Agronomic Management of Corn for Silage

Summary

- After selecting the proper genetics for corn silage, maximizing silage quality and yield depend on optimizing plant population and row spacing, nitrogen fertility, planting date, harvest timing and cutting height.
- Narrow-row corn systems may increase corn silage yields about 7% above 30-inch rows with little impact on quality.
- Proper soil fertility can improve corn silage quality. As nitrogen availability increases, the crude protein (CP) content of harvested corn plants increases.
- The effect of early planting on yield and quality of corn for silage is dramatic, just as it is for corn grown for grain. Early planting also allows for early harvest potential.
- Growers can affect silage quality by correctly timing harvest and adjusting cutting height. Harvesting at the right time is needed for proper fermentation in the silo.
- As cutting height is increased, forage yield declines and quality increases due to the fact that lower quality, high NDF material is left in the field.

Introduction

Corn silage yield and quality are highly dependent upon the hybrid selected and crop management practices utilized. Corn silage hybrid selection targets include: 1) high forage yield, 2) high grain content, 3) proper relative maturity placement, 4) strong agronomic strengths (e.g.: standability), and 5) high fiber digestibility. Agronomic practices that influence yield and quality include plant population and row spacing, nitrogen fertility, planting date, and harvest management. This article will discuss how growers can optimize other cropping practices for maximum corn silage production and profitability.

Narrow Row Spacing for Corn Silage

Growers have begun to adopt narrow-row (15 to 22 inches) corn practices in North America because of the potential for increased yields, better weed control, reduced soil erosion, and better nutrient use. While narrow-row systems may have greater yield potential, they are challenging because of the equipment costs and limitations for cultivating and sidedressing fertilizers.

A number of university and private company studies have been conducted to compare corn grain yield in narrow-row corn systems versus conventional 30-inch row spacing. Most of these studies show a small positive yield response to narrow-row spacing, averaging about 4-5%. The yield response seems to be greatest and most consistent in northern environments where the growing season is short. More southern locations measure very small or even negative responses to narrow-row spacing.

Recently, researchers have studied the use of narrow-row planting configurations for corn silage production. Table 1 summarizes the results of studies conducted in four states where

corn silage is produced. The yield increase due to narrow-row spacing for corn silage averages about 7%. This is a larger response than is measured for corn grain yield. Forage quality of whole corn plants does not differ among the various row spacing systems.

In spite of the 7% yield response to narrow-rows, the cost of planting and harvest equipment changes and increased fertilizer and insecticide costs is high. A Cornell University study determined that it would require growing over 400 acres of corn silage with a yield increase of two tons/acre to achieve an adequate return on investment. This assumed the grower owned the planting and harvest equipment, however. These relationhips could change with custom harvest, which is becoming more common.

Table 1. Yield response of corn grown for silage in narrow versus 30-inch row spacing.

State	No. of Studies	Row Spacing (inches)	Yld Advantage vs. 30-inch spacing
Michigan	3	15/22	8.40%
Wisconsin	12	15/20	6.90%
Pennsylvania	10	15	8.80%
New York	3	15	4.20%
Wisconsin (Pioneer)	8	15	7.00%

Narrow Rows and High Plant Density

Narrow-row studies frequently include a plant density variable to determine if narrow-row spacing changes the optimum plant density. A Michigan State University study compared three row spacings at plant densities ranging from 24,000 to 36,000 plants/acre at harvest (Figure 1).

This study showed that corn silage yield was increased by both narrower rows and higher plant density. The population response was similar across all row widths. The narrowest row width at the highest population resulted in the maximum yield in this study.

The ideal plant population depends on many factors including soil type, planting date, hybrid, soil fertility, and moisture conditions during the growing season Growers are often concerned about stress-induced yield loss due to high density plant stands. However, high-density corn stands can typically

PIONEER. A DuPont Company

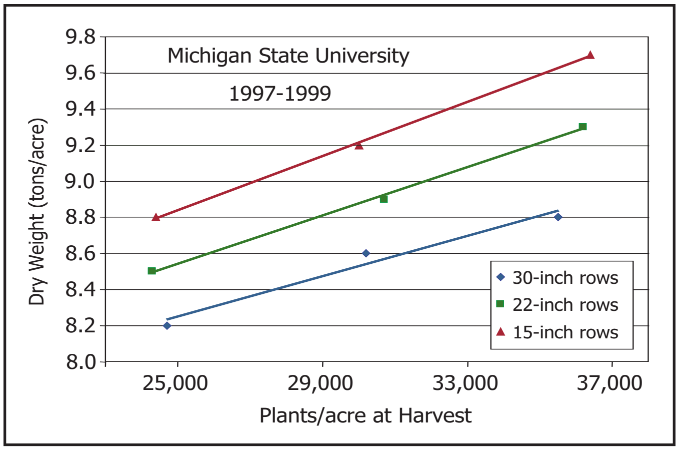

Figure 1. Silage yield response to row width and density, 1997-1999. Michigan State University.

withstand the stress of drought conditions if soil fertility is high, a stress-tolerant hybrid is planted, and pests are controlled. Also, the concern about increased lodging due to higher plant density is less important for corn silage production since the crop is harvested early in the fall.

Soil Fertility for Corn Silage Production

Corn silage fertility programs must compensate for the large amount of nutrients removed with the whole plant. Figure 2 shows the nutrient removal per acre of corn silage and corn grain. Because of high nutrient removal, subsequent rotational crops may suffer if these nutrients are not replaced in a soil nutrient management program.

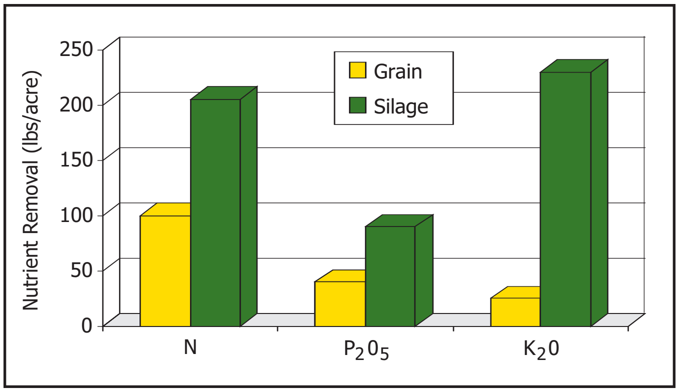

Figure 2. Nutrient removal of corn grain and silage. (U. of Wisconsin).

Additionally, high soil fertility can improve the forage quality of corn silage. As nitrogen availability increases, the crude protein (CP) content of harvested corn plants increases. Cornell University researchers studied the effect of nitrogen rate and row width on yield and quality of silage in a two year study. Pioneer brand 3525 corn hybrid was planted in both 15-inch and 30-inch rows at 32000 and 46000 plants/acre. Nitrogen (urea) was applied at planting at six rates ranging from 0 to 250 lbs actual N/acre. Results showed that:

- Optimum N-rate was 150 lbs/acre (+20 lbs applied through planter), for both silage yield and milk/acre.
- Optimum N-rate was the same for both row spacings and plant populations.
- Crude protein was slightly increased for 15- vs. 30-inch rows (higher N uptake by 20 lbs/acre).
- These results were confirmed with a 2000 on-farm study.

The authors suggest that nitrogen rates can be increased by about 20 lbs/acre compared to grain to maximize nutrient yields of the corn silage crop.

Corn Silage Response to Planting Date

Because corn silage is harvested before full grain maturity, the entire growing season is not always utilized. Consequently, some growers have not adapted early planting practices. However, the effect of planting date on the yield and quality of corn silage is dramatic, just as it is for corn grown for grain. Corn silage growers can ill-afford to give up the benefits of early planting.

Recent work at the University of Wisconsin demonstrates that corn silage profitability is maximized when silage corn is planted during the optimum time for a region. Highest silage yields were obtained in a Wisconsin study when corn was planted in early May. Late May and early June planting dates reduced yield by 5-15% and mid-late June plantings yielded only 65% of early May plantings.

When considering the value of corn silage production, both the yield and quality must be factored together. The digestibility of corn silage in the Wisconsin study showed a steady decline from the earliest to latest planting dates. Equations have been developed to combine the effects of yield (tons/acre) and the effect of silage digestibility on milk production (milk/ton) into a single number, milk/acre. Table 2 shows the effect of planting date on predicted milk per acre of corn silage.

Table 2. Milk / acre response of corn grown for silage at various planting dates in Wisconsin (Lauer).

Planting Date	Milk per acre (lbs)	% Change vs. Optimum Date
April 15-May 15	18,000	-
May 15-June 1	15,000	-17%
June 1-10	10,000	-44%
June 10-June 30	5,000	-72%

Clearly large penalties exist for late-planted corn silage. Delaying planting past May 15 resulted in a 17% reduction in milk/acre. When planting occurred from June 1 to June 10, a 44% reduction was incurred. After June 10, milk/acre was reduced 72% compared to the optimum planting date.

Early planting offers several advantages such as the ability to use full-season hybrids for a region and earlier harvest opportunities. As with grain, the advantages of high plant densities, fertility, vigorous hybrids, and other yield maximizing management practices are best realized when corn grown for silage is planted early.

Harvest Strategies for Corn Silage

Harvest management strategies for corn silage should take into account several factors, including time of harvest and cutting height of corn.

Timing Silage Harvest

Plant maturity and moisture must be closely monitored to determine when to harvest corn to assure proper fermentation in the silo. The drier and more mature the forage, the shorter should be the theoretical length of cut setting on forage harvesters. Silo structures will determine the recommended moisture content for best fermentation. The following table provides recommended guidelines for maturity, % moisture, and length of cut:

Table 3. Corn silage maturity, moisture and length of cut guidelines. Source: Pioneer Hi-Bred.

	----------- *Storage Type* ---------				
	Bunker	Stave	Sealed	Bagged	TLC*
Corn Silage, Non-Processed					
Maturity	----------- % Moisture -----------				**Inches**
Milk line 1/8-2/3 down the kernel	67-72	63-68	55-60	60-68	3/8 - 5/8"
Corn Silage Processed**					
Maturity	----------- % Moisture -----------				**Inches**
Milk line 1/8-3/4 down the kernel	63-72	60-68	55-60	60-68	Up to 3/4"

*TLC = Theoretical Length of Cut

** Roller setting 1-3mm depending on moisture

If silage is ensiled too wet, clostridial fermentation may occur resulting in excessive nutrient losses and unpalatable silage. Forage ensiled too dry can have aerobic yeast and mold problems that may result in excessive nutrient loss, heating, and unpalatable silage. The challenge for the grower is how to easily predict the moisture content of the corn crop prior to harvest.

Kernel milkline has been used as an indicator of whole plant moisture content of corn. While kernel milkline can give an indication of whole plant moisture content, there is variability among hybrids and years. This method is best used as a trigger indicator for growers to begin testing the moisture content of whole plants using a microwave or a commercial moisture tester. The kernel milkline can then be easily and continuously monitored to observe the rate of drying in the field.

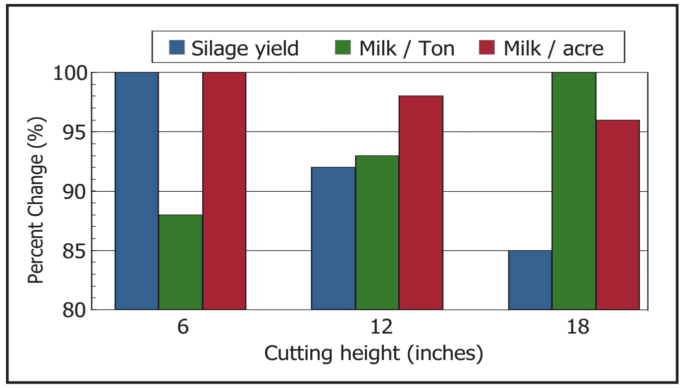

Figure 3. Relative change in silage yield and quality at different cutting heights during 1996 (Univ. of Wisconsin).

Cutting Height of Corn for Silage

In general, as cutting height is increased, forage yield declines and quality increases due to the fact that lower quality, high NDF material is left in the field. University of Wisconsin studies and Pioneer studies indicate that as cutting height is increased from 4 to 18-20 inches above the soil, yields are reduced by 12-15%. Digestible energy of the corn silage increased as cutting height increased. When yield and quality (milk/ton) are combined into a single number that represents the potential milk that would be produced from an acre of land (milk/acre), the true tradeoff of yield and quality can be measured. In both the Wisconsin study (Figure 3) and the Pioneer Hi-Bred study (Tables 4 and 5), the breakeven point between yield and quality is an intermediate cutting height of about 10-12 inches. Depending on the market value of the silage, the grower could choose to emphasize quality or yield by raising or lowering the corn cutting height.

Table 4. Yield response to silage cutting height. Average of 8 hybrids, 4 irrigated environments, 1998-1999. Pioneer Hi-Bred.

Silage Cutting Height (Inches)	30% Dry Matter Tons/Acre
4	29.8
8	28.4
20	26.6
LSD *(0.05)*	0.4

***Yield significantly different at P<0.01.**

Table 5. Influence of cutting height on the quality characteristics of corn silage. Average of 8 hybrids, 4 irrigated environments, 1998-1999. Pioneer Hi-Bred.

Cut Height	Whole Plant Digestibility	RAE	Milk/acre	Milk/ton
4 in.	71.7	48.2	21930	2452
8 in.	72.1	48.3	21308	2500
20 in.	73.3	49.3	21110	2646
LSD *(0.05)*	0.3	0.4	577	68