Corn Silage for the South: Management & New Technology

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Introduction

Corn silage-based diets are the general rule for most milk producers in the south. High producing dairy herds require high quality feed. Corn silage is generally the feed of choice for milk producers because of it's high energy content, good palatability, good keeping quality, little field loss at harvest, ability to harvest at optimum stage of growth, flexibility in feeding, and high yield. Harvesting the whole plant as silage results in 55 to 65% more dry weight than harvesting as grain. It has disadvantages of needing special harvest equipment, need for large, specialized storage areas, excessive losses if not stored properly, not readily marketable if not used on the farm, and the need to be fed soon after its removal from the silo or pit to minimize spoilage. Hay production is the traditional way of preserving forage in most other types of livestock operations. However, weather conditions often do not favor rapid drying and may delay cutting at the proper growth stage. Hay is usually not as suitable as silage for providing the large volumes of feed needed on dairy farms. Many other crops can be ensiled but the digestibility of corn is superior to other commonly used silage crops (Table 1).

Table 1. Digestible Nutrients as a Percentage of Those in Corn

Crop	Digestible Nutrients (% value of corn)
Corn	100
Grain Sorghum	92
Forage Sorghum	87
Sorghum-Sudangrass hybrid	48
Sudangrass	46

Factors in Silage Production

Fertility- Influence on Nutrient Uptake and Silage Yield

As good quality feed is necessary for high milk production, a good nutrient program is necessary for high corn silage quality and yield. Providing nutrients for the corn crop has gone through its

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own evolution. Much of the corn planted on farms years ago had fertilizer applied in-row from hoppers mounted on a tool bar with the planters; generally, low rates of fertilizer were applied without sacrificing yield. As farmers increased the size of farming operations, fertilizer began to be spread with spreader trucks prior to planting. This allowed more acreage to be covered on a timely basis. In the 70's, in-row subsoiling became popular because of the sometimes dramatic yield increases in dry years to breaking the soil compaction layer. This was followed by strip-till planting in the late 70's when machinery became available that could plant in thick cover crops and provide in-row subsoiling. Subsequent research with dry or liquid starter fertilizer in strip-till plantings resulted in a higher percentage yield increase than in conventional plantings.

After years of debate on the matter, most of the research from several southeastern states has shown significant yield increases with the use of starter fertilizers. Starter fertilizers consist of nitrogen and phosphorous fertilizer applied at low rates near the row at planting. Yield increases have come from many fertilizer sources which give initial growth enhancement. Those which have been used with success are ammonium polyphosphate (10-34-0), diammonium phosphate (18-46-0), monoammonium phosphate (12-50-0), urea and triple super phosphate mixtures, and complete fertilizer (3-9-18 and 5-10-15, etc.). Placement of starter fertilizer always brings about questions. Farmers using strip-till methods of planting have had very few options. Dry fertilizer could either free fall into the slot behind the subsoil shank or liquids could be dribbled on the surface behind the planter. Our research with placement of liquid fertilizer on the subsoil shank below the seed has generally not resulted in yield increases. Table 2 shows that either surface dribble or the 2" x 2" placement result in highest grain yield in most years. The surface dribble is usually applied one to two inches to the side of the seed furrow. The rule of thumb for surface N applications is to apply the fertilizer one inch to the side of the row for each 10 lbs. of N. Early growth is increased when compared to no starter fertilizer, and time to maturity is shortened as noted by faster dry down. This would be beneficial for silage growers who want to double crop in a given year. Several years of plant tissue analysis shows higher uptake of N and P at the early growth stages which results in larger plants and root systems.

Table 2. Starter Placement Influence on Corn No-tilled into Clover Under Irrigation (FL).

Placement of Starter	plant ht (in.) mid-April	Grain H_2O mid-July	Yield bu/A
Control	5.2	97	141.8
In furrow	6.3	67	107.1
2" x 2"	7.0	44	171.7
Surface	6.2	45	169.5
2" below	6.3	67	122.1
5" below	5.0	91	115.4
8" below	4.5	88	138.7

Corn or grain sorghum make better silage than legumes or other grasses because of the greater amounts of readily-soluble carbohydrates contributed by the grain portion of the plant. About 40 to 50% more total energy is harvested from a field when corn is made into silage than when only the grain is removed. Consistent production of high-yielding corn silage requires good management and knowledge of the amounts of plant nutrients removed by the crop. Very similar to the deposits and withdrawals with a bank account, adequate nutrients must be provided for the crop to achieve desired yields. Amounts of macro nutrients removed per acre by a 30-ton corn-silage crop are shown in Table 3.

Table 3. Total Nutrient Uptake of Corn Plants at Several Stages of Growth and Age (FL)

Stage of Growth	Days After Planting	N	P	K
		Lbs uptake/A		
20 inches	41	14	2	27
48 inches	60	72	8	116
tassel	82	122	18	191
maturity	132	280	45	296

The crop removed almost 300 lbs/A each of both nitrogen and potassium, and about 50 lbs/A of phosphorus. These nutrients must be available from the soil or applied to the crop during growth, along with about 30 lbs/A of sulfur in the sulfate form, and 2 lbs/A of boron. Nitrogen, sulfur and boron should be applied in at least three split applications if grown under irrigation because of their mobility in the soil, with a third or less at planting and two sidedress applications. Since starter fertilizer is important for early growth of corn, the initial application of nutrients should be applied as starter. Micronutrient applications of zinc and manganese at 2 to 3 lbs/A often result in dramatic responses in grain yield. Soil-test levels of phosphorus and potassium should be determined and the rate of application adjusted accordingly. A silage crop that takes up 300 lbs. of N has about one ton of protein produced from that acre.

Over a number of years, grain protein content has been evaluated with several hybrids with N fertilizer applied near the row at planting. Generally, row applied N increased protein levels slightly but has resulted in about a 7 bu/A grain increase. Certain hybrids consistently gave a 25 bu/A yield increase of grain while others had little or no yield increase. One surprise has been less lodging when using a NP starter over many hybrids. Stalk strength has generally been attributed to K by decreasing stalk and root disease, however, NP fertilizers have shown beneficial results on lodging in most studies. In one study using 26 hybrids, lodging was reduced by half over no starter fertilizer.

Corn plants take up small amounts of nutrients during initial growth stages. Therefore, starter fertilizer does not need to contain high rates of N, P or K. If an early sidedress application of N is

made, 30-40 lbs/A of N, and 20-30 lbs/A of P is adequate for starter effects (vigorous early growth). However, all P requirements may be met with the starter fertilizer if soil test levels are not low. Where soil test levels are low, benefits from broadcasting a complete fertilizer has been noted in addition to the starter fertilizer. There are other nutrients that have been found to be beneficial in starter fertilizer. These include Zn, Mn, S, and B. Care has to be taken with liquid fertilizer to keep from clogging the system because certain reactions may occur depending on the form of the nutrient. Where dry and liquid fertilizers were compared, no difference was noted in growth of the plants. Source of the NP nutrients also made no different in growth or yield. The important factor is to have the nutrients near the plant when soils are cool, and root growth is limited.

To recap: a starter fertilizer can be any fertilizer source, liquid or dry, that contains at least N, P and S and may include a complete fertilizer plus micronutrients. It should contain at least 20 lbs N and 20 lbs P_2O_5/A and be applied close to the row. Dry fertilizers may be allowed to free-fall into the subsoil slot on a ripper planter. Liquid fertilizers may be applied 2" x 2" or in a surface dribble behind the press wheel, about 2" to the side of the row for each 20 lbs of N. Application of liquid fertilizer below the seed on the subsoil shank has shown little benefit.

Application of Zn and Mn in starter fertilizer have been shown to increase yields whereas delayed applications on foliage has shown little benefit.

Benefits to the plants from starter fertilizers are:

A. Better early growth (plants and roots)

B. More nutrient uptake

C. Less lodging

D. Faster dry down

E. In many cases, shorter plants and ear heights

F. Slightly higher grain protein

G. Higher yields

Nutrient removal from a high yielding silage crop is quite high. Two silage crops in a single year or removal of silage over several years makes it necessary to monitor fertility levels on a yearly basis to insure proper fertility for sustained yields. Many other factors in addition to fertility are involved in economically sustainable crop production and should be utilized in crop production practices (proper rotation, tillage, irrigation, liming, cover crops, etc.).

Planting Date Influence on Maturity, Silage Yield, and Digestibility

Recommended planting dates for corn in the south have been determined by amount of insect and disease damage and other influences on yield and quality. These factors have led to a planting window of about 45 days in the early spring. Table 4 shows the typical influence of 4 planting dates one month apart and their affect on yield of silage. Mid April is the last recommended planting date in the deep south due primarily to severe fall army worm pressure. Conventional hybrids have a sharp yield decline as the planting dates are delayed. However, some of the tropical germplasm has some tolerance to insect pests and are not as severely affected. Table 5 shows an atypical year with insect damage much lighter than normal. Neither silage yield or digestibility changed much except for the month of May when yield was lower but digestibility did not change. Sunbelt 1876 was perhaps the most widely grown silage variety in our state at one time until all of the corn varieties were checked for digestibility and it turned out to be the lowest each year; it may have had some anti quality factors that made it unattractive to insects, which led to it's high yield. Planting date influences the days to maturity of corn as well because of heat units (Table 6). As we produce better varieties that can stand up to harsh conditions of disease and insects, corn may be planted over a 6 month period instead of a 45 day period. This could provide a more uniform supply of feed and make better utilization of equipment and storage facilities.

Table 4. Comparison of Temperate (Sunbelt 1876) and Tropical (Pioneer 304C) Corn Silage Yield Over Four Planting Dates (FL).

Planting Date	Tropical	Temperate
	Silage ton/A (35% DM)	
Mid-April	18.1	19.1
Mid-May	14.3	9.5
Mid-April	13.6	6.5
Mid-July	11.1	7.1

Table 5. Influence of Planting Date on Silage Yield of Tropical and Temperate Corn Varieties (FL)

Planting Date	Pioneer 3098 ton/A 35%DM	IVOMD %	Pioneer X304C ton/A 35%DM	IVOMD %	Sunbelt 1876 ton/A 35% DM	IVOMD %
Mid-April	14.9	62.1	14.3	60.9	22.9	53.3
Mid-May	10.9	61.6	10.1	58.5	10.6	45.5
Mid-June	14.7	56.6	13.1	55.2	16.9	45.4
Mid-July	14.8	68.9	18.2	67.0	18.9	61.9

Table 6. Growing Period Pattern as Affected by Corn by Planting Date

	Planting Date				
	Feb 9	Feb 27	Mar 17	Apr 8	May 1
Days to emerge	14	10	13	5	5
Days from emergence to 50% tassel	72	71	55	50	49
Days from tassel to 35% moisture	60	57	59	58	54
Days from emergence to 35% moisture	132	128	114	108	103

Varietal and Genetic Technology Influence on Yield and Silage Quality

Variety testing is a part of the responsibility of the land grant university in each state to keep farmers up to date on best varieties for planting under their conditions. When open pollinated varieties were grown, farmers would select the best ears from the best looking stalks and save it for seed for the next year. With hybrids, farmers have to depend upon industry and university tests to determine which hybrids are best. There is no best hybrid for every purpose. Some are better for grain production while others are better for silage production. All growers would like to have good agronomic characteristics of high yield, good standability, disease resistance, wide adaptability, and for the south, insect tolerance. Table 7 shows a variety trial with digestibility and crude protein content of silage comparing the top 5 to the bottom 5 hybrids. Some of the best yielding hybrids were in the top 5, while one of the best yielding hybrids was the least digestible in both years. Having digestibility data for selecting hybrids for silage would have increased digestibility by more than 16% in the first year and more than 34% in the second. At the time of this trial, the least digestible hybrid in both years was the most widely grown corn for silage in the state by dairy farmers. Crude protein did not correlate with the digestibility of the silage. Likewise, tropical corn (Table 8) varied in a similar manner in digestibility as the temperate corn variety trial. The most widely grown tropical corns are in the middle or lower class in digestibility of the varieties tested. Tropical corn does not usually yield as well when planted in the normal planting season as temperate hybrids, but yields are superior when planted later than the normal planting season, because of their tolerance to insects and disease.

Table 7. Digestibility and Crude Protein Content of Silage Varieties (FL)

	Best 5 Varieties Avg		Lowest 5 Varieties Avg		Increase
	IVOMD %	CP%	IVOMD %	CP %	IVOMD %
Year 1	71.1	8.6	61.1	8.4	16.4
Year 2	67.6	7.7	50.3	8.6	34.4

Table 8. Digestibility of Tropical Corn Silage for Several Hybrids (FL)

	IVOMD %		
	Best 5 Variety Avg	Lowest 5 Variety Avg	Increased IVOMD %
Year 1	61.5	49.3	24.7
Year 2	63.0	54.7	15.2

Many factors are important for growers to consider when determining the best variety to grow for their operation. However, for on farm use, a farmer would desire excellent feeding quality. Feeding quality can be described by digestibility, protein and fiber analysis, grain content, among other factors. Quality analysis is seldom a part of variety testing, but should be to determine the total value of that hybrid. Many top yielding hybrids are not the most digestible or may have a low protein content as compared to other hybrids. Total value of any hybrid cannot be determined until it is known what the farmer needs in the way of nutrients.

One big advantage that the southeast has in corn production is its long growing season. However, we have not been able to take advantage of it in late planting or double cropping because of the insect damage and disease problems caused by the high summer humidity. With the introduction of Bt (Bacillus thuringiensis Berliner) corn, we felt that we may be able to solve the insect problem and be able to produce a high quality corn late in the season and perhaps two silage crops in one year (Wright et al., 1998). Tables 9 and 10 show the influence of planting date on both silage and grain yield. Although 1997 was a relatively light year for insects, it looked like the Bt corn may extend planting date by one to two months after the normal planting period. Tropical corn yield was very satisfactory throughout the entire period, which would indicate a light insect infestation. Digestibility decreased with a reduction in grain yield. The main reason for the decreased grain and silage yield from both the temperate and Bt corn in 1997 was due to disease. As Bt varieties are developed with better disease resistance, or Bt is introduced into tropical germplasm, high yielding corn will be produced over an extended period, giving producers more flexibility and better utilization of resources.

Table 9. Silage Yields of Three Corn Hybrids Over Four Planting Dates FL in 1997.

Planting Date	Corn hybrid: Pioneer 3098 (tropical)	Pioneer 31B13 (Bt)	Pioneer 3223 (temperate)	Avg.	LSD (0.05)
	-----T acre^{-1}-----				
April 21	17.2	16.2	15.9	**16.4**	NS *
May 15	22.0	18.9	15.2	**18.7**	4.64
June 16	19.8	13.2	6.0	**13.0**	2.89
July 7	16.7	9.2	4.4	**10.1**	1.20
Avg.	**18.9**	**14.4**	**10.4**	***14.6***	
$LSD_{(0.05)}$	NS	1.57	2.13		

$LSD_{(0.05)}$ for planting date: 1.53
$LSD_{(0.05)}$ for corn hybrid: 1.32
$LSD_{(0.05)}$ for planting date x corn hybrid: 2.65
* NS - not significantly different at 5% probability level

Table 10. Grain Yield of Three Corn Hybrids Over Four Planting Dates FL, 1997

Planting Date	Corn hybrids: Pioneer 3098 (tropical)	Pioneer 31B13 (Bt)	Pioneer 3223 (temperate)	Avg.	LSD (0.05)
	Bu acre^{-1}				
April 21	133.3	129.9	122.2	**128.5**	NS *
May 15	127.3	107.8	82.5	**105.9**	4.64
June 16	83.5	46.1	7.9	**45.9**	2.89
July 7	87.5	42.7	3.6	**44.6**	1.20
Avg.	**107.9**	**81.6**	**54.1**	***81.2***	
$LSD_{(0.05)}$	14.9	16.8	15.0		

$LSD_{(0.05)}$ for planting date: 8.00
$LSD_{(0.05)}$ for corn hybrid: 6.93
$LSD_{(0.05)}$ for planting date x corn hybrid: 13.85
* NS - not significantly different at 5% probability level

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