DS21

UNIVERSITY OF FLORIDA
IFAS EXTENSION

Corn Silage for Dairy Cows[1]

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It is a well known fact that milk production is highly dependent on the amount of energy a cow consumes. In addition to energy, fiber is required by the lactating cow for normal functioning of the rumen. The demand for a high energy forage is therefore obvious. Whole-plant corn silage is such a high quality forage and is often a wise decision when selecting forages to plant. Not only is corn silage an excellent energy source, it also is readily consumed by the animal. Corn silage is also an excellent energy source to complement protein coming from well-managed grass-legume pastures or oil seed meals. In addition to corn silage being a high energy forage, yields of digestible energy per acre are greater than any other feed crop when land and climate are suitable for corn. Planting, growing, and harvesting practices determine dry matter yields. These practices also influence the feeding value of corn silage. Recommended production, harvesting, storage, and feeding methods are discussed below.

CORN VARIETY SELECTION

A corn variety that is well suited for grain production in your area likely will also be an excellent choice for yielding quality silage. However, new research indicates that varieties can differ widely in the digestibility of the fiber portion of the plant. Those varieties which have greater fiber digestion often have equal or greater overall digestion than varieties containing more grain. Feeding corn silages with readily digestible fiber will likely improve milk yield due to improved feed intake. This characteristic plus yield may be the most important criteria when selecting a variety to grow for corn silage. The University of Florida and the University of Georgia at Tifton can provide information to aid in the selection of corn varieties.

CORN PLANT GROWTH

Approximately 24,000 to 30,000 seeds should be planted per acre when planting corn for silage . The amount of fertilizer applied per acre is usually increased compared to that used for growing corn for grain. Corn silage removes nearly twice as much nitrogen and phosphorus and about five times more potassium than a corn crop harvested for grain.

The soil depth of the seed and soil moisture and temperature will affect how long it takes for the new plant to emerge. This usually happens in 6 to 10 days. The early development of leaves is very important because they often dictate the amount of dry matter the plant accumulates and the amount of grain produced. The rate of plant growth between first

1. This document is DS21, one of a series of the Animal Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date September, 1992. Reviewed June, 2003. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.
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emergence and tassel appearance most significantly affects the total time required for maturity and establishes the date it will be ready for harvest. See Agronomy Facts Number 149, "Corn Silage Production," for information on the agronomic practices of growing corn.

The silk emerges from the husks about 4 to 8 days after tasseling. Most pollination occurs one to three days after silking. Growth of the cob portion accelerates after pollination. Grain development is now very rapid and is complete in about 3 weeks. It takes about 30 to 34 days for most fast maturing hybrids to reach physiological maturity after they silk.

In Florida, irrigation of corn planted in the spring will often yield about 25 wet tons per acre. Nonirrigated corn (dry land) seldom will yield over 16 wet tons per acre.

TROPICAL CORN HYBRIDS

Tropical corn hybrids are more resistent to insects and diseases than temperate hybrids. Therefore tropical corn hybrids should be planted under the following conditions:

1. If planting is delayed until late April or May, then tropical corn hybrids should be used in order to optimize yield.

2. With the long growing season in Florida, double cropping of corn is possible. A temperate corn hybrid should be selected for the first planting due to greater yields. However, tropical corn hybrids should be selected over temperate varieties for the second crop, ie. a July or August planting.

Under irrigation, yields of tropical corn have been between 11 and 17 wet tons per acre. Without irrigation, yields normally will be less than 12 wet tons per acre.

The management of tropical corn for silage is similar to that for temperate corn hybrids. One large difference is the threat of armyworms to tropical corn planted beyond May. The fall armyworm is the biggest challenge to successfully producing tropical corn silage. Several applications of herbicides may be required to control the pests, especially at the larval stage. Once the tassel emerges out of the whorl, eggs are laid on the plant's leaves rather than the whorl. Few of these eggs survive and threat from armyworm damage is reduced greatly. See Extension Entomology Report No. 69, "Field Corn Insect Control," concerning the proper use of chemicals for armyworm control.

HARVEST TIMING

Harvesting corn plants at the proper time is one of the most important keys to successfully growing corn for silage. If the harvest is done when the corn is physiologically mature, you will:

- harvest the most digestible nutrients per acre,
- reduce field and storage losses, and
- maximize feed intake per animal.

The location of the milk line and the degree of indentation of the kernels is the best indication of optimum maturity. The milk line is the point where the liquid and solid portions of the kernel meets. It appears when the kernels have dented in their crown portion but it is not obvious in all hybrids. Normally the milk line can be seen without cutting the kernels (Figure 1) but sometimes the kernels must be cut lengthwise in order to determine the milk line location. When the milk line has moved from 1/2 to 2/3 down from the crown, the corn plant has its maximum energy content and yield. It also has an ideal moisture content for tight packing into a silo (65 to 70%). If the corn plants are harvested too early, the grain yield will be reduced and seepage losses during storage will increase. However this is preferred to a late harvest which results in dropped ears, stalk breakage, and leaf loss so that less dry matter is recovered and packing in the silo is more difficult due to a drier plant material. Harvesting earlier or later than this will result in dry matter losses. Nevertheless, starting harvest a little early is often a good management step in anticipation of potential weather and machinery problems.

CHOP SIZE

Use a 1/4 inch theoretical length of cut to chop the corn plants prior to storage. This will break 90%

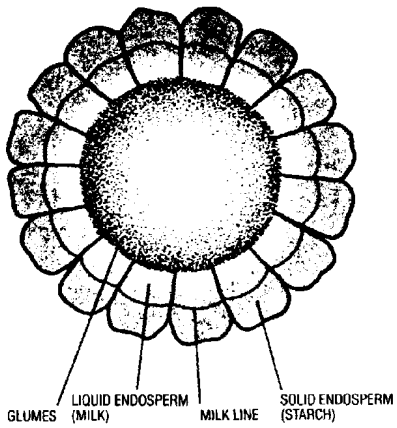

Figure 1. Cross section of cob showing location of milk line.

of the kernels as well as provide material for tight packing in the silo. A finer cut, such as a 1/8 theoretical length of cut, may be desirable only if corn is harvested beyond the hard dent stage or for drought-stress corn. This makes successful packing easier. A finer chop will not improve animal digestibility. Long hay should be fed with corn silage which was chopped extra fine.

QUALITY SILAGE PRESERVATION

Besides harvesting at the right stage of maturity and chopping to the right particle size, other important practices during harvest can help produce excellent quality silage.

Fill Rate

Filling the silo as rapidly as possible will prevent much spoilage. If filling is delayed more than 24 hours, then level and cover the top each day.

Sealing

Spoilage at the top of the pile may be high when using horizontal silos. Each square foot of surface area exposed to the environment will result in loss of 10 pounds of silage dry matter. Plastic sheets carefully placed and weighted down can keep spoilage losses to less than 20%. Used automobile tires cut in half (available for purchase) which are strung together make excellent weights and reduce labor during covering.

Silo Structure

Use a good sound structure. If your horizontal silo is above ground, make sure the walls will be able to withstand the pressure of the silage once it is packed tight. A horizontal silo with wooden sides should be lined with plastic to reduce air infiltration. If you have a vertical silo, make sure the doors are in good shape so that an air-tight seal is probable. Walls of bunker silos should slope 1.5 inches for every foot of silage depth so that silage remains tight during settling.

Removing Silage

At least 4 to 6 inches of silage must be fed per day from the silo during the hot summer months to prevent spoilage of the silage face exposed to air. Only half that amount needs to be removed in the cooler months to prevent spoilage. The amount of silage in a 4 inch layer in horizontal silos is given in Table 1. From this table, we can calculate the pounds of silage one must feed per animal per day in order to remove the minimum 4 inches. For example, a dairyman has 300 milking cows and a bunker silo that is 10 feet deep and 40 feet wide at the bottom. According to Table 1, this silo contains 8.4 wet tons per linear foot which is the same as 2.8 wet tons per 4 linear inches. So 300 cows need to eat 2.8 wet tons or each cow must eat 19 wet pounds per day to prevent spoiling of the "face" of the silage. This table also can be used to calculate the size of a silo to be built for a particular size herd.

FEEDING CORN SILAGE

Corn silage contains 40 to 50% grain (dry matter basis) and is therefore an excellent energy source for a forage. If cows are allowed to eat as much corn silage as they want along with some soybean meal for protein, daily milk production will be about 35 to 40 pounds. Low producers, dry cows, and heifers can get too fat if fed corn silage ad libitum which can lead to ketosis or low milk production in the following lactation. These animals should not be allowed to eat more than 1.5 pounds (dry matter) per 100 pounds of body weight daily. Normally corn silage should not exceed 55% of the total diet (dry matter basis) for lactating dairy cows.

Although an excellent energy source, corn silage is a relatively low protein feedstuff, usually ranging from 7.5 to 9.0% crude protein. Half of the protein is in the nonprotein nitrogen form. Therefore milking cows fed corn silage must be supplemented with natural protein sources such as soybean meal. Feeding 3/4 pound of this type of protein supplement per 1000 pounds of body weight per day provides adequate amounts of protein for dry cows and heifers. The crude protein content can be raised to 12% by adding 10 pounds of urea per ton of wet silage. In no case should an animal consume more than .4 to .5 pounds of urea per day.

Corn silage also contains low amounts of the macrominerals (calcium, phosphorus, potassium, and sulfur) and the microminerals (iodine, manganese, cobalt, and zinc) (Table 2). Other dietary ingredients must supply the animal's requirements for these minerals.

Concern sometimes is expressed over the presence of whole corn kernels in the feces Usually less than 4% of the kernels pass out of the animal when the plants have been properly chopped and this has little effect upon digestibility. Finer chopping only leads to greater problems for the cow such as acidosis, low milk fat, and displaced abomasum.

Adding buffers (sodium bicarbonate or sodium sesquicarbonate) to diets containing large amounts of corn silage will help reduce acid accumulation in the rumen and keep feed intake up. Because the silage has a low pH and contains a lot of energy, acid content of the rumen can be high.

How much concentrate should be mixed with corn silage to optimize profit? In a study at the University of Florida, diets were formulated to three differing corn silage to concentrate ratios. They were 46:54 (31% NDF), 56:44 (35% NDF), and 66:34% (39% NDF) corn silage:concentrate (dry matter basis). Table 3 shows the performance and profitability of cows on the experiment.

As corn silage made up a bigger part of the diets, cows ate less feed and produced less milk. However, the diet containing the most corn silage was the cheapest to feed, namely $0.42 per day cheaper than the diet containing the least corn silage. This resulted in the high corn silage diet being the most "profitable" of the three diets.

Is the nutritive value of corn superior to tropical corn or sorghum silage? Spring-planted corn silage was compared to summer-planted forage sorghum silage and tropical corn silage for lactating cows. Diets were about 45% forage and 55% concentrate on a dry matter basis. Cows fed either of the two corn silages outperformed cows fed sorghum silage (Table 4). Poor digestibility of sorghum NDF may help explain these differences in cow performance.

NITRATE PROBLEMS

Under normal conditions, nitrogen enters the plant in the form of nitrate ions and is converted into amino acids for protein synthesis. Drought, insect damage, hail, or cloudy weather may limit plant growth below that expected with normal fertilization. As a result, nitrates may accumulate in the plants. Livestock eating plants containing excessive nitrate-nitrogen can suffer harm. Animals with nitrate toxicity will have some of the following symptoms: increased pulse rate, quickened respiration, heavy breathing, muscle trembling, weakness, staggered walk, and blindness. This risk is lowered when the plants are ensiled because one-half to one-third of the nitrates are converted to nitrogen dioxide by the fermentation process. Guidelines for using silage with increasing nitrate concentrations are in Table 5.

CORN SILAGE PROGRAM COSTS

Costs to produce, harvest, store, and feed irrigated (center pivot) corn silage from a bunker silo under Florida conditions is in Table 6. The dollar values are on a wet ton per acre basis. If irrigation is not used, maximum yield will likely be around 16 wet tons per acre (muck land corn production will be more). The cost to produce, store, and feed nonirrigated corn silage at 15 tons per acre is about $37.82.

SUMMARY

1. Corn silage yields more digestible energy per acre than any other feed crop when the land and climate are suitable for corn.

2. Select hybrids adapted to your soil and growing season.

3. Increase your planting rate and fertilization rate when growing corn for silage rather than for grain.

4. Use the "milk line" test to determine when to harvest your corn. Also at this time, the grain will be in the hard dent stage and the total plant moisture will be about 70 to 65%.

5. Chop at a 1/4 inch theoretical length of cut.

6. Test your silage for nitrate content during times of drought or heavy insect damage and then observe proper feeding guidelines.

7. Supplement corn silage diets with natural protein and minerals especially calcium.

8. Do not feed corn silage ad libitum to dry cows, heifers, or cows in late lactation as they will tend to become too fat.

9. Because corn silage is a high energy forage, it can replace a good portion of the concentrate resulting in a favorably priced ration.

Table 1. Horizontal silo capacities for corn silage.

	Average width, feet[1]						
Average Depth (ft)	20	30	40	50	60	70	80
	- - Dry tons per foot of length[2] - -						
8	0.90	1.35	1.85	2.30	2.75	3.20	3.65
10	1.20	1.80	2.40	2.95	3.55	4.15	4.75
12	1.50	2.25	2.95	3.70	4.45	5.20	5.95
14	1.80	2.70	3.60	4.50	5.40	6.30	7.20
16	2.15	3.20	4.30	5.35	6.40	7.50	8.55
18	2.50	3.75	5.00	6.25	7.50	8.75	10.0

[1]Front surface is assumed to have a 45 degree slope.

[2]Divide numbers by dry matter content of silage to determine the number of wet tons per foot of length.

Table 2. Average nutrient content of properly-harvested corn silage.

Nutrient	100% Dry	As-fed
Dry matter,%	100	35
NEL[1], Mcal/lb	.68	.24
TDN[2], %	70	24.5
NDF[3,%]	51	17.8
ADF[4],%	31	10.8
Calcium,%	.27	.09
Phosphorus,%	.20	.07
Potassium,%	1.05	.37
Magnesium,%	.28	.10
Sulfur,%	.08	.03
Sodium,%	.01	.004
Copper,ppm	13.2	4.6
Iron,ppm	640	224
Manganese,ppm	34	11.9
Zinc,ppm	21	7.4

[1]Net energy of lactation.

[2]Total digestible nutrients.

[3]Neutral detergent fiber.

Table 3. Performance and profitability of diary cows fed diets of three mixtures of corn silage and concentrates.

	Corn silage to concentrate ratio (dry matter basis)		
Measurement	46:54	56:44	66:34
Dry matter intake, lb/day	43.8	43.0	41.2
Milk yield, lb/day	51.6	51.6	50.3
Milk fat, %	3.39	3.38	3.51
Milk protein, %	3.20	3.10	3.10
Milk income, $/day	7.69	7.69	7.54
Feed costs, $/day	3.13	2.95	2.71

Table 3. Performance and profitability of diary cows fed diets of three mixtures of corn silage and concentrates.

Milk income minus			
feed costs, $/day	4.56	4.74	4.83

Table 4. Performance of lactating cows fed temperate corn silage, tropical corn silage, or sorghum silage.[1]

Silage	Dry matter intake (lb/day)	Milk yield (lb/day)	Milk fat (%)	NDF digestion (%)
Spring corn	43.8	51.6	3.39	54.9
Summer tropical corn	43.1	50.4	3.33	52.3
Summer sorghum	43.0	47.4	3.35	43.7

[1]1992 Dairy Production Conf., Univ. Florida, Gainesville.

Table 5. Guidelines for feeding silage containing increasing amounts of nitrates.

		Guideline	
Nitrate Ion %	**Nonpregnant**		**Pregnant**
.44 - .66	Safe		Limit to 50% of diet DM
.66 - .88	Limit to 50% of diet DM		Limit to 25% of diet DM
.88 - 1.54	Limit to 35-40% diet DM		Do not feed
1.54 - 1.76	Limit to 25% of diet DM		Do not feed
> 1.76	Do not feed		Do not feed

Table 6. Costs to produce, harvest, store, and feed irrigated corn silage.[1]

			Yield of corn silage wet tons/acre		
Item	15	20		25	30
	- - - - - $/wet ton - - - - -				
Cost to produce	22.67	17.01		13.60	11.34
Costs to harvest, haul, pack[2]	4.62	4.62		4.62	4.62
Cost to store (10x30x185 feet concrete bunker)	7.24	7.24		7.24	7.24
Sub total	34.53	28.87		25.46	23.20
15% storage loss[3]	5.18	4.33		3.82	3.48
Sub total	39.71	32.18		29.28	26.68
Cost to feed	5.56	5.56		5.56	5.56
Total cost	45.27	37.74		34.84	32.24

[1]Dr. Tim Hewitt, Food and Resource Economics Dept., University of Florida, Gainesville.