Urea Corn Silage for Dairy Cattle
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CORN SILAGE, a highly productive crop on many Michigan farms, is an excellent source of energy for cattle.

But corn silage is low in protein. It must be balanced with protein from other sources to meet the requirements of cattle. Alfalfa hay and protein supplements such as soybean meal, for example, are common sources of protein to balance corn silage.

Urea is another source. It is a cheap source, compared to others. The main reason for using it is to reduce the cost of protein supplement.

Urea Increases Protein Content

Modern corn silage contains about 2.75% protein at normal moisture (29% dry matter). The dry matter contains 9.4% protein with two-thirds of the samples taken in a recent study ranging between 7.2 and 11.6%.

Ten pounds of urea per ton of silage—the recommended rate—raises the protein content 1.3 percentage units to about 3.5 or 4.0% protein. Urea-treated corn silage will contain 13 to 14% protein on a dry matter basis (plus or minus about 2.2% normal variation).

The average protein content of 10 urea-treated silage samples collected from farms by M.S.U. scientists was 3.53% (11.1%) of the dry matter).

The lower protein content of these silages suggests that wagon loads of ensilage may have been heavier than estimated; thus the full 10 pounds of urea per ton was not actually added. Experiments indicate about 90 to 100 percent of the urea nitrogen is recovered in good corn silage.

Lower Cost Protein

Urea supplies the nitrogen for 26.2 pounds of protein per ton of silage at the recommended rate—0.5% (10 pounds per ton). Since urea is usually considered to have no energy value in the ration, 70 pounds of shelled corn are required with the 10 pounds urea to be equivalent in protein and TDN (total digestible nutrients) to 70 pounds soybean meal. Corn already in the silo will be used to make protein rather than energy.

Table 1 shows that the cost of soybean meal is 40 to 75% higher than an equivalent amount of urea-corn protein and energy at the prices used.

Urea Becomes Protein

Urea breaks down into ammonia (NH_3) and carbon dioxide (CO_2) in both the silo and the cow's rumen. The ammonia is probably combined with silage, acids, and lactic, and acetic forming salts—ammonium lactate and ammonium acetate.

Ammonia is a common ingredient of the rumen. The rumen bacteria destroy and rebuild over half of the protein consumed. Ammonia is liberated in this process. Most rumen bacteria require it for growth. It does not matter whether this ammonia comes from urea or conventional protein provided it is present in adequate but not excessive amounts. The bacterial protein formed in this process is true protein used by the animal.

Nutritionists agree that one-third of the protein in the diet of ruminants can come from urea and maintain performance—growth, production, reproduction—equivalent to other sources of protein.

Table 1. Comparative Cost: Urea-Corn Protein vs. Soybean Meal

Urea-Corn Protein Ingredient	Lbs.	Price	Cost	Protein Equivalent	Total Digestible Nutrients	
Urea	10	6¢	$0.60	26.2	0	
S. Corn	70	2¢	1.40	5.1	56	
			$2.00	31.3	56	
Soybean Meal						Cost as % of Urea-Corn
SBM (44%)	70	4¢	2.80	31.8	56	140%
SBM (44%)	70	5¢	3.50	31.8	56	175%

Ten pounds of urea per ton of corn silage supplies only 25 to 30 percent of the silage protein. At this level, urea can still be used to supply up to one-third of the protein in the grain ration without exceeding the recommended limits.

Calculating Urea Protein

Crude protein is defined as the nitrogen content of a material multiplied by 6.25. For example the average protein (such as soybean meal protein) contains 16% nitrogen. Thus 16 x 6.25 = 100% of the protein.

Feed grade urea contains 42% nitrogen. Then 42 x 6.25 = 262% protein—1 pound of urea is equivalent to 2.62 pounds of protein.

In the case of 10 pounds of urea per ton of corn silage, the urea furnished 26.2 pounds of protein—equivalent per ton of silage.

Research and Experience

Successful results with urea in corn silage feeding experiments with dairy cows were reported in 1944 from the South Carolina and U.S.D.A.-Beltsville (Md.) stations. Corn silage treated with 10 pounds urea per ton was used in both trials. Feed consumption and milk production were comparable to the "control" cows getting regular untreated corn silage. Palatability was slightly lower for the treated silage but affected feed consumption very little.

A urea-corn supplement was comparable to an equivalent amount of soybean meal for milk production in further Beltsville studies. When urea was added at higher rates, a Holstein cow ate 104 pounds of silage containing 1.17 pounds of urea and a Jersey cow ate 58 pounds containing 0.58 pounds urea without harmful affects.

At the Florida station, urea was added to sweet sorghum in pilot silos (one ton) at the rates of 0, 10, 30, and 50 pounds of urea per ton. In palatability trials, cattle ate the silages containing no urea and 10 pounds urea equally well followed by that containing 30 pounds.

Cattle refused to eat the silage with 50 pounds of urea per ton until much of the free ammonia had disappeared from it.

Beef cows ate sorghum silage with 10 pounds urea per ton better than untreated silage in Mississippi trials.

Urea appeared to preserve more of the silage carotene in some experiments but not in others. In recent Ohio experiments (1959-61) feeder cattle showed some improvement in rate of gain and 5% to 7% better feed efficiency with urea and limestone both added to corn silage. Urea only in corn silage resulted in equal gains in one trial, but 10% lower gains (1.59 vs. 1.76 pounds per day) in another trial at Minnesota.

Silage that is too dry to produce a normal fermentation and excessive rates of urea both result in inferior silage with a distinct ammonia odor that is refused by cattle. Ammonia odor was not reported in any of the silages when used at 0.5%—10 pounds per ton of silage.

The observations of some 20 Michigan farmers who used urea in corn silage in 1963 indicate it was a successful practice and the silages were very acceptable to cattle at the 10 pound per ton rate.

The economic advantages of using urea outweigh the disadvantage when protein supplements are high priced and high levels of corn silage, sorghum, or sudan grass silage that requires additional protein are being fed.

Methods of Adding Urea to Silage

Urea is added to silage at the time of filling by spreading the weighed (or measured) amount of urea over the top of loads. One or two loads should be weighed to estimate the amount of urea to be added. Thereafter, filling wagons to the same level will result in about the same amount of dry matter per load in spite of changes in the moisture content.

The urea is uniformly mixed by passing through self-unloading wagons, the blower, and silage distributor.

Addition of urea to bunker or trench silos is not recommended unless the silage and urea are blown into the silo to allow fairly good mixing.

Feed Grade Urea

Urea containing 42% nitrogen (262% protein) is recommended. Small size particles will allow more uniform distribution in the silo. This type of urea has been cleared for livestock feed by the Federal Food and Drug Administration.

Most fertilizer grade urea is usable, but it is usually of larger particles and does not have Federal Food and Drug Administration clearance since it is not marketed as livestock feed.

PROCESSING POINTERS FOR CORN SILAGE

Hard-Dough Stage Makes Good Corn Silage

Good corn silage is made from corn that produces a high yield of grain. The crop should be ensiled when the grain has reached a hard-dough stage of maturity. Ensiling at the later stages of maturity results in the maximum yield of grain in the silage and produces a dryer silage.

Cattle consume more dry matter and produce more milk from silages that contain more than 30% dry matter. Corn silage made at the hard-dough stage will contain about 33% dry matter. Fine chopping is desirable to insure good packing and break the grain kernels.

Silages harvested in the "milky" soft-dough stage will contain about 25% or less dry matter and result in excessive seepage from the silo and lower consumption by cattle.

Higher Protein in Dryer Silage

A study of 21 silage samples from Michigan farms and Michigan State University Farm reveals that silages with the highest dry matter content also contain the most protein. From these silages the protein content of dry matter could be predicted by the formula Protein % = (0.375 x dry matter %) − 1.65.

The lower protein content was most apparent in the wetter silages containing less than 30% dry matter. The dry matter of these silages contained about 2% less protein than silages containing more than 30% dry matter. This represents about 20% of the protein normally contained in corn silage. The protein was probably lost through seepage of the wet silages. Seepage losses can account for 0 to 10% of the dry matter stored in the silo.

Energy Value of Corn Silage

The dry matter of corn silage will normally be about 68% total digestible nutrients (TDN). Thus a silage containing 25% D.M. will contain 17% TDN; a 30% D.M. equals 20% TDN; and a 33% D.M., silage contains 22.4% TDN. About half of the TDN comes from grain and the other half from stalks, leaves, and cobs.

Nitrates

The level of nitrates accumulated in corn silage is normally small and insignificant. Occasionally a silage is found to contain harmful amounts of nitrates. Such silage is not readily eaten by cattle, but they will eat it if other feed is not available. Replacing part of the feed with lower nitrate feeds will help reduce the problem.

Excessive nitrates (approximately 2% of the dry matter) in the feed may cause nitrate poisoning—although not always. Some evidence indicates that nitrates may cause destruction of the carotene (Vitamin A) in the silo without causing the nitrate poisoning symptoms. Supplemental Vitamin A is helpful in such cases. Some 50 samples from the 1962 and 1963 silage crops showed very little evidence of nitrates in Michigan corn silages.

Limestone

The addition of limestone to corn silage (20 pounds per ton) at filling time does not increase milk production or affect butterfat test, body weight change, or proportions of fatty acids in the rumen when fed to dairy cows according to Illinois and Georgia studies.

Limestone does increase the fermentation of lactic and acetic acids in the silo, but lactic acid did not affect milk production when fed to dairy cows in experiments at Michigan State.

On the basis of research to date there is no advantage from adding limestone to corn silage for dairy cows.

Corn Silage Feeding Programs for Milk Production—Free Choice Silage, Limited Alfalfa Hay, 1,300 Pound Cows.

Milk Production Level:	10	20	30	40	50	60	70	80	90	100
Total TDN Required, lbs.	13	16	20	23	27	30	33	36	39	41
Total Protein Required, lbs.	2.1	2.7	3.3	3.9	4.5	5.1	5.7	6.3	6.9	7.5
Ration I: Corn Silage - Ear Corn, Alfalfa Hay, Soybean Meal										
Corn Silage, lbs.	80	80	80	65	60	55	50	45	40	35
Alfalfa Hay, lbs.	10	10	10	10	10	10	10	10	10	10
Ear Corn, lbs.	0	0	0	10	15	20	25	30	35	40
Soybean Meal, lbs.	0	0	0	0	0.5	1.0	1.8	2.7	3.2	4.3
Total Dry Matter, lbs.	33	33	33	36	40	43	46	50	53	56
TDN in Ration, lbs.	21	21	21	25	28	31	33	36	39	41
Protein in Ration, lbs.	3.7	3.7	3.7	4.1	4.5	5.1	5.7	6.3	6.9	7.5
Ration II: Corn Silage - Shelled Corn, Alfalfa Hay, Soybean Meal										
Silage and hay rations same as above										
Shelled Corn, lbs.	0	0	0	7	12	16	21	24	28	32
Soybean Meal, lbs.	0	0	0	0	.8	1.8	2.6	3.9	4.7	5.6
Total Dry Matter	33	33	33	34	38	41	45	48	51	54
TDN in Ration	21	21	21	24	27	31	34	38	39	42
Protein in Ration	3.7	3.7	3.7	3.9	4.5	5.1	5.7	6.3	6.9	7.5
Ration III: Urea-Corn Silage - Ear Corn, Alfalfa Hay, Soybean Meal										
Silage and hay rations same as above.										
Ear Corn, lbs.	0	0	0	10	15	20	25	30	35	40
Soybean Meal, lbs.	0	0	0	0	0	0	1.0	1.8	2.7	3.6
TDN in Ration	21	21	21	25	28	31	33	36	39	41
Protein in Ration	4.4	4.4	4.4	4.6	4.9	5.1	5.7	6.3	6.9	7.5
Ration IV: Urea-Corn Silage - Shelled Corn, Alfalfa Hay, Soybean Meal										
Silage and hay rations same as above										
Shelled Corn	0	0	0	7	12	16	21	24	28	32
Soybean Meal	0	0	0	0	0	.5	1.5	2.3	3.2	4.3
TDN in Ration	21	21	21	24	27	31	34	38	39	42
Protein in Ration	4.4	4.4	4.4	4.4	4.7	5.1	5.8	6.3	6.9	7.5

Urea-Corn silage considered 3.6% protein, alfalfa hay 15%, corn grain 8%, SBM 44%. One pound soybean meal equivalent to 1.4 pounds 32%, 0.9 pounds 50%, .8 pounds 55%. Grain rations containing 12% protein will meet requirements at the higher levels.

Balancing Corn Silage Rations

Feeding programs using corn silage free choice and alfalfa hay are shown in the tables on page 4.

Feed consumption figures are typical of herds averaging about 1,300 pounds body weight (Holstein, Brown Swiss, Ayrshire.) Supplemental protein is necessary for cows milking above 40 pounds per day with regular corn silage free choice and 10 pounds of alfalfa hay per day plus ear corn or shelled corn. When urea-corn silage is fed (10 pounds urea per ton) supplemental protein is required for cows milking above 50 pounds per day.

Vitamin A

Ten pounds of good quality alfalfa hay, or an equivalent amount of haylage, with full feed of corn silage will normally provide an excess of Vitamin A. When the hay is poor quality (discolored, or mostly grass) and the silage is made from corn that was badly frozen, supplemental Vitamin A would be in order—25,000 to 30,000 International units per head daily will be adequate supplementation.

Minerals

Steamed bonemeal or dicalcium phosphate must be added to the grain ration to provide calcium and phosphorus. One percent (1%), 20 pounds per ton of grain ration, is adequate. Trace mineralized salt should be added to the grain ration at the 1% level—20 pounds per ton.

Corn Silage Feeding for Heifers

Corn silage and limited alfalfa hay or urea-corn silage provides both the protein and total digestible nutrients (TDN) for growing dairy heifers. The table below illustrates that 5 pounds of alfalfa hay is desirable with regular corn silage to meet protein requirements until heifers reach a weight of about 600 to 700 pounds.

At this stage of growth heifers will eat enough silage to meet both protein and TDN requirements from corn silage. Urea-corn silage requires no supplemental protein for growing heifers above 400 pounds body weight. Steamed bonemeal or dicalcium phosphate and trace mineral salt must be available at all times.

Corn Silage Feeding Programs for Heifers

Body Weight	Requirements			Regular Corn Silage				Urea-Corn Silage		
	DN	Prot.	TDN	Silage	Alf. Hay	TDN	Prot.	Silage	TDN	Prot.
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
400	10.5	1.25	6.5	20	5	6.5	1.3	35	7	1.3
600	13.5	1.33	8.5	30	5	8.5	1.5	45	9	1.6
800	16.5	1.40	10.0	55	-	11.0	1.5	55	11	1.9
1,000	19.5	1.48	11.0	65	-	13.0	1.8	65	13	2.3
1,200	22.5	1.56	12.0	75	-	15.0	2.0	75	15	2.7

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