NATURAL RESOURCES CONSERVATION SERVICE
VIRGINIA TECHNICAL NOTE

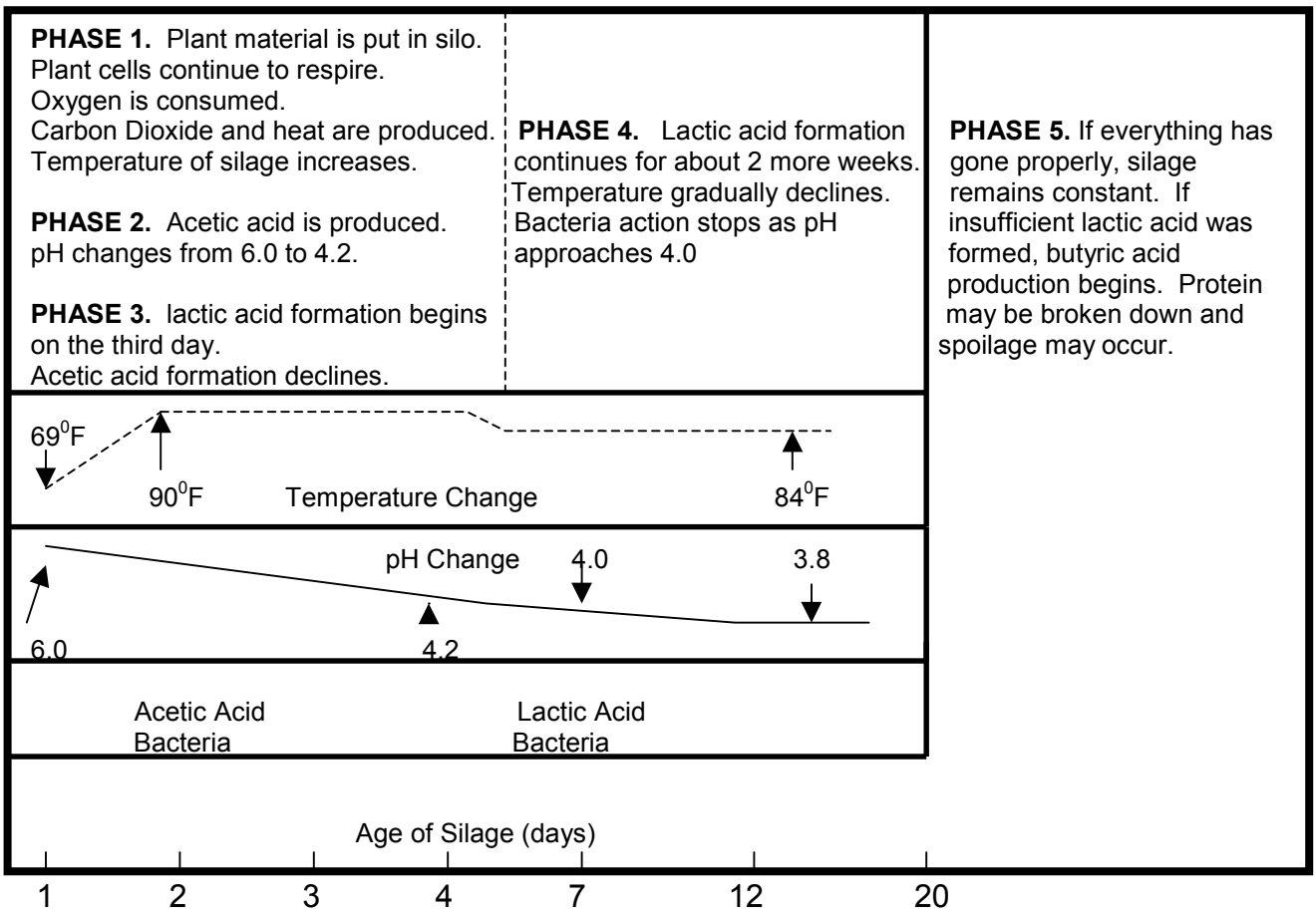
Agronomy – Forages/Pasture and Hayland Management #5

HARVESTING CORN FOR SILAGE

I. INTRODUCTION

Most crops grown for livestock feed can be allowed to ferment and fed as silage. Handling of the crop for silage should always favor proper fermentation. Direct cut silage is the harvest of a standing crop while wilted silage is first mowed and then harvested at a moisture content lower than standing silage but higher than hay.

Figure 1. Changes in Bacteria Concentrations, pH, and Temperature During the Ensiling Process 1/



1/ Agronomy Handbook, Publication 424-100, Revised 2000, page 36, Virginia Cooperative Extension

DIRECT CUT

Grain crop silage such as corn, barley, wheat, oats, and grain sorghum are normally chopped directly as they stand in the field when the grain reaches the dough stage. The relatively high dry matter content of the grain in such silage, plus the drying effects of advancing maturity, results in silage within the desirable dry matter range (35-42%).

WILTED SILAGE

When these same crops are harvested at a less mature stage, or when the traditional hay crops are handled as silage, it is necessary to partially dry or "wilt" the plants in the field before ensiling. Such wilting usually requires about one day under favorable drying conditions. Crushing the stems hastens drying.

Table 1. Annual Yield and Composition of Silage Crops [2/]

Crop	Stage	Yield, Tons/Acre 35% Dry matter	Dry Matter Basis %CP*	Dry Matter Basis %ADF**
Corn	hard dough	15-25	8	28
Grain Sorghum	dough	10-15	9	42
Forage Sorghum	early head	10-15	11	29
Sorghum Sudan	early head	7-15	12	45
Barley	dough	7-15	9	36
Wheat	dough	7-15	9	36
Oats	dough	5-10	10	38
Rye	Boot	4-6	13	40
Alfalfa (4x)	late bud-early bloom	10-12	18	33
Red Clover	early bloom	7-8	12	43

* crude protein
** acid detergent fiber, the lower the value, the higher the energy

2/ Agronomy Handbook, Publication 424-100, Revised 2000, page 37, Virginia Cooperative Extension

II. HARVEST AND STORAGE OF CORN FOR SILAGE

Corn harvested for silage yields about one third more feed nutrients per acre than corn harvested for grain. Corn in the full dent stage produces 50% more feed than in the milk stage and 100% more feed than in the silking stage. Corn harvested in the milk or silking stage can result in poorer quality silage because of its high moisture content.

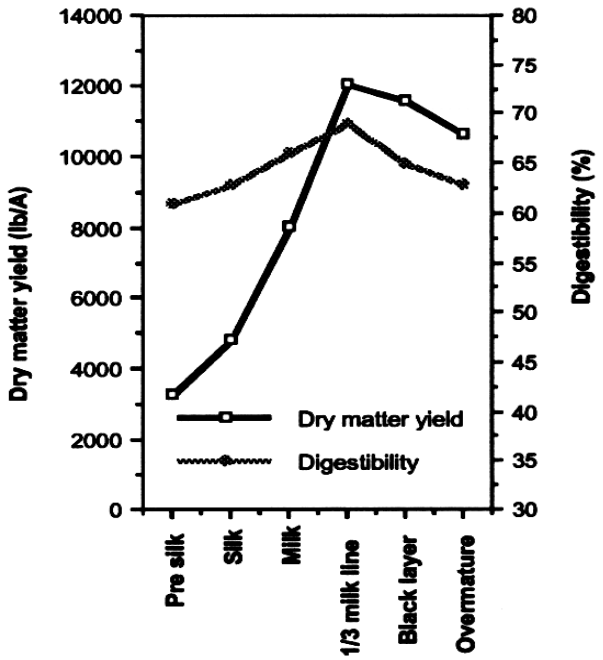
One of the most important steps in producing quality corn silage is to harvest at the proper moisture which depends on the type of storage structure. Harvest between 60 and 70% moisture levels to maximize yield and quality.

Table 2. Desired Moisture Levels for Different Structures [3/]

Type of Structure	Desired Moisture Level
sealed airtight silos	60-65%
upright silos	63-68%
trench silos	65-70%

3/ Penn State Agronomy Guide, 1999-2000

Figure 2. Corn Silage Yield and Quality as Influenced by Growth Stage [4/]



4/ Corn Silage Production and Management, Greg W. Roth, Agronomy Fact Sheet 18, Penn State College of Agriculture, Cooperative Extension

Table 3. Expected Dry matter Losses of Whole Plant Corn Silage Harvested at Different Moisture Contents [5/]

Moisture	Harvest	Storage	Feeding	Total
----------	percentage	----------		
≥70	4.0	13.4	4.0	21.4
61-69	5.0	6.3	4.0	15.3
<61	16.2	6.3	4.0	26.5

5/ Corn Silage Production and Management, Greg W. Roth, Agronomy Fact Sheet 18, Penn State College of Agriculture, Cooperative Extension

Corn that is ensiled too wet will ferment poorly and lose nutrients by seepage. Silage that is too dry will result in air pockets that prevent anaerobic fermentation and allow development of molds. In dry, over-mature corn silage, the stover portion of the plant is less digestible and contains lower amounts of Vitamin A and E than corn ensiled at the recommended moisture levels. The kernels are also harder and less digestible.

Moisture content can be estimated by the stage of crop development as characterized by the position of the kernel milk line. The firm starch is deposited in the crown (outer) area of the kernel and the "milk" occupies the basal area. The kernel milk line appears near early dent stage as a whitish line separating the kernel starch and milk and moves down the kernel as the grain matures. When the milk line reaches the base of the kernel, a black layer forms and the crop is physiologically mature. Silage moisture content at full dent (all kernels dented) and black layer stages average 68-70 and 60 percent respectively. These estimates may vary by plus or minus 5% depending on the year and the hybrid.

As a general rule, harvest should begin at the full dent stage to one-third milk line stage. This will usually maximize digestible dry matter yields and help avoid harvest of fields that are over mature.

Average particle size should range from 3/8 to 3/4 of an inch in length. This excludes air by allowing proper packing.

Once harvesting has begun, fill the silo as rapidly as possible and continue until completed. Loads should not stand overnight because they can heat and spoil.

Figure 3. Typical Storage Dry Matter Losses [6/]

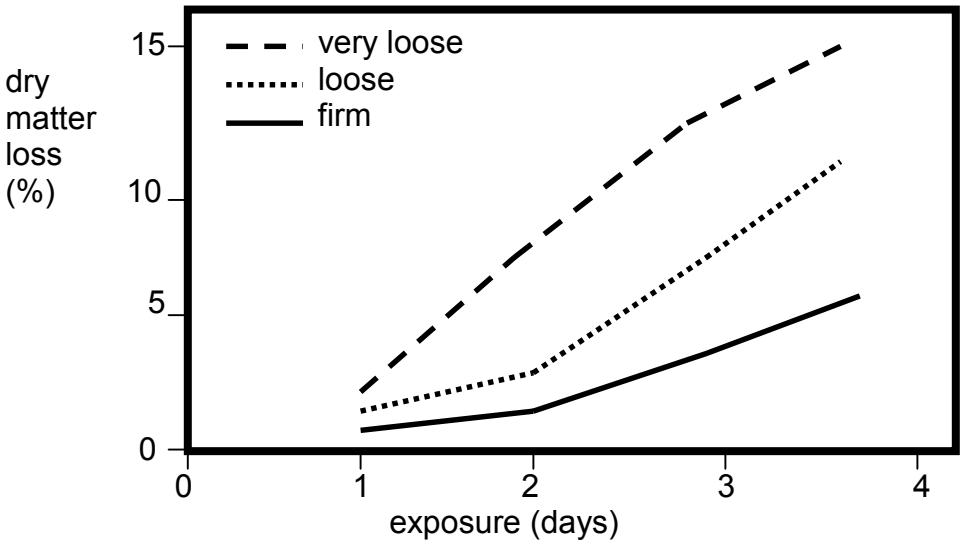
6/ Corn Silage Production, Management, and Feeding, Greg Roth and others, American Society of Agronomy, 1995, page 18.

III. FEEDING

Removing silage from the whole silo face at a rate of at least 4 to 6 inches per day reduces loss. Slow feed-out rates allow more time for losses due to the growth of yeasts, molds, and aerobic bacteria. This in turn decreases dry matter intake.

Silo face management is also important in managing aerobic deterioration in silage. Loose silage is more porous and allows greater air infiltration, increasing the rate of aerobic growth.

Figure 4. Dry Matter Losses From Trench Silages With Different Face Characteristics 7/



7/ Zublena et al., North Carolina, 1987 in Corn Silage Production, Management, and Feeding, Greg Roth and others, American Society of Agronomy, 1995, page 21.

IV. DROUGHT STRESSED CORN AND EXCESSIVE NITRATES

When corn is so drought stressed (few developed ears and leaves have turned brown and are falling off the plant) that it may not resume growth, it should be ensiled. One concern with drought stressed corn is the potential for high nitrate levels in the silage. High nitrate levels are found most frequently where excessive nitrogen rates were applied and when a drought stressed crop was chopped within three days following a rain. Ensiling crops that are suspected of high nitrate levels is preferable to green chopping because the fermentation process will decrease nitrate levels by about 30 to 50 percent. When in doubt, obtain a forage analysis with nitrate determination before feeding.

The level of nitrate in plant tissues varies greatly and depends on many factors. Enzymes in plant leaves convert nitrates into proteins. Nitrates accumulate in the plant tissue during unfavorable conditions when growth is slow and yet nitrates are plentiful. Factors that affect nitrate accumulation are:

- nitrogen availability - nitrate content of corn increases as nitrogen increases;
- drought - long sustained droughts are not as likely to cause accumulation of nitrates in corn as are brief, intense droughts; nitrate accumulation is highest after a drought ending rain;
- cloudy weather - cloudy days often cause elevated nitrate levels because the enzyme that converts nitrates to protein is less active;
- extremely high plant populations - thick stands can produce barren stalks which prevent movement of materials into kernels; nitrates accumulate in the leaves and stalks;
- nutrient deficiencies - deficiencies of nutrients such as phosphorus and potassium increase the concentration of nitrate; root uptake of nitrate continues but growth is limited causing nitrates to accumulate; and
- plant age and plant part - nitrates accumulate most in the lower, older parts of plants; the stem and roots have higher concentrations than the leaves and ears.

Fermentation in the silo will reduce nitrate levels by 30 to 50%. In addition, a number of management options can be used to reduce or prevent high nitrate levels in corn.

1. Apply nitrogen at recommended rates. Be sure to subtract residual soil nitrogen and manure applications from the total recommended amounts.
2. Minimize plant stresses due to nutrient imbalances, diseases, insects, weeds, and insufficient moisture.
3. Harvest on bright, sunny days.
4. Dilute high nitrate corn silage with feed grains or legume hay.
5. Cutting the corn higher up the stalk may reduce the amount of nitrates.

V. SAFETY RULES

SILAGE HARVESTING EQUIPMENT AND OPERATIONS

The key to safety begins with prevention.

1. Properly maintain equipment to reduce the chance of an accident.

2. Study the operator's manual before each harvest season, especially the safety instructions.

3. Make certain that all guards and shields are in place.

4. Always turn off equipment before making any adjustments. Never try to adjust or unclog a machine while its parts are in motion.

5. Space tractor and equipment wheels as far apart as possible to increase stability.

6. Make certain that the RPM of the tractor's PTO match the design RPM of the equipment.

7. Inspect the field for stumps, stones, washouts, ditches, and other obstacles which might damage equipment or cause an overturn.

8. Never permit riders.

9. Keep children, uninformed adults, and pets away from the machinery.

10. Wear close fitting clothes and sturdy slip resistant work shoes.

11. Never operate equipment if you are ill, tired, or have alcohol or medications in your system. You must stay alert at all times!

SAFETY RULES FOR WORKING AROUND SILOS

Lethal gases may occur in upright silos at any time during and soon after filling but the greatest danger is from 12 to 72 hours after filling. A few simple precautions will prevent tragedy or injury from silo gases.

1. The blower should be run for 15 to 20 minutes before anyone goes into a partially filled silo. It should be left running as long as anyone is inside.

2. No one should enter the silo for two weeks after it has been filled.

3. The silo room should be ventilated for at least two weeks after filling.

4. Close the doors between the silo room and barn to protect livestock.

5. If a person in the vicinity of the silo experiences the slightest throat irritation or coughing, they should get into fresh air immediately. Immediate treatment by a physician is essential.

OTHER SILO SAFETY RULES

1. Wear slip resistant shoes.

2. Always have one firm hand and foot hold when working on a silo.

3. When working high up in a silo, wear a safety belt secured to a ladder rung.

4. Keep others away from the bottom of the ladder in case a tool or part falls.

5. Do not climb a silo if afraid of heights.