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*A report  
of 3 years of  
tests at  
five locations  
in Alabama*

HARVESTING  
*and*  
STORING  
SILAGE



*Agricultural Experiment Station of the*



ALABAMA POLYTECHNIC INSTITUTE

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## CONTENTS

	<i>Page</i>
SILAGE HARVESTING METHODS STUDIED.....	3
Direct-Cut Method Using Forage Harvester at the Black Belt Substation.....	3
Direct-Cut Method Using Row-Crop Forage Harvester at Tennessee Valley Substation.....	5
Baled Silage Method Using Hay Baler at the Piedmont Substation.....	7
Buckrake Method at the Piedmont and Turner-Hulsey Farm.....	10
Hay-Loader Method at the Dairy Research Unit, Auburn.....	12
GENERAL SUMMARY OF METHODS TESTED.....	14
ACKNOWLEDGMENT .....	15

# HARVESTING *and* STORING

# SILAGE

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## *A Report of 3 Years of Tests at Five Locations in Alabama*

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CATTLEMEN AND DAIRYMEN recognize the necessity of an adequate supply of reserve feed as insurance against weather adverse to production of good forage crops. Good quality, stored forages are second only to grazing crops as low-cost feeds for livestock. Since occasional periods of adverse weather are inevitable, livestock producers must maintain a supply of hay or silage to keep feed costs down when pastures are inadequate.

Recent developments in farm machinery and in storage structures make possible the reduction of much back-breaking toil and long hours normally associated with hay and silage making. Equipment is now available to move a silage crop from field stand to silo without hand labor. To further reduce labor requirements, structures have been designed to permit stored hay or silage crops to be self-fed. This circular reports the results from experiments with silage harvesting in the period of 1953-55 at several substations of the Agricultural Experiment Station of the Alabama Polytechnic Institute.

### **SILAGE HARVESTING METHODS STUDIED**

#### **Direct-Cut Method Using Forage Harvester at the Black Belt Substation**

Winter grazed Caley peas usually produce surplus forage in April and May. Because of weather conditions during those two

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\* Resigned

months, there is considerable risk in making hay of the surplus forage growth.

At the Black Belt Substation, where the direct-cut method was tested, the land is fairly flat and the fields are relatively large. In 1954, a surplus growth of Caley peas was harvested as silage with a power-take-off driven forage harvester. A year before, Johnsongrass was harvested as silage by the same direct-cut method.

Three tractors, one forage harvester, one forage blower, and two wagons equipped with unloaders were used in this silage-making operation. Three laborers were used. One man drove the tractor that towed and powered the forage harvester. Another man and tractor shuttled the two wagons between field and silo. The third man leveled and packed silage at the silo, operated the tractor that powered the forage blower, and helped unload. The hauling tractor could go from field to silo, unload, and return in about the time required for the harvester to fill the other wagon. Distance from field to silo averaged 1 mile.

The yield of Johnsongrass silage was 4.4 tons of 67 per cent moisture material per acre. The Caley peas produced 3.3 tons per acre at a moisture of 79 per cent. Data covering these two operations are presented in Table 1.

TABLE 1. CAPACITY, LABOR, AND EQUIPMENT REQUIREMENTS FOR HARVESTING JOHNSONGRASS AND CALEY PEA SILAGE AT BLACK BELT SUBSTATION

Crop	Tons per hour	Man hours per ton	Laborers required	Tractors required	New-cost cash outlay for silage equipment*	Adaptable to:	
						Trench silo	Upright silo
<b>1953:</b>							
Johnson-grass	2.59	1.16	3	3	\$2,985	yes	yes
<b>1954:</b>							
Caley peas	4.25	0.71	3	3	\$2,985	yes	yes

\* Includes forage harvester, forage blower, and two wagons, but no tractors. Note: These data do not include time used to service equipment.

Clear, smooth fields were found necessary for satisfactory operation of forage harvesters. Fire ant mounds, and rocks, stumps, and gulleys in other sections of the state caused delays and breakdowns resulting in increased labor costs and crop losses. Smooth, level roadways from field to silo helped increase silage-making capacity by reducing travel time and breakdowns. Excessive

loading of wagons slowed travel time and caused blowouts to worn tires, indicating the importance of good, heavy duty tires. The importance of a straight-through approach to the forage blower was evident. In this experiment, time was lost maneuvering the loaded wagon into position for mechanical unloading into the forage blower because of a short turn necessary just before aligning with the blower.

**Advantages.** Only three laborers and three tractors were required for the direct method. The silage was chopped, making it easier to remove from the silo than unchopped silage. This harvest method can be used for either upright or trench silos. The labor requirement of 0.71 and 1.16 man hours per ton for harvesting silage was low.

**Disadvantages.** Relatively large acreages must be harvested with this equipment to have low per-acre or per-ton costs. Some economists estimate 60 to 100 acres per year as minimum usage. This suggests custom work for small farm operators. The possibility of spring and fall silage crops and the use of the forage harvester to harvest hay crops should be considered. Chopped hay offers self-feeding possibilities. The cash outlay for new equipment of \$2,985 was moderately high.<sup>1</sup>

### **Direct-Cut Method Using Row-Crop Forage Harvester at Tennessee Valley Substation**

At the Tennessee Valley Substation, a level, smooth field of Tracy sorghum was harvested with a forage harvester and auxiliary engine using row crop attachment. The sorghum was grown specifically as a silage crop for beef cattle.

Four tractors, one forage harvester, one forage blower, and two combination forage wagons were used. Five laborers were required. One man drove the tractor that towed the forage harvester. Two men and two tractors towed the forage wagons from field to silo and operated and powered the mechanical unloaders on the wagons. The fourth man helped supervise the unloading and operated the tractor powering the forage blower. The fifth

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<sup>1</sup> For details of these harvesting, storing, and feeding cost studies, see Progress Report 54, "Cost Comparisons of Johnsongrass Silage and Hay," and Progress Report 55, "Summary of a One-Year Test on Cost of Producing, Harvesting, Storing, and Feeding Caley Pea Silage," published by this Experiment Station.

man distributed and packed silage in the upright silo. A load was field chopped every 15 minutes. Approximately the same time was required for the full wagon to travel from field to silo, position and unload, and return to field. Four loads were completed each hour. Men and machinery were not idle. Average distance from field to silo was about a quarter mile.

The yield of sorghum silage was 19.8 tons per acre and average moisture content was 77 per cent. Table 2 is a summary of pertinent data.

TABLE 2. CAPACITY, LABOR, AND EQUIPMENT REQUIREMENTS FOR HARVESTING TRACY SORGHUM SILAGE AT TENNESSEE VALLEY SUBSTATION, 1955

Crop	Tons per hour	Man hours per ton	Laborers required	Tractors required	New-cost cash outlay for silage equipment*	Adaptable to:	
						Trench silo	Upright silo
Tracy sorghum	9.64	0.52	5	4	\$5,460	yes	yes

\* Includes forage harvester, forage blower, and two wagons but no tractors. Note: These data do not include time used to service equipment.

Grassy spots in the field slowed the operation slightly, and occasional spots of lodged sorghum caused delays. The crop was standing well except for occasional spots. However, decreased efficiency and extreme difficulty were evident in harvesting a crop subjected to high winds. Occasional gusts of wind during harvest resulted in some material blowing from the wagons. Use of wind covers for the wagons was considered but not deemed necessary. Insufficient turning room at ends of the rows resulted in some time loss.

The use of flexible downspouting inside the silo permitted distribution of the silage without forking. Smooth, steady feeding of the forage blower by the mechanical wagon unloaders kept unloading time at a minimum. No manual handling of silage was necessary. A straight-through approach to the silage blower for the silage wagons helped reduce unloading time.

**Advantages.** The silage-making capacity of 9.64 tons per hour for the direct-cut, row-crop method was relatively high. The man-hour requirement of only 0.52 per ton of silage was quite favorable. The method can be used for both trench and upright silos. No manual handling of silage was required. The harvester can be used to harvest hay crops. The forage wagons can serve as manure spreaders or green forage feeding wagons.

**Disadvantages.** Five men and four tractors were required. Investment in silage equipment totaled \$5,460. This high investment makes it necessary that large acreages or tonnages be handled to hold per-acre costs to a minimum. It is estimated that such equipment be used at least 80 to 120 hours per year. Custom work might provide additional usage.

### **Baled Silage Method Using Hay Baler at the Piedmont Substation**

The Piedmont Substation, located in the Piedmont Area of Alabama, is characterized by hilly, rocky, rough terrain. Alfalfa was harvested as baled silage in 1953. A wire-tie baler with auxiliary engine was used in the tests. The bales were placed in an above-ground trench silo and fed to beef animals.

Five tractors, one hay baler, one rake, one mower, and two wagons were required. Eleven men were needed. One man and tractor mowed; another man and tractor raked; a third man and tractor pulled the automatic baler; and two tractors, two wagons, and eight men were needed for hauling the bales to the silo. Actually, one wagon and four men hauled the baled silage, but they handled only one-half as much as the baler was baling. Therefore, it was concluded that two wagons and eight men were needed. All men and machines were kept busy during the time required to cover the test field of about 3 acres. Hauling crews placed the bales in the silo and attempted to stack the bales to exclude cracks that might allow passage of air and rain water.

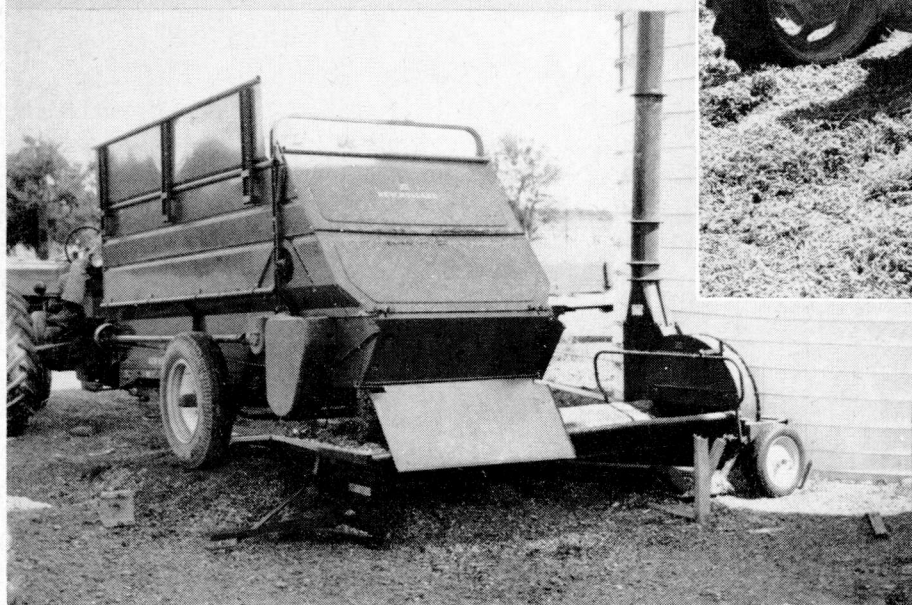
Distance from field to silo was about a quarter mile. It was necessary to cross several terraces in traveling from field to silo which slowed handling. Data pertaining to this operation are presented in Table 3.

TABLE 3. CAPACITY, LABOR, AND EQUIPMENT REQUIREMENTS FOR HARVESTING ALFALFA AS BALED SILAGE AT PIEDMONT SUBSTATION, 1953

Crop	Tons per hour	Man hours per ton	Laborers required	Tractors required	New-cost cash outlay for silage equipment*	Adaptable to:	
						Trench silo	Upright silo
Alfalfa	7.54	1.46	11	5	\$4,750	yes	yes

\* Includes hay baler, side delivery rake, mower, and two wagons but no tractors. Note: These data do not include time used to service equipment.

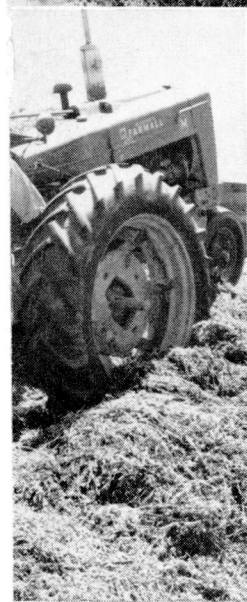




**UPPER LEFT.** Tractor-drawn forage harvester and wagon are used in direct-cut method of harvesting silage at the Black Belt Substation. **LOWER LEFT.** Tracy sorghum, harvested by direct-cut method, is unloaded mechanically from forage wagon onto conveyor and then blown into

upright silo at Tennessee Piedmont Substation, where silage in the trench silo is baled to spread and harvest. **UPPER RIGHT.** Silage





alley Substation. CENTER. loaded by a tractor. At the ends were driven over silage. Close joints between bales. Gathered by buckrake with

push-off unloader attachment at Turner-Hulsey Farm. Silage is unloaded into trench silo by pushing load off ahead of tractor. LOWER RIGHT. Alfalfa is distributed on wagon from hay loader at the Dairy Research Unit. Hay loader method works well over terraces.

Although the number of laborers required was high, man hours per ton of silage was relatively low because of the high tonnage per hour handled by the crew. Loading the wagons and stacking the bales in the silo were done by hand. A bale loader would undoubtedly reduce labor requirements. The tightly formed bales, made as small as possible without a special machine part (not immediately available), averaged 148 pounds each. About 10 per cent of the bales fell apart in handling. These broken bales were used to fill cracks between bales that were not square at the corners. Tractors were driven over the bales in the silo to spread the bales and help close the joints between bales. Except for surface and side spoilage, the silage appeared satisfactory and the animals ate directly from the bales.

This method of making silage has been used in Alabama by farmers with adequate labor and who prefer not to purchase a silage harvester or other silage equipment. Some lightweight balers will not handle high-moisture silage material.

**Advantages.** The amount of silage handled per hour by the baled silage method, 7.54 tons, was relatively high, and the man-hour requirements was 1.46 hours per ton. Hay harvesting equipment was used without additional purchases.

**Disadvantages.** Eleven laborers and five tractors were needed for a continuous operation. Equipment, in addition to tractors used in the silage operation, had a new cost value of \$4,750 which was high. This harvest method is suited only to trench silos. Much hard, hand labor is involved.

### **Buckrake Method at the Piedmont Substation and Turner-Hulsey Farm**

The buckrake method of harvesting silage was observed at the Piedmont Substation in 1953 and at the Turner-Hulsey Farm, Eastaboga, in 1954. The buckrake used on the Piedmont Substation was an old unit operated as a front-end loader. When lowered to the raking position, it locked in place. To haul, it was lifted 2 to 3 feet above the ground; to place in the trench silo, the rake was lowered and the tractor and rake backed away leaving the load in the silo. At the Turner-Hulsey Farm, a buckrake with push-off unloader manipulated by winches was used.

This unit unloaded in the trench silo "on-the-run" by pushing the load off ahead of the moving tractor.

At both locations three tractors, a mower, and a buckrake were required to make silage. Three men were needed. One man and tractor were kept 50 to 80 per cent busy mowing. A second man and tractor operated the buckrake, picking up silage directly from the swath. The third man and tractor remained at the trench silo to pack silage and, occasionally, to spread the silage. The man operating the mower had to time the cutting operation to have ample silage down for the buckrake, yet not get enough ahead to allow the forage to wilt excessively. Data regarding these operations at the two locations are given in Table 4.

TABLE 4. CAPACITY, LABOR, AND EQUIPMENT REQUIREMENTS FOR HARVESTING GRASS SILAGE WITH BUCKRAKE AT PIEDMONT SUBSTATION, 1953, AND TURNER-HULSEY FARM, 1954

Crop	Tons per hour	Man hours per ton	Laborers required	Tractors required	New-cost cash outlay for silage equipment*	Adaptable to:	
						Trench silo	Upright silo
<b>Piedmont Substation</b>							
Alfalfa	1.22	2.46	3	3	\$ 700	yes	no
<b>Turner-Hulsey Farm</b>							
Ryegrass-crimson clover	5.50	0.55	3	3	\$1,500	yes	no

\* Estimated values; includes mower and buckrake but no tractors.

Note: These data do not include time to service equipment.

There was wide variation in tons per hour handled by the two buckrake methods. Also, there was considerable variation in capacity due to experience of the operator. A smooth field free of gulleys, irregularities, rocks, and other obstructions is a *must* for satisfactory operation of a buckrake. The buckraking tractor must operate at high speeds to handle high tonnages per hour. Loads varied from less than 300 pounds to over 1,000 pounds. Average load for the front-end-loader was 440 pounds and for larger buckrake 750 pounds. Average time to complete load with small buckrake was 10.8 minutes; with larger buckrake, 4.1 minutes. These factors contributed to the advantage in favor of the larger unit: (1) larger capacity and faster raking, (2) smoother fields permitting higher travel speeds, (3) skill of operator in handling buckrake, (4) shorter traveling distance—a tenth mile

as compared to quarter mile, and (5) high tonnage of green materials per acre.

Man hours per ton of material varied inversely with the capacities. With the large buckrake, the labor requirement per ton was quite low, whereas with the smaller unit, the per ton labor requirement was relatively high. Special equipment cost was comparatively low, \$700 to \$1,500. The equipment could be used also to harvest hay crops. This method appeared to be better adapted to small farms where high equipment investments are not justified. Fields must not be over a half mile from the silo. Overdrying will result if too much silage is mowed ahead of the buckrake. This causes spoilage because of difficulty in compacting the overdry silage.

**Advantages.** Only three laborers and three tractors were needed to make silage by the buckrake method. The equipment, fairly low in cost, could be used to harvest hay crops as well as silage. Little manual labor was required.

**Disadvantages.** The method is limited to short hauls and to smooth fields and roadways. It is better adapted to trench than to upright silos. It requires a skilled operator to load rakes heavily (700 pounds or more) and obtain speed for high operating capacity.

#### **Hay-Loader Method at the Dairy Research Unit, Auburn**

A hay loader was used to harvest alfalfa for silage at the Dairy Research Unit, Auburn. The field had terraces that had to be crossed to reach the silo  $1\frac{1}{2}$  miles distant. The equipment of the hay-loader method worked better over terraces and drainage ditches than that of other methods.

Four tractors, one mower with windrowing attachment, one hay loader, and two wagons were required. Five laborers were needed. One man and tractor mowed and windrowed the silage to stay ahead of the loaders. The mower was idle about one-third of the time. Another man rode the wagons and distributed the silage on the wagons. Two men drove tractors to shuttle the wagons from field to silo. A fifth man and fourth tractor were stationed at the silo to distribute and pack the silage in the silo.

Silage was unloaded by connecting the packing tractor to chains that were fixed at the rear of the silage wagons. These chains were placed along the bottom of the wagons before loading. After unloading, the silage was spread by hand and then packed with the tractor.

A load could be hauled, unloaded, and the wagon returned to the field 3 to 5 minutes before the other wagon was loaded. A wagon was loaded every 31.7 minutes. Data regarding this harvest method are given in Table 5.

TABLE 5. CAPACITY, LABOR, AND EQUIPMENT REQUIREMENTS FOR HARVESTING LONG GRASS SILAGE WITH HAY LOADER AT DAIRY RESEARCH UNIT, AUBURN, 1954

Crop	Tons per hour	Man hours per ton	Laborers required	Tractors required	New-cost cash outlay for silage equipment*	Adaptable to:	
						Trench silo	Upright silo
Alfalfa	3.90	1.28	5	4	\$1,200	yes	no

\* Includes mower, hay loader, and two wagons but no tractors.

Note: These data do not include time to service equipment.

Considering the length of haul involved, the method was relatively efficient. The tonnage per hour of 3.90 was good and the man-hour requirement of 1.28 per ton was comparatively low. Hand labor was used in placing the silage in the wagons and in spreading it in the trench silo. The method used in unloading the wagons (2.05 tons per load) required only 5.3 minutes. Since four tractors and five laborers were required, the possibility of farmers trading the use of tractors and labor is suggested. The new cost of special equipment of \$1,200 places this method in the low-cost range. It is not readily adaptable to upright silos because additional handling would be necessary.

**Advantages.** Total man-hours per ton of material by the hay-loader method was fairly low, 1.28 hours. Special equipment value of \$1,200 was low. The equipment could be used also to harvest hay. The procedure gave a fairly high silage-making capacity. The method is adaptable to small or medium acreages.

**Disadvantages.** Four tractors and five laborers were needed. The method is better adapted to trench than upright silos. Occasionally, loads become entangled while being placed in the silo making spreading and packing difficult. The method is adaptable only to long silage.

## **GENERAL SUMMARY of METHODS TESTED**

Certain general summarizations may be made concerning all harvesting methods studied:

(1) Regardless of method of harvest, the necessity for smooth fields with good access to roadways was apparent in all observations.

(2) Silage fields should be as near silo as possible to reduce hauling time and increase capacity and efficiency.

(3) Approach routes to silage blowers or trench silos should be straight and should permit through traffic to speed operation and aid in alignment of wagons.

(4) Some means of unloading silage wagons mechanically should be used.

(5) For efficient use of labor and equipment, the harvest procedure should provide continuous operation of equipment with minimum delays where one step of the operation awaits another. This can often be adjusted by the size of the load harvested.



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