn may be ground before ensiling, especially in conventional tower silos.

Shelled corn will provide more energy per unit of dry matter. It may fit better into overall corn handling, especially if some corn is harvested for purposes other than high-moisture ensiling. On the other hand, ear corn provides a more fibrous feed which is useful in maintaining cows on feed and in preventing milk fat depression. The value of the cob is much less than the grain, but it does contain some feed value (table 4).

Table 4. Feed value of corn grain components.

	Percent of crude protein ¹	Mcal net energy per lb. ¹
Shelled corn	9.3	.94
Ear corn	8.0	.82
Corn cobs	2.5	.38

¹100 percent dry matter basis.

Methods of feeding high-moisture corn. Several procedures can be used to feed high-moisture corn. These include:

- * feeding a constant amount to all cows and an added grain mix to supply additional energy and protein to top producing cows;
- * mixing high-moisture corn with protein, mineral, and vitamin supplements to provide a complete grain mix;
- * feeding high-moisture corn according to production with a protein supplement used as a "top-dress" (fed individually on top of a base grain);
- * blending high-moisture corn and supplements with forages and offering these as an "all-in-one" ration.

When a constant amount of corn is fed to all cows, an automatic feeder can be used to deliver the grain into a feed bunk. A dry grain mix containing enough protein for the cows may be fed in a parlor or in a stanchion barn. With this method, the energy requirements of lower producing cows are met in the feed bunk, and a protein supplement is fed to the higher producers at milking.

The complete grain mix requires that supplements be added to the corn as it comes from the silo. Mixing is required. The grain mix is then formulated the same way it is for conventional rations. Simple mixtures are shown in table 5. They are based entirely on high-moisture grain. Other grains may be added.

With the top-dress method, high-moisture corn is fed according to production. The amounts of corn and protein supplement needed to meet cows' requirements at different production levels are given in table 6. At higher levels, feed intake may become limiting; some high producing cows may not consume enough to meet their needs. If this occurs, these

Table 6. Guide¹ for top-dressing protein supplement on high-moisture shelled corn with various forage feeding systems².

lbs. of milk	Alfalfa hay		Alfalfa hay and corn silage		Corn silage		Urea-corn silage	
	lbs. HMC	lbs. 44% supplement	lbs. HMC	lbs. 44% supplement	lbs. HMC	lbs. 44% supplement	lbs. HMC	lbs. 44% supplement
40	17	1	12	3	8	6	9	4
50	20	2	16	4	11	7	13	5
60	23	3	20	5	14	8	17	6
70	26	4	23	7	16	10	20	7
80	30	5	26	8	20	11	23	9
90	34	6	29	9	24	12	27	10

¹Calculated to meet the requirements of cows weighing approximately 1300 lbs. and producing milk that test 3.5 percent fat.

²Feed intake may be limited at higher levels of production. Forage dry matter fed at approximately 1.5 percent of body weight.

cows' protein needs should be met even though energy intake may still be limiting. Some protein supplements contain large amounts of urea. These supplements should be mixed with dry feed rather than top-dressed. This method works well in a stanchion barn. It is useful in providing protein supplement in amounts that cows need. This could be of important economic significance when protein prices are high.

The all-in-one ration may be useful for extremely large herds where cows may be grouped by production level. A complete feed may be formulated for each group and then be fed free choice. Cattle that are to receive large amounts should gradually be adjusted to high-moisture grain to avoid off-feed problems during the initial stages of the feeding period.

Low fat test. Some dairymen feeding high-moisture corn have experienced a low milk fat test. The reason is not always clear. Generally, milk fat test declines when forage intake decreases. If the total ration contains 15-18 percent crude fiber, there is usually no problem. However, when high-moisture corn is offered to cattle in a feed bunk, many cows will consume the corn at the expense of other feeds. In this situation, milk fat may be reduced for individual cows. If a drop in test does occur, make sure that the forage or fiber intake is adequate. If the problem persists, the use of sodium bicarbonate or magnesium oxide may partially help restore fat.

Mixing supplements with high-moisture corn during ensiling. Generally, the addition of protein supplements — such as soybean meal or urea — to high-moisture corn at ensiling time is not recommended. The urea is converted to ammonia in the silo. This results in some loss of nitrogen and a lower feed intake. The addition of minerals or other supplements is not recommended. Organic acid treatment of high-moisture corn is an effective means to preserve corn. The feed value of acid-treated corn is equal to ensiled high-moisture corn. Acid-treated corn has no effect on milk production or fat test.

Table 5. Examples of simple, complete grain mixtures¹ using high-moisture corn.

Ingredient	Approximate crude protein percent ²							
	10	12	14	16	18	20	22	24
High-moisture shelled corn	1800	-	1700	-	1600	-	1500	-
High-moisture ear corn	-	1770	-	1670	-	1550	-	1450
44% Protein supplement	200	230	300	330	400	450	500	550
Trace-mineral salt	20	20	20	20	20	20	20	20
Calcium-phosphorus supplement	20	20	20	20	20	20	20	20
Vitamin premix	5	5	5	5	5	5	5	5

¹Amounts of salt, calcium-phosphorus supplements, and vitamins are estimated. The ration may need adjustment for mineral supplementation according to the kind and amount of forage fed.

²Expressed on a wet or as is basis.