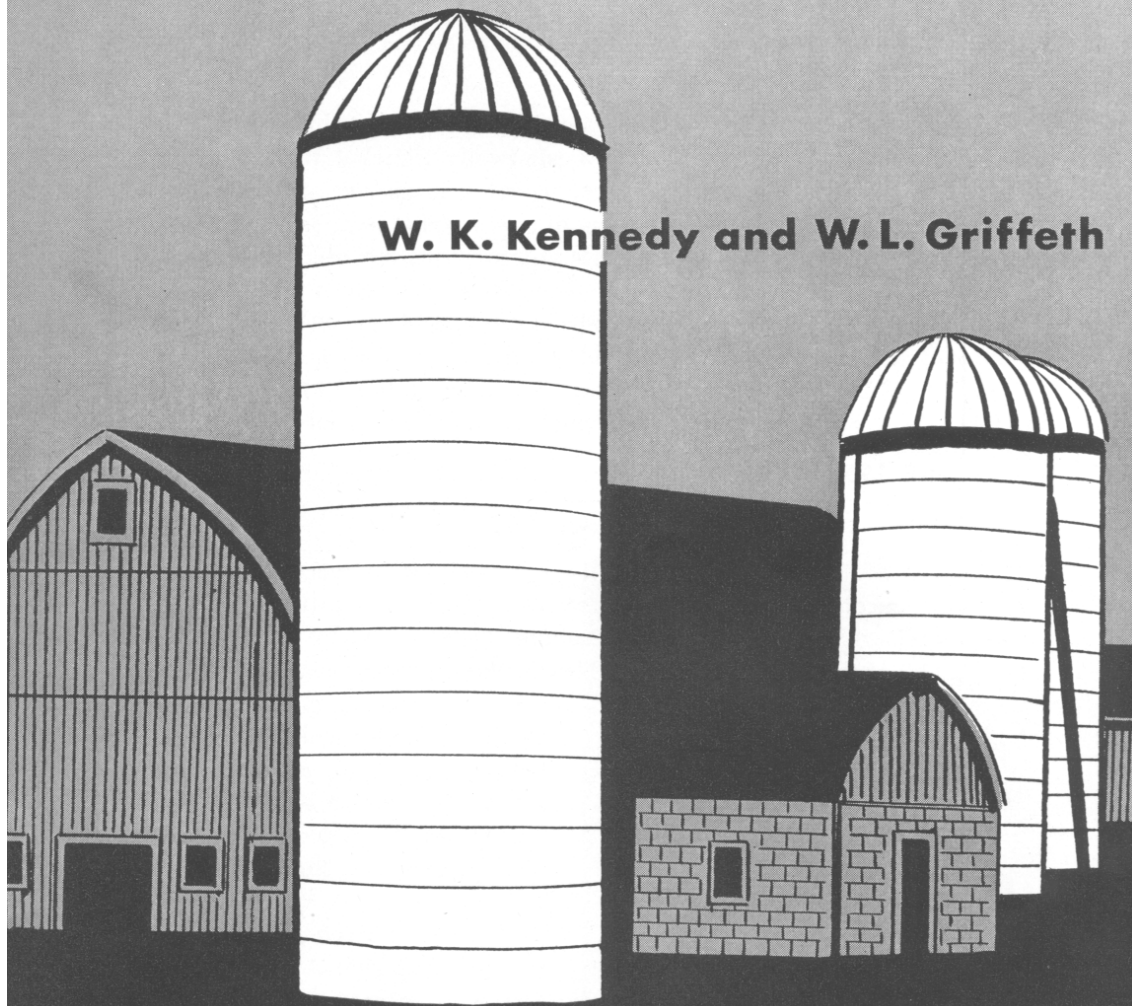


GRASS SILAGE

W. K. Kennedy and W. L. Griffeth



CORNELL EXTENSION BULLETIN 1032
New York State College of Agriculture

JUNE 1959

A publication of the
New York State College of Agriculture
a unit of the State University of New York
at Cornell University
Ithaca, New York

GRASS SILAGE

W. K. KENNEDY AND W. L. GRIFFETH

Dictators are of many kinds, but the one that plagues farmers most is the weather. If a farmer allows the weather to dictate when he can make hay from the first cutting of a forage crop, he often ends up with very poor quality feed. The most effective way to guarantee high quality feed and at the same time minimize the effects of bad weather is to store early cut forage as silage. Properly made early-cut silage is farm more valuable than late-cut hay. Cows produced 48 percent more milk when fed silage harvested in early June than when fed hay cut from the same field four weeks later. It is easy to make good silage by (1) cutting early, (2) excluding air rapidly, and (3) wilting to decrease juice losses and improve quality.

CUT EARLY

The feeding value of the hay crop decreases more than one percent per day from June 1 to July 4 (figure 2). Digestibility declines one-half percent each day cutting is delayed, while palatability declines more than one-half percent per day. Animals fed forage cut July 4 eat only 60 percent as much digestible dry matter as animals fed forage cut from the same field on June 1.

High feeding value is important, but so is yield. During late May and early June, forages are growing at a rapid rate and early harvesting decreases yields (figure 3). Greater Digestibility and palatability in early-cut forage,



Figure 1. At this stage of growth, alfalfa and smooth brome grass make excellent silage.

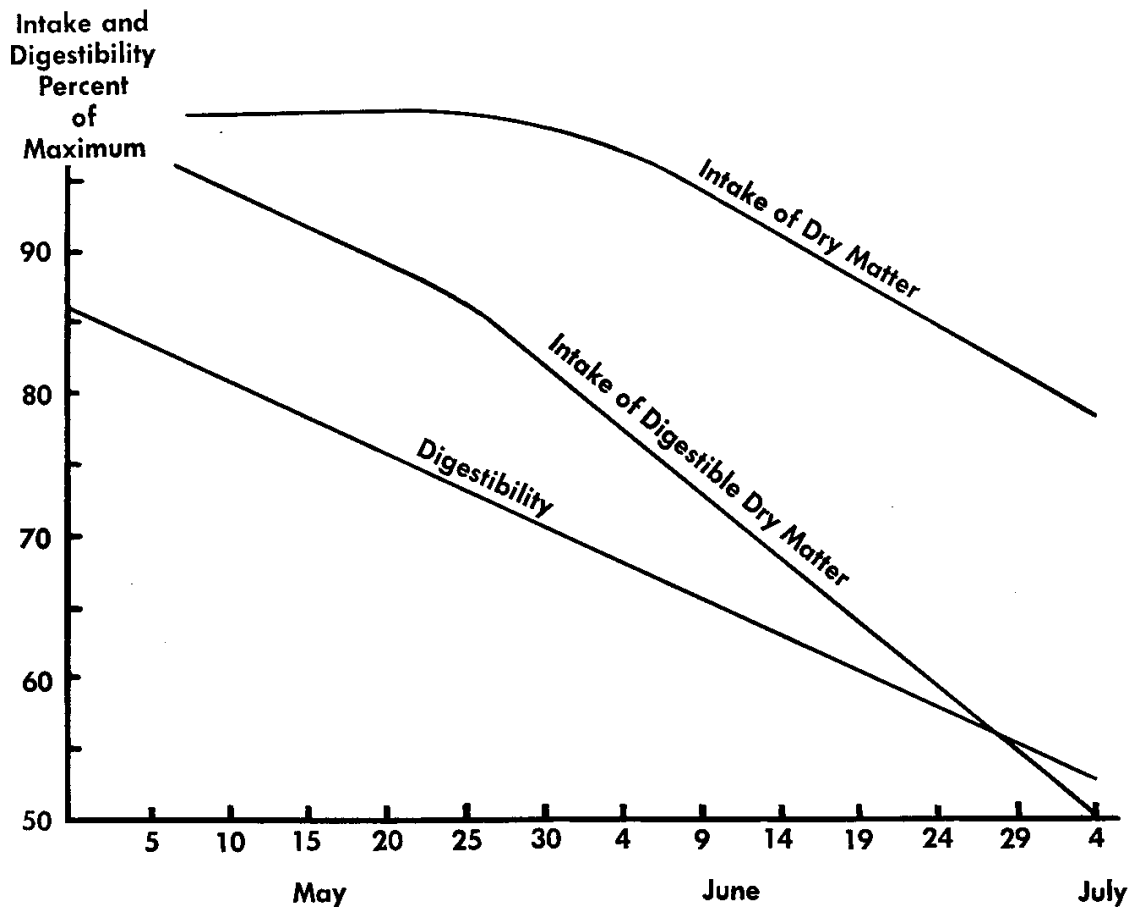


Figure 2. Relationship of time of cutting to the digestibility and intake of the first cutting of perennial forage grasses and legumes.

however, may more than offset a small loss in additional dry matter. Timothy, smooth brome grass, red clover, early-type birdsfoot trefoil, and most varieties of alfalfa reach their maximum yield of dry matter when timothy and brome grass are fully headed and the legumes are in full to late bloom. Orchard grass and early-type alfalfas may be one to two weeks earlier than the above mentioned grasses and legumes.

The maximum yield of digestible dry matter is obtained by cutting

about five days before the maximum yield of dry matter (figure 3). Furthermore, the forage can be cut at least two weeks before it will reach the maximum yield of dry matter with only a ten percent reduction in yield of digestible dry matter. Still earlier cutting results in a rapid decline in yield of digestible dry matter, but higher intake and greater aftermath (sometimes an additional cutting) more than compensate for the loss of dry matter in the early first cutting.

Silage can be made in early June

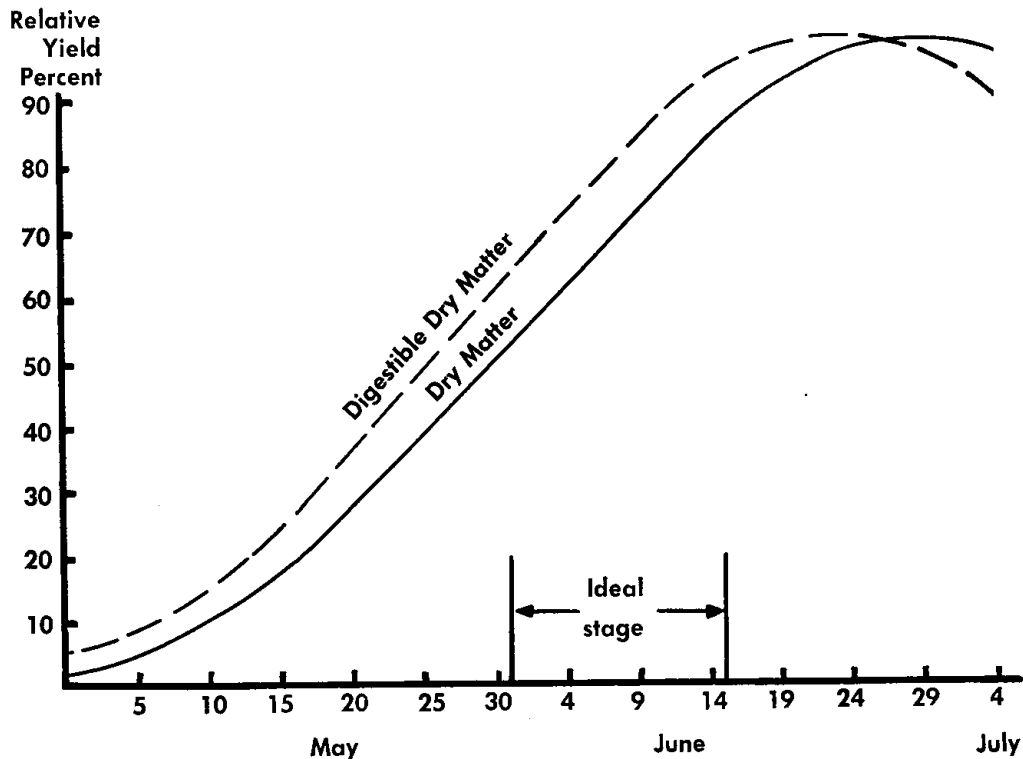


Figure 3. Relationship of time of cutting to yield of the first cutting of perennial forage grasses and legumes.

when weather conditions are unfavorable for haying. Then a good second cutting will be ready for harvesting in mid-July when haying conditions are favorable.

Early cutting coupled with the use of improved legumes and grasses will provide a third cutting which can be used for pasture, hay or silage according to need and weather conditions.

EXCLUDE AIR RAPIDLY

Rapid and complete exclusion of air is *essential* for quality silage. Respiration of plant cells and of many microorganisms continues at a rapid pace as long as oxygen is available. Respiration produces heat, and the temperature of the silage rises rapidly. Temperatures of 120° to 150° F. are common in

poorly packed forage. These high temperatures cause silage to turn dark brown; in some cases it is charred black. Silage may lose over 50 percent of its nutrients from heat.

Partially packed forage allows less air to enter, and heating is not as severe. The silage becomes

TABLE 1. Dry matter loss, pH, lactic acid, and volatile acid contents of Silage made with white clover-orchard grass and alfalfa.

Forage	Five Pounds Pressure Applied	Dry Matter Loss	PH	Lactic Acid	Volatile Acids
		Percent		Percent	Percent
White clover-Orchard grass	Immediately	16.1	3.8	6.45	0.89
	After 2 days	23.2	4.5	3.26	2.41
Alfalfa	Immediately	14.4	4.2	7.94	1.93
	After 2 days	29.8	4.8	2.12	3.97

warm but not hot, and eventually cools down. When the silo is opened, extensive top and side spoilage is found. Spots of moldy silage may occur throughout the silo and loss of dry matter is high.

Air often is a hidden thief. Small amounts of air trapped and penetrating into silage cause losses even though no visible mold growth or excessive heating is detected.

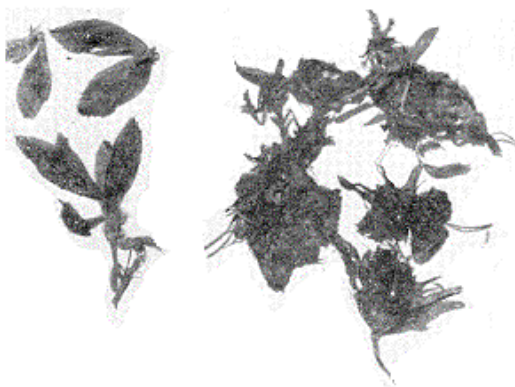


Figure 4. Alfalfa leaves at left were firm and intact when air was quickly eliminated. Leaves at right were soft and slimy when air exclusion was delayed two days.

Rapid packing excludes air

Dry matter losses and pH are lower when silage is immediately compressed than when pressure is delayed (table 1). Lactic acid that gives silage a good odor also is higher, and volatile acids that cause a bad odor are lower in silage than receives pressure immediately. Alfalfa leaves in the silage that is compressed immediately are firm, sound and easily recognized. The leaves deteriorate considerably when the pressure is delayed; they feel slimy and can not be separated from each other because they are soft and easily torn (figure 4).

Rapid filling hastens packing

The tremendous weight of a large mass compresses the forage and forces out entrapped air. Efficient silage making and good ensiling practices go hand-in-hand. Modern equipment is capable of harvesting many tons of forage in a day. Therefore rapid filling is essential if the equipment is to be used effectively.

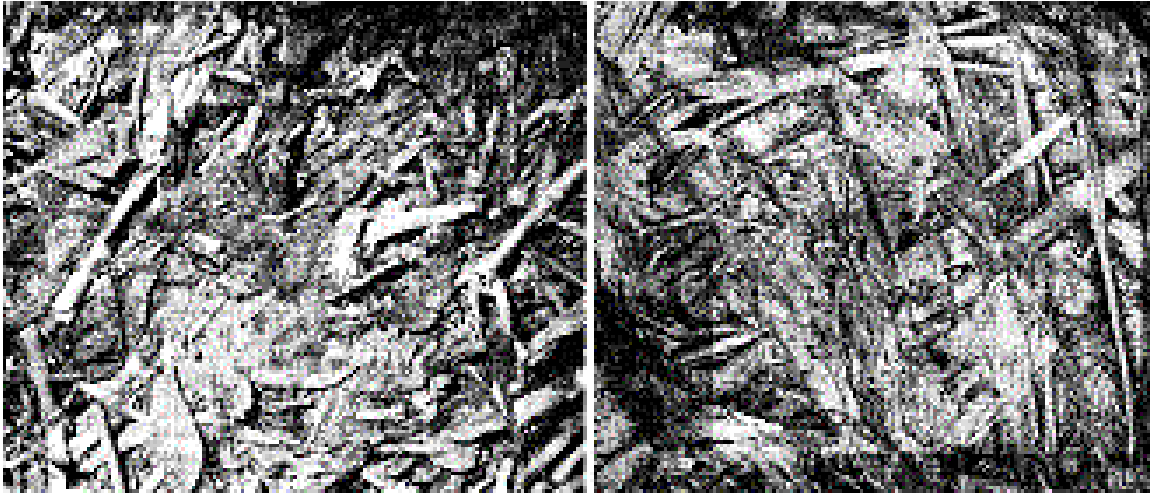


Figure 5. Good alfalfa-timothy silage at left was made by quick air exclusion with no preservative. Poor silage at right was caused by light packing and too much air.

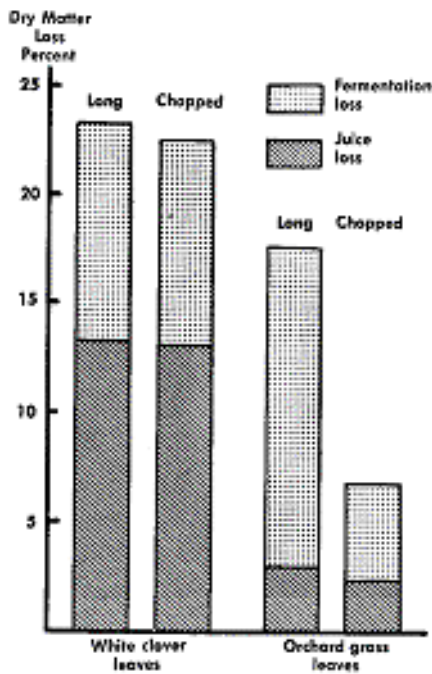


Figure 6. Effect of chopping on dry matter losses from ensiled white clover and orchard grass leaves when placed under pressure.

Chopping aids packing and fermentation

A mixture of alfalfa and timothy was ensiled both as long and as chopped forage. Pressures of five pounds per square inch were applied immediately to both. The chopped forage, which packs more closely, produces silage with a pH of 4.0 and a dry matter loss of 9.0 percent. The unchopped forage, which contained more trapped air, had a higher pH of 4.06 and a dry matter loss of 24.8 percent. The latter silage was slimy and strong smelling (figure 5). Chopping and bruising facilitate rapid compaction with prompt exclusion of air.

Long and chopped leaves of orchard grass and of white clover were ensiled under pressure of seven pounds per square inch—equivalent to placing a sample under 20 to 25 feet of settled

silage (figure 6). Rapid exclusion of air must have occurred. The white clover was extremely succulent and juice flowed from both the long and chopped treatments within five minutes after ensiling. Within ten minutes juice flowed from the chopped orchard grass, but no juice flowed from the unchopped orchard grass until the following day.

The silage from long and chopped white clover was excellent in color and odor. The pH of both silages was 4.0. The total loss of dry matter was 23 percent, because 13 percent of the dry matter was lost as juice. Wilting

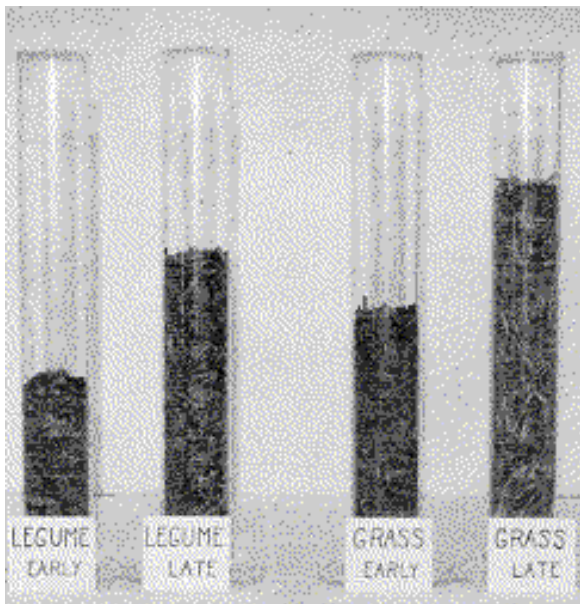


Figure 7. The same amount of forage was placed in each cylinder and the same pressure applied to each.

of such succulent material is desirable to prevent excessive juice losses.

The silage from chopped orchard grass also was excellent. The pH was 3.9 and the loss of dry matter was only seven percent. The unchopped orchard grass had a pH of 4.6, and a dry matter loss of 17 percent. The quality was fair but a distinct off-odor was detected. The concentration of volatile acids was higher than for either the clove or chopped orchard grass silages. All forages that are not extremely succulent should be chopped. The only benefit may be better packing, but the quick release of plant juices coupled with good compaction also may hasten the formation of lactic acid. Quick production of lactic acid prevents undesirable fermentation from occurring.

Grasses and legumes require different treatments

Legumes pack more easily than grasses if both are cut at the same stage of maturity (figure 7). Legumes are more succulent, the stems crush more easily, and the leaves and stems are less springy than the grasses. Young forage is succulent and easy to bruise; mature forage is tough and fibrous. Young legumes may be ensiled long or with just enough chopping to make them easy to handle. Legumes at the full bloom stage should be chopped to an average length of one-half to three-fourths inch. Young grasses

generally require chopping. Once grasses have headed, fine chopping is essential. It is not advisable to ensile forage grasses such as orchard grass, brome grass, or timothy after the early bloom stage. Rapid and complete exclusion of air from grasses is difficult and sometimes impossible, even when the

chopper is set to cut as fine as possible.

Chopping is recommended for all mixtures with less than half legume. If the forage mixture contains at least 50 percent legume, is cut very early, and is packed well, it is probably safe to ensile without chopping.

WILT TO DECREASE LOSSES AND TO IMPROVE QUALITY

Wilting is the most effective means of overcoming the high juice losses associated with the ensiling of immature high-legume forage (table 2).

The direct-cut field chopper appeals to farmers because the forage is harvested in a single operation, but from five to more than ten percent of the dry matter is lost in the juice from unwilted high-moisture forage (tables 2 and 3). The tremendous flow of juice also creates serious problems around the farm buildings and the offensive odors are objectionable. Waiting until the dew is off the forage before chopping is started will decrease but not prevent juice loss.

Wilting forage is not only effective in reducing the juice problem but the decrease in dry matter losses may pay for the extra operation required. The forage should be mowed and windrowed in a single operation by attaching a swather to the mower or by pulling a side delivery rake behind the tractor. A good crop of early-cut forage will yield at least 3000 pounds of dry matter per acre and will contain over 80 percent moisture. Eight to ten percent of the dry matter or about 300 pounds more dry matter per acre will be conserved if the crop is wilted to 70 percent moisture than if it is ensiled without wilting. If the

Table 2. The effect of wilting on storage losses and feeding value of immature red clover-grass forage ensiled in 50-ton tower silos. (Cornell University Agricultural Experiment Station Bulletin 931, 1958)

Treatment	Dry Matter			Daily consumption per cow percent	Daily milk production per cow Percent
	Loss from seepage percent	Loss from fermentation percent	Loss from seepage and fermentation percent		
Unwilted	8.2	10.5	18.7	26.3	43.7
Wilted	1.5	8.8	10.3	28.2	44.3

TABLE 3. Juice and dry matter loss from one ton of immature legumes ensiled with different moisture contents

Moisture content when ensiled	Moisture content when fed	Juice loss	Dry matter Loss in juice
percent	percent	pounds	Percent
85	79	800	16
80	77	400	8
75	75	200	3
70	72	10	0.1
65	67	0	0

300 pounds of dry matter is valued at 1.5 cents per pound, (approximately \$27 per ton for excellent hay) the gross saving for wilting would be \$4.50 per acre. Early-cut forage usually is not lodged and it is possible to mow at least two acres per hour. The gross return for driver, tractor, mower and swather therefore in \$9.00 per hour. In addition, more tons of dry matter can be stored in the silo, the silage usually is slightly more palatable, and *the juice problem is decreased.*

A farmer cannot be a slave, however, to a wilting program. During periods of rainy weather immature forage cannot be properly wilted, and to delay harvest may result in nutrient losses from lodging, lower feeding value resulting from advancing maturity, and inefficient use of labor and equipment. These losses may be greater than those saved by wilting. Silage making should continue even if wilting to the desired moisture level is impossible.

How much to wilt

The amount of wilting depends upon packing quality as determined by the botanical composition, stage of maturity, and fineness of chopping (table4). Legumes pack easier than grasses; immature forage packs easier than mature forage; and finely chopped or lacerated forage packs easier than longer forage. Estimating the desirable moisture content for different forages comes with experience just as a farmer learns when hay is dry enough to bale. A simple guide is to squeeze a handful of chopped forage as tightly as possible then quickly release the pressure. If the forage slowly expands to about twice the volume as when it was compressed, it contains sufficient moisture for good packing. If the forage springs apart quickly it is overwilted and should be mixed with unwilted forage. If it remains compressed and if free juice appears near the finger tips when the forage is squeezed, the forage is much too wet for ideal silage.

Exclusion of air in silage making is all important, and the benefits

TABLE 4. Moisture contents at the time of cutting and minimum safe levels for ensiling different forages.

Stage of Maturity	As Cut	Tower Silos	Trench or Bunker Silos	
		Chopped	Chopped	Long
Legumes:	percent water	percent water	percent water	percent water
pre-bud	85	60	65	75
early bloom	80	65	70	don't wilt
½ bloom	75	70	don't wilt	don't ensile
late bloom	70	don't wilt	don't ensile	don't ensile
Grasses:				
pre-headed	85	70	don't wilt	don't ensile
boot	80	75	don't wilt & pack very well	don't ensile
well-headed	75	don't wilt	well	don't ensile
bloom	70	don't ensile	don't ensile	don't ensile

of wilting are more than canceled if the forage is overwilted and good packing can not be obtained. Many farmers have made poor wilted silage by following the general rule of wilting to 65 percent moisture. This moisture level is correct for legumes in the early bloom stage; it is much too dry for a high-grass mixture (table 4). Mixtures can be wilted to intermediate levels depending upon the proportion of legume and grass. Overwilted or mature forage

can be ensiled in a tower silo if the forage is finely chopped and if covered with ten or more feet of immature unwilted forage. Sometimes it is feasible, and if so, highly desirable to alternate loads of overwilted forage with unwilted forage. Juice flow from the unwilted forage will increase the moisture content of the overwilted material. Unwilted material also packs very tightly and helps to form a seal for the overwilted forage.

CONTROL OF ODORS BY DIVERTING JUICE RUNOFF

Diverting the juice is relatively easy and inexpensive if the land has sufficient slope from the silo to an area away from the buildings. If possible, the drainage area should be on the leeward side of the buildings. A galvanized sheet metal trough is attached to the base of the silo. The trough, the bottom of the silo, and the floor near the unloading chute

drain into a four inch tile line that will carry the juice away from the buildings. To be effective the trough and floor drain must intercept all juice that flows from around the doors and between the staves.

The use of a dry well is not feasible except on very permeable soil because as much as 100

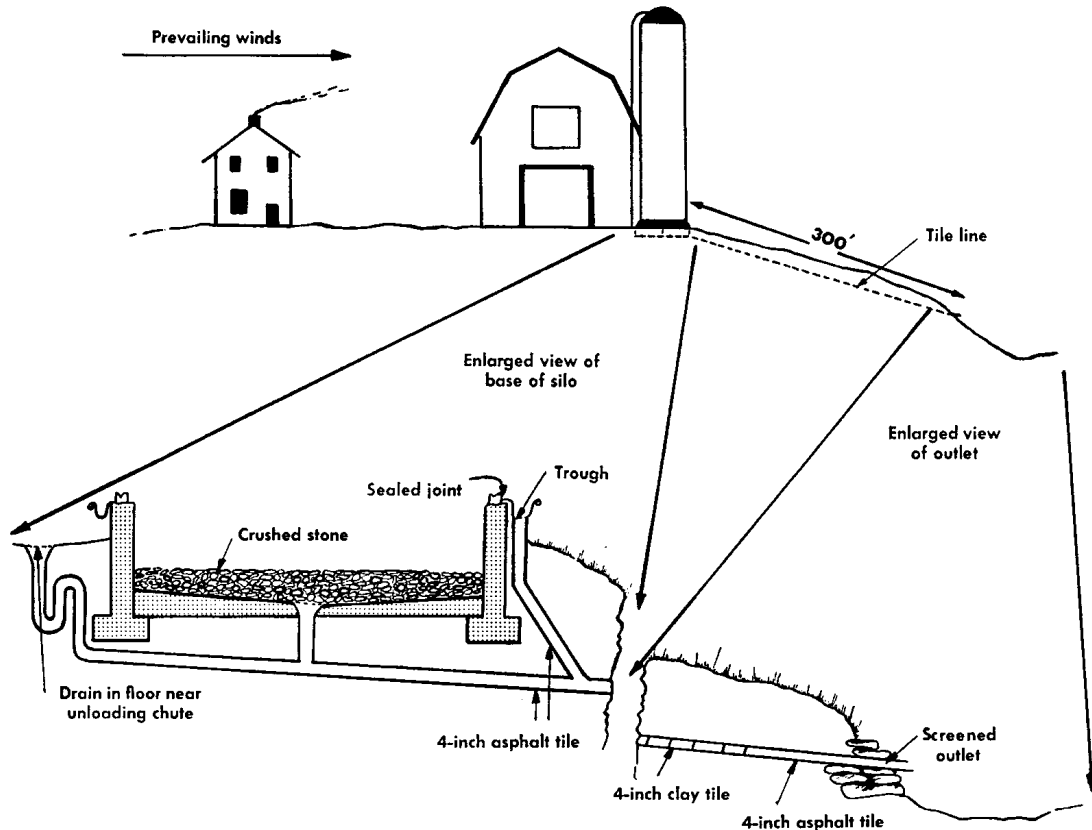


Figure 8. Suggestions for decreasing the juice problem around silos filled with direct-cut forage.

gallons (800 pounds) of juice per ton of ensiled forage may flow from a tower silo with 10 to 20 days after filling is completed. Therefore, the juice flow from a 200-ton silo could fill an empty dry well 25 feet long by 10 feet wide by 10 feet deep. The juice may be emptied into a depression or waste area. The offensive odor will not be eliminated, but will be removed from the immediate vicinity of the buildings.

Preservatives are not necessary

Acceptable silage without offensive odors, except in the juice runoff, has been made repeatedly at Cornell University from unwilted

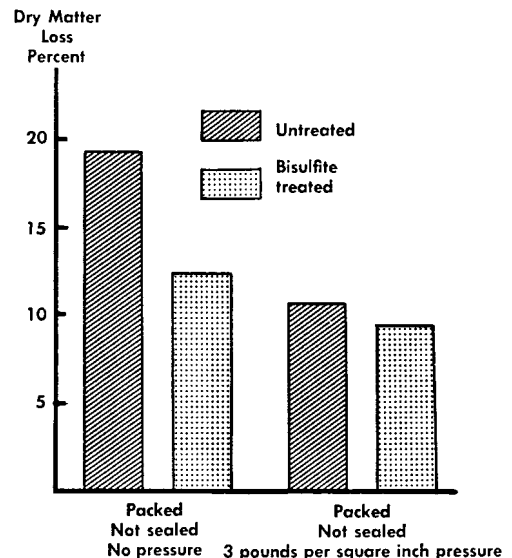


Figure 9. Effect of preservative on dry matter losses of a clover-grass mixture ensiled with and without pressure.

TABLE 5. Effect of preservatives upon storage losses and feeding value of red clover-grass forage ensiled without wilting in 50-ton tower silos. (Cornell University Agricultural Experiment Station Bulletins 912 and 913, 1955)

Preservative	Dry Matter			
	Losses from fermentation and seepage	Daily consumption by cows	Daily milk production	Net cost of preservative
	percent	pounds	pounds	cents per ton
No preservative	22.6	25.4	42.4	
Sodium metabisulfite 9 pounds per ton	22.0	24.6	40.8	68
Molasses 70 pounds per ton	22.8	26.6	42.5	26
Brewer's dried grains 100 pounds per ton	19.6	25.6	43.5	51

high legume and grass forages without the use of preservatives (table 5.). Preservatives are not needed to reduce off-odors in the silage if air is excluded by rapid filling and packing. Preservatives are helpful if the forage is ensiled slowly and not properly packed. Oxygen-loving microorganisms in poorly packed silage quickly exhaust the available sugars and then a desirable fermentation may not occur. Adding sodium metabisulfite to inhibit bacterial

growth, or adding carbohydrates to bolster the supply of sugar is beneficial, but the dry matter losses in treated, poorly packed silage are greater than in untreated well packed silage (figure 9).

No known preservative will effectively control the offensive odors associated with heavy juice runoff. Wilting the forage or intercepting and draining the juice away from the silo are the only alternatives.

SILAGE STORAGE

Air-tight containers provide the ideal storage facilities for silage. Such storage is very expensive, however, and many farmers may wish to compromise because of cost. They must consider what type of storage will provide the best silage in relation to cost, ease of filling and ease of unloading. Various storage facilities require slight variations in silage making procedures in order to ensure

rapid exclusion of air and reduction of juice runoff.

Tower silos

Tower silos favor good compression. The tremendous weight of a tall column of forage compresses the mass and forces out the entrapped air. Rapid filling hastens the exclusion of air and

immature forage can be wilted to low moisture content with little danger of poor packing. Storage losses are low. With modern equipment, tower silos can be filled rapidly and unloaded mechanically. The silage also can be stored near the animals and this makes feeding easier in severe winter weather.

Horizontal silos

In stack, trench, and bunker silos, the depth of forage alone is not great enough to insure tight packing. Horizontal silos must be filled with succulent forage that packs easily. In addition, a heavy tractor should be driven back and forth over the forage as it is ensiled and for two or three days after silo filling is completed. Unless such special precautions are taken, rapid packing does not occur in horizontal silos and high storage losses may occur.

A small properly constructed horizontal silo is nearly as expensive as a tower silo of comparable size, but a large horizontal silo (500 or more tons) provides much cheaper storage than two or more tower silos. If properly located in respect to terrain and driveways, horizontal silos can be filled more rapidly than tower silos. This is an important advantage in early summer when demands for labor and equipment are high. Horizontal silos also can be adapted for self feeding more easily than tower silos. Mechanical handling of silage is relatively simple from a horizontal silo, particularly when feed bunks

are nearby. Severe freezing of silage and drifting snow may prevent feeding from horizontal silos in mid-winter. If the silos do not have a heavy stone or concrete base, feeding from the silo also becomes impossible in late winter after the ground thaws.

Plastic silos

Recently, plastic films and other materials have been widely tested as covers for trench, bunker and tower silos; as liners for tower silos; and in some cases as the complete storage unit. The plastic films are air tight, and if properly used, form an air-tight seal. Obviously, the value of a plastic film is lost if the film is punctured or if air can enter around the edges. In fact, spoilage under a film that is not air tight frequently is greater than if no film is used. The moist conditions under the unsealed film favor the rapid growth of mold and other organisms.

The decision about whether or not to use protective covers depends upon cost versus the value of the forage saved. In well compacted silage about 15 pounds of dry matter is lost for every square foot of exposed surface. At 1.5 cents per pound this loss is worth 22.5 cents per square foot. If a cover can be purchased and placed over the silage for an annual cost of 20 cents or less per square foot of protected silage, the use of a cover therefore is profitable.

EQUIPMENT FOR SILAGE MAKING

Field chopper

The high cost of labor makes the field chopper essential for most silage operations, and farmers must decide between direct-cut or pickup attachments and between power take-off or auxiliary motors. A pickup attachment is needed for wilted silage and is recommended if high legume forage is ensiled in tower silos. A direct-cut attachment can be used if forage is stored in horizontal silos. If a suitable tractor with live power take-off is available, an auxiliary motor on the chopper is not necessary. Some farmers, however, prefer to have an auxiliary motor on the chopper and use a smaller tractor to pull it, but the advantages of the auxiliary motor may not off-set the extra cost.

Windrow attachment

An inexpensive windrow attachment or swather can be fastened to the mowing machines in order to cut and roll the forage into a windrow for wilting in one operation. The type that rolls the forage from both ends of the butter bar towards the center operates better in heavy yielding crops than the type that rolls all of the forage to the tractor end of the cutter bar. If a windrow attachment is not available, a side delivery rake can be towed directly behind the tractor and the previously cut swath raked as another one is mowed. The stone problem, however, is much greater

when the side delivery rake is used than when a swather is used. The cost of an extra operation for windrowing the forage should be avoided at all times when a wilting program is used.

Wagons

Two wagons with mechanical unloading devices are the minimum for efficient operation and rapid filling. If hauling distances are long and labor is available, three wagons should be used. Dump trucks are ideal for filling large horizontal silos, but high costs usually limit their use to large operations.

Tractors

Three tractors are required for rapid filling of both tower and horizontal silos. The size of the one pulling the chopper will depend upon whether or not power take-off is required. A two-plow tractor will tow a wagon satisfactorily if the land is reasonably level but the operator must use extreme caution when pulling heavily loaded wagons at fast speeds. A large tractor, 50 h.p. on the belt, must be used to operate the blower for rapid filling of tower silos. A similar sized tractor is also needed for packing the forage in a horizontal silo. This tractor also may be needed to help tow the wagons through the loose forage as horizontal silos are being filled.

Blowers

Blowers must be in good condition to operate at the peak efficiency required for rapid filling of tall silos. A nine inch diameter blower pipe is preferable to

smaller sizes. Either an auger or a conveyor feeding mechanism is satisfactory. High speed elevators also are satisfactory for filling 25 to 30 foot high tower silos, but high cost has discouraged their use on 40 to 60 foot silos.

SUMMARY

1. Cut the crop early when palatability and digestibility are high.
2. Wilt high-moisture forage to decrease juice and dry matter loss and to increase palatability.
3. Exclude air by rapid filling and chopping to produce good packing and favor desirable fermentation.
4. Use the type of silo and harvesting equipment that allow rapid filling, good preservation and suitable methods of feeding at a reasonable cost.
5. Cut ensiling costs by adopting efficient harvesting methods that eliminate the need of a preservative.



Cooperative Extension Service, New York State College of Agriculture at Cornell University and the U. S. Department of Agriculture co-operating. In furtherance of Acts of Congress May 8, June 30, 1914. M. C. Bond, Director of Extension, Ithaca, New York.

PS—20M