December 8, 1949

To the Committee on Graduate Study:

I am submitting to you a thesis written by Marvin E. Farris entitled "An Investigation into the Use of Silos and Silage for Feeding Dairy Cows." I recommend that it be accpted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Dairying.

R. N. Lush
Major Professor

We have read this thesis
and recommend its acceptance:

M. L. Downen

H. R. Duncan

Accepted for the Committee

E. G. Wakeman
Dean of the Graduate School

AN INVESTIGATION INTO THE USE OF SILOS AND SILAGE FOR FEEDING DAIRY COWS

A THESIS

Submitted to
The Committee on Graduate Study
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

---

by

Marvin Edward Farris

December 1949

ACKNOWLEDGMENT

My deep appreciation is expressed to Professor R. H. Lush and Professor C. E. Wylie of the Dairy Department, and to Professor C. E. Allred and Mr. M. L. Downen of the Farm Management Department of the University of Tennessee whose wholehearted cooperation, guidance and assistance have made this study possible.

A word of thanks is also extended to Mrs. Joe Broome whose speed and accuracy in typing have made it possible to complete this report at an earlier date than expected.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

TABLE PAGE

LIST OF APPENDIX TABLES

TABLE PAGE

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Approximately 4,600,000 acres of corn and 900,000 acres of sorghum are grown for silage in the United States annually (57). Add to this a growing number of acres producing grass silage and a comparatively small acreage devoted to producing sunflower and other minor silage crops, and it is evident that silage is a significant feed for livestock in this country.

Tennessee has made considerable progress in both the quantity and quality of dairy products produced in recent years. The number of milk cows on farms is estimated at 621,000 for January 1, 1949. The total acreage devoted to corn in Tennessee in 1948 was 2,255,000 of which 16,000 were harvested for silage with an average yield of 8.0 tons. Alfalfa, as a silage crop, is of growing importance in Tennessee. In 1948 there were 176,000 acres grown which produced an average of 2.05 tons of hay per acre (16). Compared to other farm animals dairy cows consume large quantities of silage. Yet the large number of silos on dairy farms which remain empty each year may indicate that the making and feeding of silage is not always profitable or desirable. This thesis is an account of an investigation conducted for the purpose of determining the circumstances under which silage may be made and fed

to dairy cattle and some of the results obtained. Special emphasis is given to the findings of an original investigation conducted in Rutherford County, Tennessee, in June 1949.

CHAPTER II

REVIEW OF RELATED LITERATURE

Cost of Silos and of Storing Silage

Silage has been stored in various kinds of silos with varying degrees of success. However, the following are the main types currently being used in the United States. Above ground permanent: concrete stave, monolithic concrete, concrete block, tile, wood stave, brick, and metal. Above ground temporary: slat and welded wire fence, baled straw, and stack. Below ground: pit and trench.

More dry matter can be stored per cubic feet of space by ensiling crops than by any other method. The cost of providing this storage space varies with several factors, the most important of which is the type of silo constructed. Ordinarily this cost is spread over many years so that the annual unit cost of storing silage is not excessive, and usually runs less than a dollar per ton.

Losses in Storing and Feeding Silage

Although silos in general conserve feed nutrients with comparatively small losses, some loss does occur. The type of silo and the efficiency with which air is excluded from the silage are very important factors in conserving feed when ensiling. Permanent upright silos are

usually the most efficient and temporary stack silos are the least efficient conservers of ensiled crops (Tables I-V).

Herman (39) found that chopped barley in a trench silo ensiled with 60 pounds of blackstrap molasses per ton showed a spoilage of 16.90 percent after six months in storage. The spoilage was 14.32 percent when eight pounds of 75 percent phosphoric acid was used as a preservative instead of molasses.

Reed (64) found dry matter losses to be excessive in four temporary upright (slatted fence) silos 15 feet in diameter and 14.5 to 18 feet high. The greatest loss occurred in the shortest silo (14.5 feet) and amounted to 34 percent. The least loss occurred in the tallest silo (18 feet) and was 21 percent. These silos were filled with grass silage. A baled straw silo surrounded by wire fence and filled with corn silage showed a dry matter loss of 20 percent after only 30 days in storage.

Smith (70) suggests the following measures to reduce spoilage in snow fence (slat) or welded wire temporary upright silos:

1. Use special lining paper heavy enough to withstand pressure and resistant to silage acids, bacteria, and moisture.
2. Do not attach the paper to the silo (it may tear as the silage settles).
3. Use two sheets of paper to line the silo (double lining). The outer sheet may be used again.
4. Do not ensile grasses in the rain as excess moisture will drain from the silo and carry away minerals and preservatives.

TABLE I

ORIGINAL AND ANNUAL COSTS OF CONCRETE STAVE SILOS (29) (INDIANA, 1947)

Size (feet)	10x25	10x35	12x35	12x45	14x35	14x45
Approximate capacity (tons)	37	54	79	102	107	140
Original cost of silo	$384.00	$518.50	$605.50	$768.00	$690.00	$861.50
Foundation	46.30	46.30	61.65	61.65	75.30	75.30
Transportation	9.37	13.37	16.18	20.56	18.37	23.63
Chute and ladder	66.25	91.00	91.00	119.25	91.00	119.25
Feed room	237.50	237.50	237.50	237.50	237.50	237.50
Labor	14.40	14.40	21.60	21.60	28.80	28.80
Roof	105.33	105.33	140.33	140.33	167.00	167.00
Total	863.15	1,026.40	1,173.76	1,368.89	1,307.97	1,512.98
Cost per year:						
Interest (4%)	17.26	20.52	23.48	27.38	26.16	30.26
Depreciation (46 years)	18.73	22.27	25.47	29.70	28.58	32.83
Maintenance	2.92	2.92	3.24	3.24	3.72	3.72
Taxes (1.22%)	5.27	6.26	7.16	8.35	7.98	9.23
Insurance (88¢/$100.)	3.80	4.52	5.16	6.02	5.76	6.66
Total	47.98	59.49	64.51	74.69	72.00	82.70
Cost per ton per year	1.30	1.05	0.82	0.73	0.67	0.51

TABLE II

AVERAGE ANNUAL COSTS OF TEMPORARY UPRIGHT SILOS (29)
(INDIANA, 1947)*

Capacity (tons)	Size feet	Interest	Depreciation (20%)	Labor	Paper (lining)	Total	Cost per ton
16	12x12	$0.83	$ 4.13	$2.40	$ 7.45	$14.81	$0.93
31	14x16	1.23	6.40	4.20	11.23	23.06	0.74
41	16x16	1.47	7.35	4.80	12.74	26.09	0.64
87	18x20	2.06	10.28	6.00	17.55	35.89	0.44
97	20x20	2.29	11.44	6.60	18.90	39.23	0.40

*Average for silos built of No. 11 welded wire @ 17¢ per foot and for silos built of snow fence @ 21¢ per foot.

TABLE III

INITIAL COST OF BUILDING TRENCH SILOS (29) (INDIANA, 1947)

Capacity in tons	Man hours	Tractor hours	Scraper hours	Team hours	Total cost	Cost per ton
37	80	32	32	—	$75.20	$2.03
50	48	—	32	32	56.30	1.13
78	24	24	34	—	34.80	0.45

TABLE IV

ANNUAL SILO COSTS PER TON—BY TYPE OF SILO (29)
(INDIANA, 1947)*

Concrete stave		Temporary upright		Trench	
Capacity (tons)	Cost per ton	Capacity (tons)	Cost per ton	Capacity (tons)	Cost per ton
37	$1.30	16	$0.93	Average of all	$0.32
54	1.05	31	0.74		
79	0.82	41	0.64		
102	0.73	82	0.44		
107	0.67	97	0.40		
140	0.59				
142	0.56				
168	0.51				

*In constructing above-ground silos for grass silage extra reinforcing is necessary as grass silage exerts 1.5 to 1.75 times the pressure of corn silage.

TABLE V

PERCENTAGE OF SILAGE RECOVERED FROM AN UPRIGHT AND A TRENCH SILO (26) (U.S.D.A. Av., 1929 AND 1930)

Type of silo	Total recovered	Total edible recovered
	Percent total weight basis	
Permanent upright	94.38	87.87
Trench	87.15	77.91

5. Place grass with highest moisture content on top as as the drainage may be absorbed by the relatively dry silage below.
6. Chop grass silage fine (1/4 inch lengths for small temporary silos).
7. Build a temporary silo only a few feet higher than the diameter. If less than 12 feet high place extra weight on top of silage.
8. Do not use HCl or H_2SO_4 as preservatives (the acid will deteriorate the paper lining).

Camburn (19) has compared the losses from a mixture of alfalfa and timothy occurring when harvested and stored by various methods (Table VI).

Huber (46) has recommended a drain for permanent upright silos which terminates above ground. After drainage ceases it can be plugged to exclude the entrance of air thus reducing spoilage. Surface spoilage will occur after a silo is opened unless silage is fed fast enough to prevent it. Morrison (57) recommends that two inches of silage be fed daily and that on the average two inches of silage in a 10 foot permanent upright silo will weigh approximately 620 pounds. From a 12 foot silo two inches will weigh about 895 pounds, from a 14 foot silo 1,215 pounds and from a 16 foot silo 1,590 pounds. To prevent surface spoilage Lush (51) has recommended a certain relationship between size of herd and diameter of silo (Table VII).

There is some difference between the estimates of Morrison (57) and Lush (51) as to the weight of silage in a two-inch layer when stored in silos of a given diameter. This can be largely accounted for by the various heights of silos. The taller the silo the more pounds of silage contained per cubic foot of silage.

TABLE VI

NUTRIENT LOSSES FROM A MIXTURE OF ALFALFA AND TIMOTHY--VARIOUS METHODS OF HARVESTING AND STORING (19) (VERMONT, 1948)

Item	Sun cured (hay)	Artificially dried (hay)	Ensiled without a preservative*	Ensiled with molasses*
	% loss	% loss	% loss	% loss
Dry matter	15.8	5.0	9.3	8.2
Ash	21.5	9.9	1.1	6.8
Crude protein	22.8	16.7	5.8	8.0
Crude fiber	11.8	+1.0	1.9	0.6
Nitrogen free extract	13.8	3.0	17.9	13.9
Ether extract (crude fat)	28.4	4.5	+21.8	+15.6

*Permanent upright silo. Top spoilage before feeding began is excluded.

TABLE VII

RELATION OF DIAMETER OF SILO TO SIZE OF HERD (51)

Diameter of silo (feet)	Weight of silage in two-inch layer (pounds)	Minimum size of herd	
		Jersey 30# daily	Holstein 37# daily
10	496	16	13
12	716	24	19
14	975	32	26
16	1,273	42	34
18	1,574	52	42

To prevent surface spoilage and to match the capacity of the silo to the size of the herd Grimes (37) suggests various dimensions for trench silos as tabulated in Table VIII.

The question of grain losses in feeding corn silage to dairy cows is a subject of interest and importance. Since the grain is not ground and many kernels are not broken or cracked by the ensiling process, it is to be expected that some of them will pass through the digestive tract and be excreted in the feces. Becker (9) in a 20-day experiment involving four cows calculated that 8.47 percent of the grain contained in corn silage was lost in the feeding operation--95.09 percent of this loss was due to grain passing through the digestive tract and 4.91 percent was due to grain contained in refused silage (losses in feeding shelled corn to dairy cows often approximate 23 percent). The above losses of grain in feeding corn silage to dairy cattle may be salvaged by running hogs or poultry after the cows.

Use of Preservatives in Making Silage

Preservatives are often needed for grass and legume silage to facilitate proper bacterial growth which inhibits the decomposition of protein that is present in comparatively large amounts in grass silages. Grass silage which contains an unusually large percentage of water is more likely to spoil than silage of relatively low moisture content. With a tight silo and the silage chopped short and well packed, there

TABLE VIII

SUGGESTED DIMENSIONS FOR TRENCH SILOS (37)

Number of cows	Width at top	Width at bottom	Depth	Length when feeding period is 100 days	125 days	150 days
	Feet	Feet	Feet	Feet	Feet	Feet
6	6	4	5	24	30	35
10	6	4	5	40	50	60
14	7	5	6	39	49	59
20	9	7	7	36	45	54
28	12	8	7	40	50	60
36	12	8	8	45	57	68
44	13	9	8	50	63	75
52	14	10	8	55	68	82

may be no need for a preservative. However, a preservative may prove to be good insurance. The preservative used largely depends on what is available and relative prices.

Shepherd (66) recommends various amounts of various preservatives to be used with grass silages (Table IX).

Carncross (21) in a survey conducted among dairy farmers in New Jersey ascertained the actual amounts of blackstrap molasses used in making grass silage (Table X).

Composition of Various Silages and Hays

The nutrient content of crops and the efficiency with which various methods of storing preserve nutrients are important considerations in selecting feeds for dairy cows.

Shepherd (66) compared alfalfa silage with alfalfa hay harvested the same year from the same field, and found that ensiling preserved 83 percent of the dry matter contained in the crop at cutting time as compared to 75 percent preserved when put up as field-cured hay. On a dry matter basis the alfalfa silage contained 20.6 percent protein compared to 18.2 percent for the same crop put up as field cured hay.

Hodgson (43) found that first cutting alfalfa contained 21.97 percent protein on a dry matter basis. The same crop as barn-cured hay contained 18.35 percent protein and as field-cured hay the percentage of protein was 18.43.

TABLE IX

SUGGESTED QUANTITIES OF PRESERVATIVES TO USE IN MAKING GRASS SILAGES (66) (U.S.D.A. 1948)

Silage	Molasses (black strap)	Phosphoric acid (75%)	Corn and cob meal	Ground corn, barley or wheat	Dried whey
	Expressed in pounds per ton				
Fresh green alfalfa or red clover	80	20	200	150	40
Fresh green soybeans or Ladino clover	100	30	250	200	60
Wilted legumes (all crops)*	60	15	150	100	30
Fresh green mixed legumes and grasses (not headed out)	80	20	200	150	40
Wilted mixed legumes and grasses (not headed out)*	60	15	100	100	30
Fresh green mixed legumes and grasses (headed out)*	60	15	100	100	30
Wilted mixed legumes and grasses (headed out)	None	None	None	None	None
Fresh green grasses and cereals (not headed out)	60	20	200	150	40
Wilted grasses and cereals (not headed out)*	40	10	100	100	30
Fresh green grasses and cereals (headed out)*	40	10	100	75	20
Wilted grasses and cereals (headed out)	None	None	None	None	None

*Preservative may be omitted when silo is tight and good ensiling methods are used.

TABLE X

MOLASSES ADDED PER TON OF GRASS SILAGE (21)
(50 NEW JERSEY FARMS, 1938)

Range in pounds per ton	Number of farms		
	Alfalfa	Soybeans	Mixed Grasses
0	2	0	0
25 - 49	1	1	3
50 - 74	16	2	5
75 - 99	10	3	3
100 and over	15	5	0
Total number	44	11	11

Newlander (61) reported that alfalfa silage on a dry matter basis contained 8.22 percent protein and 53.34 percent total digestible nutrients. Alfalfa stored as sun-cured hay contained 8.43 percent protein and 55.20 percent total digestible nutrients. As barn-cured hay the analysis was 9.32 percent protein and 56.77 total digestible nutrients.

Branaman (15) has published an analysis of a mixture of alfalfa and clover stored as silage and as hay and compared with corn silage (Table XI).

Hinton (41) compared the composition of corn silage with grass silage. His results are tabulated in Table XII.

Bennett (10) has stated that sorghum silage harvested in the soft dough stage contained 4.10 percent crude protein, 1.90 percent crude fat, 22.71 percent crude fiber, 66.44 percent nitrogen free extract, and 14.60 percent starch and sugar. All percentages are expressed on a dry weight basis.

Feeding Value of Various Silages and Hays as Determined by Experiments

The feeding value of various crops and of a specific crop harvested and stored by various methods are best determined by actual feeding trials.

TABLE XI

COMPARATIVE COMPOSITION OF LEGUME HAY, LEGUME SILAGE AND CORN SILAGE (15) (MICHIGAN, 1939)

Feed	Crude protein	Ether extract	Carbohydrates	
			Crude fiber	N-free extract
	Expressed in percent dry weight			
Alfalfa-clover hay	12.19	1.77	38.69	41.53
Alfalfa-clover silage	14.28	5.02	35.74	37.13
Corn silage	8.78	3.95	23.15	60.09

TABLE XII

CHEMICAL ANALYSIS OF CORN, ALFALFA AND SERICEA SILAGES (41)

Item	Corn	Sericea	Alfalfa*
Moisture (%)	75.82	68.79	75.54
Dry matter (%)	24.18	31.21	24.46
Crude protein (%)	1.46	4.33	4.47
Crude fat (%)	—	0.64	0.65
Crude fiber (%)	6.46	10.28	8.86
Nitrogen free extract	14.11	13.99	8.06

*60 pounds molasses and 10 pounds of 80 percent phosphoric acid added as preservatives.

Hodgson (43) found that second-cutting alfalfa fed as silage produced 100 pounds of four percent fat-corrected milk on a total dry matter intake of 92.9 pounds. Second cutting alfalfa fed as barn-cured hay produced 100 pounds of four percent fat-corrected milk on a total dry matter intake of 96.5 pounds. Field-cured second-cutting alfalfa hay produced 100 pounds of four percent fat-corrected milk on a total dry matter intake of 97.4 pounds. Because ensiling preserved more dry matter per acre (as pointed out in the previous section) and made more milk per unit of dry matter, alfalfa fed as silage produced 12.5 percent more milk per acre compared with feeding as field-cured hay.

Moore (56) found that alfalfa fed as hay required 97.4 pounds of dry matter to produce 100 pounds of four percent fat-corrected milk but when fed as silage 92.9 pounds of dry matter produced 100 pounds of milk.

Wilbur (73) determined that 2.74 pounds of corn silage are required to replace one pound of alfalfa hay for cows in milk.

Lush (50) showed that 3.3 pounds of corn-soybean silage are required to replace one pound of good legume hay for cows in milk.

Eckles (30) determined that a ration of alfalfa hay and corn silage produced better winter gains on dairy heifers than did alfalfa hay alone.

Hinton (41) reported that an alfalfa silage ration produced 717.10 pounds of fat in 540 cow days. A sericea silage ration produced 600.12 pounds of fat in 541 cow days and a corn silage ration produced 698.04 pounds of fat in 532 cow days. The cows on the alfalfa silage ration lost some weight during the experiment while the cows on the corn silage and sericea rations gained weight.

Hinton (42) also determined that a corn silage ration produced 1.0688 pounds of fat per cow per day. A corn-soybean silage ration produced 1.0682 pounds of fat per day, and a soybean silage ration produced 0.9775 pounds of fat per cow per day.

Separate experiments conducted by Camburn (18) and Pratt(63) showed that there was little difference in the milk yield due to the succulent or non-succulent character of the ration so long as total digestible nutrients consumed remained the same. Dehydrated silage produced practically as much milk as did normal silage. However, the succulent rations in the two experiments produced an average of 28.48 pounds of four percent fat-corrected milk compared with 27.74 pounds for the non-succulent rations.

Feeding Value of Silage As Determined by Surveys

Several surveys have been made in which the value of silage in the feeding of dairy cows on practical dairy farms has been determined.

Robertson (65) in a survey of 192 Indiana dairy farms in 1941-42 found that dairymen feeding no silage produced 8,019 pounds of 3.8 percent milk per cow per year at a cost of $1.34 per hundred. Dairymen feeding silage in medium amounts (4,000-5,712 pounds) produced 7,942 pounds of 3.8 percent milk at a cost of $1.42 per hundred. The no-silage dairymen made $36.08 profit per cow while the dairymen feeding a medium amount of silage realized $32.73 profit per cow. The same survey showed that light silage feeding (314-3,999 pounds) produced only 7,791 pounds of 3.8 percent milk, but produced it at the low cost of $1.30 per hundred. Profit in the light silage group was the highest, being $40.70 per cow. Dairymen feeding silage at a heavy rate (5,713 to 10,857 pounds) realized only $31.34 profit per cow which was the lowest of any group studied. Each dairyman included in the survey kept standard records in an Indiana cost account book.

Elrod (31) conducted a survey of 54 Georgia dairy farms in 1944 and found that the ten farms making the largest labor incomes fed 1,874 pounds of silage per cow compared to 1,100 pounds of silage fed per cow when all farms were considered. The ten best farms produced 5,145 pounds of milk per cow compared to 4,888 pounds per cow for all farms. The ten best farms produced milk at a cost of $3.34 per hundred. The average cost of producing milk for all farms was $3.65 per hundred. The ten farms showing the least labor income fed only 133 pounds of silage per cow. The average production per cow was 4,256 pounds, and the cost of producing this milk was $4.56 per hundred.

Cunningham (23) reported that a survey of 106 farms in New York in 1945-46 revealed that the more silage fed per cow the greater the production per cow and the larger the labor income. Cost per hundred pounds of milk varied and the trend was not entirely in one direction as Table XIII shows.

Higgins (40) reported the results of a survey conducted in 1933 in which the average daily milk production per herd just prior to feeding silage was 72.8 pounds. On the seventh day after silage was included in the ration the daily production had increased to 101 pounds, and on the fourteenth day the production reached 107 pounds.

Morrison (57) reported that a survey of herds in cow-testing associations revealed that herds receiving silage, mixed hay and grain averaged 279 pounds of fat per cow per year. Herds receiving mixed hay and grain with no silage averaged only 248 pounds.

Baker (1) reported that a survey of 227 Ohio farms revealed that farms feeding silage produced 6,720 pounds of milk per cow per year at a cost of $4.13 per hundred pounds of four percent milk. No-silage farms produced 6,453 pounds of milk per cow at a cost of $4.12 per hundred. More than 50 percent (125 of 227) of the dairymen interviewed fed silage.

Bond (14) in a survey of 452 farms found that production per cow increased as the amount of silage fed per day increased. However, feeding silage in relatively small amounts (20-29 pounds daily) proved to be most profitable (Table XIV).

TABLE XIII

SILAGE FED PER COW PER YEAR AND VARIOUS FACTORS (23) (NEW YORK, 1944-1945)

Number of farms	Tons of silage per cow	Pounds of grain per cow	Tons of hay per cow	Pounds of milk per cow	Cost per 100 pounds milk $	Labor income $
11	None	1,791	3.1	5,809	3.89	1,045
33	2.7	2,030	2.5	6,158	3.93	1,590
40	4.1	2,280	2.6	6,400	4.09	1,590
22	5.6	2,582	2.5	7,609	3.74	2,492

TABLE XIV

RATE OF FEEDING SILAGE AND VARIOUS FACTORS (14)
(VERMONT, 1932-1933)

Number of farms	Pounds of silage per cow per day (range)	Pounds of milk per cow per day	Net cost per 100 pounds milk	Pounds T.D.N. per 100 pounds milk
61	1-19	11.0	$2.15	151
103	20-29	13.3	2.11	151
110	30-39	14.2	2.21	156
81	40 or more	15.5	2.21	153
355	Average	13.7	2.18	153
97	No silage	12.0	2.32	162

Downen (27) in a survey of 72 farms in Rutherford County, Tennessee, selling market milk in 1947, found that herds receiving silage produced 5,364 pounds of milk per cow at a gross cost of $5.69 per hundred. Profit per cow for the year was $10.90. Herds receiving no silage produced 5,590 pounds of milk per cow at a gross cost of $5.05 per hundred. Profit per cow for the year was $34.20. Only 38.9 percent of the herds received silage.

Downen (28) also reported that a survey of 68 farms selling milk for manufacturing purposes for the same county and year showed that herds receiving silage produced 4,424 pounds of milk per cow at a gross cost of $6.62 per hundred. Each cow lost $113.17 for the year. Herds receiving no silage produced 4,596 pounds of milk per cow per year at a cost of $4.97 per hundred. Each cow lost $35.40 for the year. Only 16.2 percent of the herds received silage.

Yields of Various Silage and Hay Crops

Ewing (33) at the Middle Tennessee Experiment Station determined the 1946 yield of corn silage to be 9.90 tons per acre. Average yield of 12 varieties of sweet sorghums was 14.49 tons per acre for the same year.

Bennett (10) in three-year trials found that corn yielded 8.07 tons of silage per acre in Mississippi. Sweet sorghum (Texas Seeded

Ribbon Cane) yielded 19.60 tons per acre. These trials were conducted in 1926-7-8.

Morrison (57) reported that corn yielded 8.00 tons of silage per acre containing 4,384 pounds of dry matter. Alfalfa as hay yielded 2.23 tons per acre containing 4,036 pounds of dry matter. These figures are averages of various results from various localities.

Bierly (12) by surveying in five counties of New York State found that corn as silage yielded 9.70 tons per acre. Alfalfa as hay produced 2.28 tons per acre. This survey was conducted in 1939-40.

Morrison (58) in a survey of 380 New Jersey farms in 1938 found that the first cutting of alfalfa yielded 7.80 tons of silage per acre. Soybeans alone and a mixture of soybeans and sudan grass each yielded 9.00 tons of silage per acre.

Hodgson (43) stresses that various methods of harvesting and storing may affect the final yield of forage crops. On two cuttings of alfalfa (first and second) he determined that 92.5 percent of the crop was stored and 82 percent was fed when the alfalfa was ensiled. This represented a 7.5 percent loss from cutting to storage and a 10.5 percent loss from storage to feeding. Storing and feeding the alfalfa as barn-cured hay resulted in 85.5 percent stored and 81 percent fed. The loss from cutting to storage was 14.5 percent and storage to feeding 4.5 percent. Handling the alfalfa as field-cured hay showed that 81

percent of the crop was stored and 76.5 percent fed. The cutting to storage loss was 19 percent and storage to feeding loss was 5.5 percent. Rain in the amount of 0.66 inch fell on the first cutting.

Costs of Producing Silage Crops and of Making Silage

Carncross (21) made a study of the cost of producing various silage crops. His findings are summarized in Table XV.

Carncross (20) also reported the results of a survey in New Jersey in 1938 which showed the costs of producing T.D.N. with various feed crops. He found that pasture produced one hundred pounds of T.D.N. for 97 cents. Alfalfa silage provided the same quantity of T.D.N. for 98 cents, corn silage $1.33, hay $1.16, and concentrates $2.60.

Dunbar (29) determined that it cost $17.28 to harvest an acre of corn for silage when the yield was nine tons, and that it cost $5.76 to harvest an acre of corn for grain. The additional cost of harvesting corn for silage amounted to $1.28 a ton. He also reported that it cost $11.15 to harvest an acre of alfalfa for silage when the yield was 5.9 tons and no preservative was used. To harvest the alfalfa for hay cost $10.83. The additional cost of harvesting alfalfa for silage amounted to five cents a ton. All costs based on conditions in northern Indiana and 1946 prices for both corn and alfalfa.

TABLE XV

AVERAGE COST OF PRODUCING ENSILAGE CROPS (21)
(50 NEW JERSEY FARMS, 1939)

Item	Crop			
	Alfalfa	Mixed grasses	Soybeans	Corn silage
Number of records	22	22	15	43
Number of acres	415	325	209	830
Yield per acre (tons)	5.2	4.2	5.5	8.0
Cost up to harvest:				
Per acre	$8.38*	$11.39*	$22.64	$28.12
Per ton	1.59	2.80	4.10	3.51
Cost of harvesting:				
Per acre	7.88	9.07	12.75	11.80
Per ton	1.50	2.14	2.30	1.47
Total cost:				
Per acre	16.26	20.96	35.39	39.92
Per ton	3.09	4.94	6.41	4.98

*These costs up to harvest represent the cost charged to only one cutting used for silage. Where three cuttings of alfalfa were made during the year, the first cutting was charged with forty percent of the cost up to harvest.

Wrigley (76) determined the average cost of putting up corn silage with a field harvester in Pennsylvania in 1931 and 1932 to be $1.29 a ton. He also determined that it required 1.59 man hours to harvest and put one ton of silage in the silo.

Myers (60) reported the results of an extensive study of the cost of making corn silage in Illinois and found that the use of field harvesters lowered harvesting costs. Tables XVI and XVII give details of his findings.

Davidson (25) made a study of the labor requirements of making corn silage in Iowa using three methods. Tables XVIII, XIX and XX tabulate the results.

TABLE XVI

COST OF FILLING UPRIGHT SILOS (60) (ILLINOIS, 1928-1929)

	Stationary cutters		Field harvesters	
	Owned machines	Hired machines	Power take-off machines	Motor mounted horse-drawn machines
Number of farms	47	40	39	49
Acres cut per farm	17.5	14.5	21.5	14.4
Yield per acre (tons)	7.6	7.3	8.2	8.2
Average cost per 100 tons of silage:				
Unpaid labor (40¢ hour)	$35.15	$32.02	$19.47	$19.57
Family labor (40¢ hour)	35.15	32.02	29.21	29.35
Horse work (14¢ hour)	29.33	30.57	15.24	24.55
Tractor				
Depreciation and repairs	9.22	2.17	16.71	9.14
Interest	4.97	1.17	9.00	4.92
Stationary cutter				
Depreciation	5.00			
Interest	2.40			
Repairs	1.95			
Binder				
Depreciation	3.66	4.23		
Interest	1.46	1.45		
Repairs	0.62	0.59		
Field harvester				
Depreciation			15.24	15.08
Interest			5.94	5.92
Repairs			1.91	2.21
Fuel and oil	6.35	5.56	10.81	11.80
Twine	3.50	4.43		
Wagon use (two cents hour)	1.67	1.62	1.23	1.23
Building charge	0.68	0.44	0.88	0.88
Custom charge		32.40		
Total cost (100 tons)	$141.11	$148.67	$131.15	$130.68

TABLE XVII

AVERAGE AMOUNTS OF LABOR AND POWER USED IN FILLING UPRIGHT SILOS (60) (ILLINOIS, 1928-1929)

	Using stationary cutter			Using field harvester
	Corn cut by hand	Corn cut with binder	All farms	
Number of farms	26	47	87*	118
Corn cut per farm (acres)	11.7	18.8	16.1	15.7
Silage made per farm (tons)	99	139	121	130
Yield per acre (tons)	8.4	7.4	7.5	8.3
Tons cut per man hour	0.67	0.42	0.57	0.80
Labor and power used per acre:				
Man hours	20.1	11.0	13.2	10.4
Horse hours	14.5	16.6	16.0	11.7
Tractor hours	1.21	1.07	1.11	2.3
Labor and power used per ton:				
Man hours	2.38	1.49	1.76	1.25
Horse hours	1.72	2.24	2.14	1.40
Tractor hours	0.14	0.15	0.15	0.28

*On 14 farms part was cut by hand and part with binder. Required 5.1 man hours to cut an acre of corn silage by hand, 1.55 hours when using a binder with no bundle elevator, and 1.85 hours when using a binder with an elevator.

TABLE XVIII

LABOR USED IN HARVESTING ENSILAGE WITH CORN BINDER AND STATIONARY CUTTER (25) (IOWA, 1943)

Operation	Equipment	Labor*			
		Number of men	Man hours per acre	Man hours per ton	Percent of total
Cutting	One row binder and small tractor	1	0.8	0.08	3.7
Loading			11.7	1.11	53.7
Hauling and unloading	3 tractors and 3 trailers	3	7.0	0.66	32.1
Feeding		1	2.3	0.22	10.5
Total			21.8	2.07	100.0
Length of haul 0.4 mile					

*Does not include two men in silo.

TABLE XIX

LABOR USED IN HARVESTING ENSILAGE WITH A FIELD ENSILAGE HARVESTER (25) (IOWA, 1943)

Operation	Equipment	Labor*			
		Number of men	Man hours per acre	Man hours per ton	Percent of total
Harvesting	1 ensilage harvester and tractor	1	1.7	0.13	11
Hauling	1 tractor, 2 trailers, 2 trucks	3	5.1	0.39	33
Unloading	1 tractor and blower	3	8.5	0.65	56
Total		9	15.3	1.17	100
Length of haul 1.5 miles					

*Does not include two men in silo.

TABLE XX

LABOR USED IN HARVESTING ENSILAGE WITH A FIELD HARVESTER AND SPECIAL EQUIPMENT (25) (IOWA, 1943)

Operation	Equipment	Labor*			
		Number of men	Man hours per acre	Man hours per ton	Percent of total
Harvesting	1 ensilage harvester and tractor	1	0.8	0.09	20
Hauling	3 trailers with 7x14 beds, rubber tires and drop sides. 3 tractors with 10-12 M.P.H. road speed	3	2.4	0.27	60
Unloading	Ensilage blower with long conveyor hopper and feeding mechanism operated by power take-off shaft from tractor, automatic winch and fork for pulling silage from trailers, and raised platform to tip trailers toward blower	1	0.8	0.09	20
Total		4	4.0	0.45	100

Length of haul 0.8 mile

*Does not include two men in silo.

CHAPTER III

ORIGINAL INVESTIGATION

Introduction

This study was made in Rutherford County, Tennessee, and the records were taken in June 1949. The period included was April 1, 1948-March 31, 1949, and consisted of interviews with farmers having silos and dairy cows. Various information was obtained on silos, silage crops, silage harvesting machinery and methods, number of dairy cattle, silage feeding operations and other information. A copy of the schedule used appears in the Appendix of this report.

Farmers interviewed met the following requirements: (1) there was a silo on the farm; (2) when in use the silo was a storage place for silage which was fed primarily to dairy cattle.

Rutherford County was selected as the area in which to conduct the survey because it is one of Tennessee's better dairy counties,* and because a survey on the cost of producing milk was made in this same county by Downen (27) (28) in 1947-48. Information derived as a result of this silage study combined with the work of Downen may lead to more concrete findings.

---

*Rutherford County was second only to Giles County in 1948 in number of dairy cows. Rutherford 23,200 cows; Giles 23,700 cows (53).

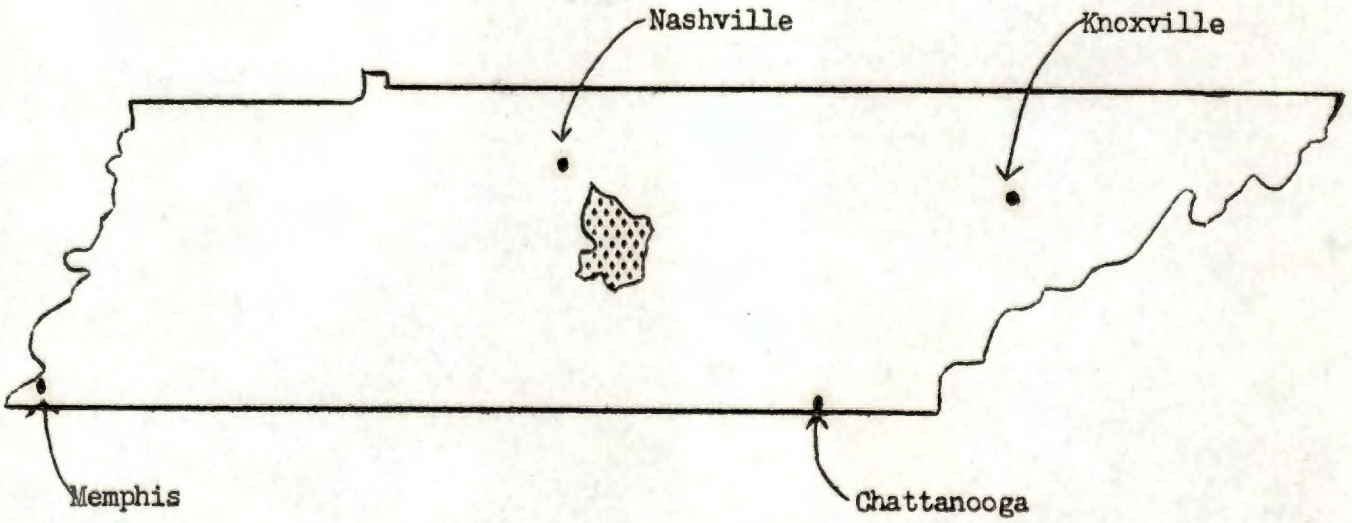

Figure 1. Location of Rutherford County, Tennessee

Silos and Silo Costs

An inventory of silos disclosed that there were 104 silos of all types on the 78 farms which made silage in 1948—an average of 1.33 silos per farm. The average capacity of each silo was 84 tons. The 17 farms having silos and dairy cows but making no silage in 1948 had a total of 18 silos—an average of 1.06 silos per farm. The average capacity of these silos was 65 tons. The concrete stave silo was by far the most numerous. Only 15 of 122 silos had roofs. Table XXI gives a detailed count of silos found on the 95 farms included in the survey.

The 95 farmers interviewed were polled as to the type of silo preferred, and it was found that 82 preferred concrete stave silos. Only 13 expressed a preference for other types. The chief reasons given for favoring concrete stave silos were durability, preservability (keeps silage) and low upkeep. Table XXII tabulates in detail the types of silos preferred and reasons for preferring each type.

The first cost of a silo and the annual cost for storing a ton of silage are important items when considering whether to erect a silo. The cost of silos constructed as early as 1916 was secured. However, since the figures were converted to a 1948 equivalent by use of price indexes, only those silos constructed in the ten year period 1939-48 were considered. Only the concrete stave silo was constructed in quantities large enough to provide sufficient information for cost

TABLE XXI

SILO INVENTORY (RUTHERFORD COUNTY, TENNESSEE, 1949)

Type of silo	Number	Number with roof	Total capacity in tons	Average capacity in tons	Tons of silage made	Percent of silo capacity filled
78 farms making silage in 1948						
Solid concrete	15	2	1,530	102		
Concrete stave	60	8	5,591	93		
Steel	7	2	521	74		
Wooden stave	17*	1	820	48		
Tile	1	0	135	135		
Temporary (fence)	4	0	166	42		
Total or average	104	13	8,763	84	7,677	88
17 farms with silos but making no silage in 1948						
Solid concrete	7	0	499	71		
Concrete stave	5	1	384	77		
Steel	3	0	133	44		
Wooden stave	2	1	78	39		
Trench	1		76	76		
Total or average	18	2	1,170	65		

*Includes two home made silos.

Figure 2. A 10x12x20 Foot Home Made Wooden Silo Lined with Used Sheet Tin (in Use on the Farm of Frank Peyton, Rutherford County, Tennessee, 1948 - Capacity 42 tons)

TABLE XXII

TYPE OF SILO PREFERRED (RUTHERFORD COUNTY, TENNESSEE, 1949)

	Concrete stave	Solid concrete	Wooden stave	Tile block	Temporary (fence)	Trench	Steel	No preference
78 farms making silage in 1948								
Number expressing preference	69	3	2*	1	1	0	2	0
Reasons (with number indicating)								
Durable	44	0	0	0	0	0	1	0
Keeps silage well	29	2	0	1	0	0	2	0
Low upkeep	25	1	0	0	0	0	0	0
Easily and quickly erected	4	0	0	0	0	0	0	0
Low first cost	4	0	1	0	1	0	0	0
Keeps silage from freezing**	2	0	0	0	0	0	0	0
Can be moved	2	0	1	0	0	0	0	0
Attractive appearance	0	0	0	1	0	0	0	0
17 farms with silos but making no silage in 1948								
Number expressing preference	13	1	0	0	0	1	0	2
Reasons (with number indicating)								
Durable	8	0	0	0	0	0	0	0
Keeps silage well	2	1	0	0	0	0	0	0
Low upkeep	6	0	0	0	0	0	0	0
Easily and quickly erected	1	0	0	0	0	0	0	0
Low first cost	2	0	0	0	0	1	0	0
Keeps silage from freezing**	1	0	0	0	0	0	0	0
Can be moved	4	0	0	0	0	0	0	0
Won't crack	2	0	0	0	0	0	0	0

*One preferred home made wooden silo.

**A common objection to the steel silo was that it permitted silage to freeze around the edge.

calculations. Tables XXIII and XXIV tabulate costs of erecting and using concrete stave silos.

The annual costs for storing a ton of silage in concrete stave silos as calculated and tabulated in Table XXIV run somewhat lower than that found by Dunbar (29) and tabulated in Table I. However, the added costs of a roof and an adjoining feed room are included in Dunbar's calculations.

Crops Grown for Silage and Crops Preferred for Silage

The 78 farms surveyed which made silage in 1948 grew an average of 11.67 acres of silage per farm which yielded an average of 8.43 tons per acre. Corn alone, corn and sorghum mixed, and sorghum alone were the only crops used for silage. Sorghum, with an average yield of 12.41 tons, made the most silage per acre. This is a little lower than the average yield reported by Ewing (33) at the Middle Tennessee Experiment Station for 1946. Corn was second in yield of silage per acre, averaging 8.67 tons. This compares favorably with the average for Tennessee of 8.0 tons per acre (16) in 1948. Contrary to the opinions of many of the farmers interviewed, corn and sorghum yielded less than corn alone—(Table XXVI) 8.13 tons per acre for corn and sorghum. This was largely brought about by a low yield of 4.74 tons per acre obtained by one large operator with 100 acres of corn and sorghum silage.

TABLE XXIII

COST OF CONSTRUCTING CONCRETE STAVE SILOS, 1939-1948*
(RUTHERFORD COUNTY, TENNESSEE)

Number of silos**	Dimensions in feet	Capacity in tons***	1948 equivalent cost per silo	1948 equivalent cost per ton capacity
2	10x35	59	$816.53	$13.84
2	10x40	74	827.20	11.18
2	12x30	68	1,085.21****	15.96
6	12x35	83	1,055.67****	12.72
2	12x40	100	1,156.30	11.56
2	12x45	120	1,272.18	10.60
2	12x50	141	1,375.59	9.76

*Without roofs.
**Cost on silos not included in this table for those types and sizes for which only one case was available. See Appendix Table III for details.
***Based on Appendix Tables I and II.
****Note that according to information received from farmers 12x35 silos were constructed cheaper than 12x30 silos.

TABLE XXIV

ANNUAL COST OF STORING A TON OF SILAGE IN CONCRETE STAVE SILOS WITHOUT ROOFS
(RUTHERFORD COUNTY, TENNESSEE, 1948)

Size of Silo		1948 equivalent cost per silo	Annual depreciation per silo (life - 46 yrs.)*	Annual interest per silo @ 4% of average value (½ of cost)*	Annual insurance per silo @ 88¢ per $100 of average value (½ of cost)*
Dimensions in feet	Capacity in tons				
10x35	59	$816.53	$17.75	$16.33	$3.59
10x40	74	827.20	17.98	16.54	3.64
12x30****	68	1,085.21	23.59	21.70	4.77
12x35****	83	1,055.67	22.95	21.11	4.65
12x40	100	1,156.30	25.14	23.13	5.09
12x45	120	1,272.18	27.66	25.44	5.60
12x50	141	1,375.59	29.90	27.51	6.05

*Table I, Chapter II of this thesis.

****Note that the first cost of 12x30 silos is given as less than the cost for 12x35 silos. Details in Appendix Table III.

TABLE XXIV

ANNUAL COST OF STORING A TON OF SILAGE IN CONCRETE STAVE SILOS WITHOUT ROOFS
(RUTHERFORD COUNTY, TENNESSEE, 1948)
(Continued)

Size of silo		Annual upkeep per silo 9.73¢ per ton of capacity**	Annual taxes per silo @ 1.22% of average value (½ of cost)*	Total annual cost per silo	Annual cost per ton***
Dimensions in feet	Capacity in tons				
10x35	59	$5.74	$4.98	$48.39	$0.82
10x40	74	7.20	5.04	50.40	0.68
12x30****	68	6.62	6.62	63.30	0.93
12x35****	83	8.08	6.44	62.23	0.76
12x40	100	9.73	7.07	70.14	0.70
12x45	120	11.68	7.76	78.14	0.65
12x50	141	13.72	8.39	85.57	0.61

*Table I, Chapter II of this thesis.

**Average cost per ton for upkeep, all silos, 78 Rutherford County, Tennessee farms making silage in 1948.

***Assuming silos are filled to capacity each year. Twenty-five percent (27 of 108) of dairy farmers in Rutherford County, Tennessee, allowed their silos to stand empty in 1948. Those making silage filled silos to an average of 88 percent of capacity as determined by interviewing 78 farmers.

****Note that the first cost of 12x30 silos is given as less than the cost for 12x35 silos. Details in Appendix Table III.

All farmers making corn silage left the ears on the corn, and all farmers making sorghum silage left the heads on the sorghum. One farmer making corn and sorghum silage cut the heads from the sorghum and sold them. All other farmers making corn and sorghum silage ensiled ears of corn and heads of sorghum along with the stalks.

Information as released by Barto (3) (4) (5) indicated that the 1948 crop year was drier than average at the nearest weather station at Nashville, Tennessee. Therefore, yields of silage crops may have been below normal.

According to the stated preferences of those making silage in 1948 (78 farms), some failed to grow their favorite crop that year (Tables XXV and XXVI). There were 40 who grew corn alone, but only 29 preferred corn. There were 36 who grew corn and sorghum and 44 expressed preference for corn and sorghum. There were three who grew sorghum alone but only one stated a preference for it.

Costs of Making Silages

The cost of making silage was broken down by crop, method of cutting in the field, and the cost of each operation. The costs were also figured at actual value (hired labor and machinery at actual cost, other labor and machinery at standard rates) and at theoretical values (all labor and machinery at standard rates). Appendix Table IV tabulates these rates and their derivation. The theoretical rates were used to get

TABLE XXV

CROPS GROWN FOR SILAGE AND ACRES AND YIELDS PER ACRE
(RUTHERFORD COUNTY, TENNESSEE, 1948)

Crop	Number of farms	Total acres	Total tons	Yield per acre (tons)
Corn*	40	371.5	3,221	8.67
Corn and sorghum**	36	522	4,245	8.13
Sorghum	3	17	211	12.41
Total or	79***	910.5	7,677	
Average		11.67	98.42 tons per farm	8.43

*One farm had a small amount of sorghum which was placed in silo with corn. This sorghum counted as corn.

**Part of the corn and sorghum for silage was interplanted in the drill row and part was planted in separate rows--two rows of corn and then two rows of sorghum alternating.

***Only 78 farms involved. One farm had sorghum in one field and corn in another. Each crop processed separately and placed in separate silos. This farm is listed twice.

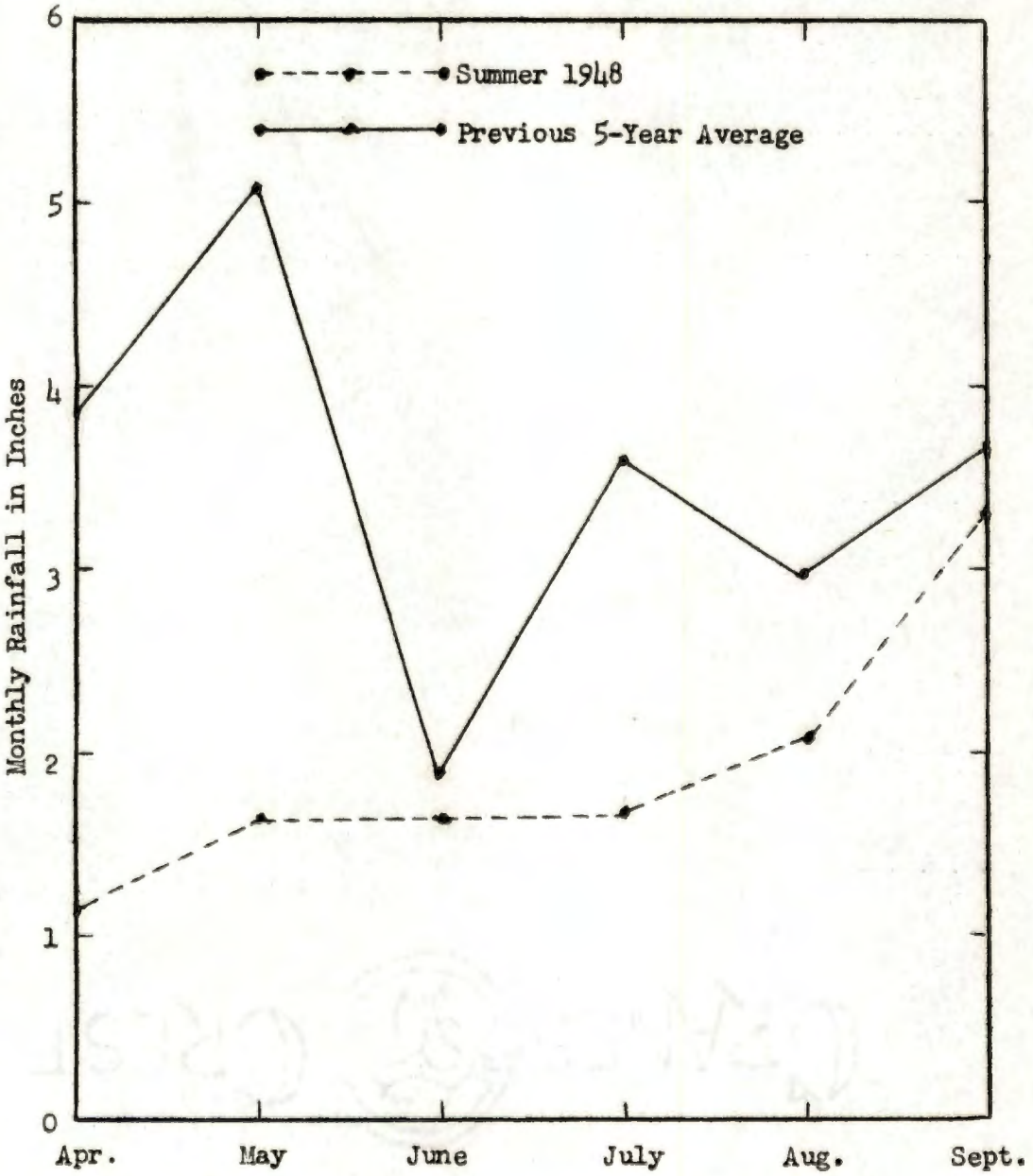

Figure 3. Comparison of Monthly Rainfall - Summer of 1948 to Previous 5-Year Average (Nashville, Tennessee)

TABLE XXVI

CROPS PREFERRED FOR SILAGE (RUTHERFORD COUNTY, TENNESSEE, 1949)

	Corn alone	Corn and sorghum	Corn and soybeans	Sorghum alone	Grass (hay crops)
78 farms making silage in 1948					
No. expressing preference	29	44	2	1	1
Reasons (No. indicating each)					
Bigger yield	0	24*	2	1	0
Better feed	20	17	1	0	0
Doesn't flavor milk	2	2	0	0	0
More palatable	4	10	0	0	0
Keeps well	4	8	1	0	0
Easy to put in silo	5	1	0	0	0
Custom in community	0	1	0	0	0
Does not deplete soil**	2	0	0	0	0
Saves first crop***	0	0	0	0	1
17 farms with silos but making no silage in 1948					
No. expressing preference****	6	8	0	0	0
Reasons (No. indicating each)					
Bigger yield	0	7	0	0	0
Better feed	4	1	0	0	0
More palatable	2	3	0	0	0
Keeps well	0	3	0	0	0
Custom in community	0	1	0	0	0

*Especially in a dry year or on poor ground.
**Compared to mixture of corn and sorghum.
***One expressed preference for alfalfa for silage though he had never used alfalfa silage.
****Three had no preference.

all costs for all crops and all methods of cutting on the same basis. Table XXVII summarizes the costs of making silage for all 78 farms. Appendix Tables VII through XVI give these costs in detail. Standard rates (as tabulated in Appendix Table IV) were used in the calculations in these Appendix tables.

The different methods of cutting the crop in the field would logically affect the cost of the cutting operation more than other operations. However, the method of cutting in the field could have an indirect effect on the cost of other operations, such as loading, by affecting the ease and efficiency of handling the silage.

Wrigley (76) found that it cost $1.41 cents per ton to make corn silage yielding 7.6 tons per acre (owned machinery) and using stationary cutters and blowers. This study was made in Illinois in 1928-29. The cost was reduced to $1.31 per ton when using a field harvester on crops averaging 8.2 tons per acre (Table XVI). The theoretical cost of making corn silage yielding 8.5 tons per acre--when cut with a binder and chopped with a stationary cutter--in Rutherford County was $1.69 per ton. This cost was reduced to $1.26 a ton when a field harvester was used on corn yielding 11.4 tons.

The theoretical cost of making a ton of corn and sorghum silage in Rutherford County was $1.84 when cut in the field with a binder and the yield was 9.15 tons. The cost rose to $4.38 when cut by hand and the yield was 4.45 tons. When cut with a field harvester the cost

TABLE XXVII

COMPARATIVE COST OF MAKING SILAGE—VARIOUS CROPS, VARIOUS METHODS OF CUTTING (RUTHERFORD COUNTY, TENNESSEE, 1948)

Crop	Method of cutting*	Number of farms	Acres	Tons	Tons per acre	Operation	Cost of making silage: Actual cost** Per acre	Actual cost** Per ton	Theoretical cost*** Per acre	Theoretical cost*** Per ton
Corn	Binder****	30	280	2,831	8.50	Cutting	$3.91	$0.46	$2.83	$0.34
						Loading	1.99	0.23	1.92	0.23
						Hauling	5.51	0.65	5.46	0.63
						Chopping and blowing	3.52	0.41	3.20	0.38
						Tramping	0.90	0.11	0.93	0.11
						Total	15.83	1.86	14.34	1.69
Corn and sorghum	Binder****	32	402	3,680	9.15	Cutting	3.82	0.42	3.28	0.36
						Loading	1.80	0.20	2.10	0.23
						Hauling	6.25	0.68	6.65	0.72
						Chopping and blowing	3.95	0.43	3.25	0.35
						Tramping	1.33	0.15	1.61	0.18
						Total	17.15	1.88	16.89	1.84
Sorghum	Binder****	2	11	166	15.09	Cutting	4.81	0.32	4.43	0.29
						Loading	5.91	0.39	4.26	0.28
						Hauling	11.95	0.79	11.22	0.74
						Chopping and blowing	6.76	0.45	6.39	0.42
						Tramping	2.73	0.18	1.96	0.13
						Total	32.16	2.13	28.26	1.86

TABLE XXVII

COMPARATIVE COST OF MAKING SILAGE—VARIOUS CROPS, VARIOUS METHODS OF CUTTING (RUTHERFORD COUNTY, TENNESSEE, 1948)
(Continued)

Crop	Method of cutting*	Number of farms	Acres	Tons	Tons per acre	Operation	Cost of making silage: Actual cost** Per acre	Actual cost** Per ton	Theoretical cost*** Per acre	Theoretical cost*** Per ton
Corn	Hand	9	71.5	612	8.56	Cutting	$2.86	$0.33	$3.15	$0.37
						Loading	1.32	0.15	1.47	0.17
						Hauling	6.32	0.74	6.49	0.75
						Chopping and blowing	5.63	0.66	5.86	0.69
						Tramping	0.43	0.05	0.44	0.05
						Total	16.56	1.93	17.41	2.03
Corn and sorghum	Hand	3	20	89	4.45	Cutting	4.15	0.93	5.58	1.25
						Loading	1.72	0.39	2.43	0.55
						Hauling	4.74	1.07	5.34	1.21
						Chopping and blowing	3.53	0.79	3.87	0.87
						Tramping	1.62	0.37	2.25	0.50
						Total	15.76	3.55	19.47	4.38
Corn	Field harvester	1	20	228	11.40	Cutting and chopping	5.79	0.51	5.96	0.52
						Hauling	4.18	0.37	4.45	0.39
						Blowing	2.84	0.25	3.02	0.26
						Tramping	0.90	0.08	1.08	0.09
						Total	13.71	1.21	14.51	1.26

TABLE XXVII

COMPARATIVE COST OF MAKING SILAGE--VARIOUS CROPS, VARIOUS METHODS OF CUTTING (RUTHERFORD COUNTY, TENNESSEE, 1948)
(Continued)

Crop	Method of cutting*	Number of farms	Acres	Tons	Tons per acre	Operation	Cost of making silage			
							Actual cost**		Theoretical cost***	
							Per acre	Per ton	Per acre	Per ton
Corn and sorghum	Field harvester	1	100	476	4.76	Cutting and chopping	$5.19	$1.09	$5.42	$1.15
						Hauling	4.36	0.92	5.20	1.10
						Blowing	2.24	0.47	2.48	0.52
						Tramping	0.30	0.06	0.54	0.11
						Total	12.09	2.54	13.64	2.88
Sorghum	Field harvester	1	6	45	7.50	Cutting and chopping	11.67	1.56	11.86	1.58
						Hauling	8.30	1.11	8.69	1.16
						Blowing	5.30	0.71	5.50	0.72
						Tramping	1.00	0.13	1.20	0.16
						Total	26.27	3.51	27.25	3.62
All 3 crops	Field harvester	3	126	749	5.94	Cutting and chopping	5.59	0.94	5.84	0.99
						Hauling	4.52	0.76	5.25	0.87
						Blowing	2.48	0.42	2.71	0.46
						Tramping	0.43	0.07	0.66	0.11
						Total	13.02	2.19	14.46	2.43

TABLE XXVII

COMPARATIVE COST OF MAKING SILAGE--VARIOUS CROPS, VARIOUS METHODS OF CUTTING (RUTHERFORD COUNTY, TENNESSEE, 1948)
(Continued)

Crop	Method of cutting*	Number of farms	Acres	Tons	Tons per acre	Operation	Cost of making silage			
							Actual cost**		Theoretical cost***	
							Per acre	Per ton	Per acre	Per ton
All 3 crops	All 3 methods	79*****	910.5	7,677	8.43	Total	$16.28	$1.93	$16.02	$1.91

*No sorghum alone was cut by hand. No binders were equipped with bundle elevators.

**Hired labor and machinery computed by actual cost. Other labor and machinery computed at standard rates as tabulated in Appendix Table IV.

***All labor and machinery computed at standard rates as tabulated in Appendix Table IV.

****Cost of binder twine not included in calculations.

*****Only 78 farms involved. One farm raised corn in one field and sorghum in another. Each field processed separately and placed in separate silos.

amounted to $2.88 with a yield of 4.76 tons. The lower cost per ton of cutting with a binder is largely due to the higher yield per acre. The use of a field harvester in making corn and sorghum silage was more economical than cutting by hand. The theoretical costs per acre of making corn and sorghum silage using a corn binder, cutting by hand, and using a field harvester were $16.89, $19.47 and $13.64 respectively.

The use of machinery affects the amount of labor required to make a ton of silage. Table XXVIII shows that the most labor was used when cutting corn and sorghum by hand (no sorghum alone was cut by hand) and amounted to 8.14 hours per ton. The average yield was 4.45 tons per acre. The smallest quantity of labor used per ton was 1.17 hours which was required when cutting corn yielding 11.40 tons per acre with a field harvester. Cutting corn yielding 8.50 tons per acre with a binder (no bundle elevator) required 1.96 man hours per ton of silage made. Wrigley (76) determined that cutting corn yielding 7.4 tons per acre with a binder required 1.49 man hours to make a ton of silage (Table XVII). Wrigley also found that the cutting operation required 1.55 man hours per acre when using a binder without an elevator and 5.10 man hours to cut an acre by hand. In Rutherford County it required 1.56 man hours to cut an acre of corn silage with a binder having no elevator and 8.76 hours to cut an acre of corn silage by hand. The corn crops cut by hand yielded practically the same--8.4 tons per acre for Wrigley's study (76) and 8.56 in Rutherford County. The average

TABLE XXVIII

LABOR HIRED, COST OF HIRED LABOR AND MAN HOURS REQUIRED PER ACRE, PER TON TO FILL SILOS—VARIOUS CROPS, VARIOUS METHODS OF CUTTING (78 FARMS, RUTHERFORD COUNTY, TENNESSEE, 1948)

Method of cutting in field	Crop	Acres	Tons	Tons per acre	Total man hours	Man hours per acre	Man hours per ton	Man hours hired	Cost of hired labor (total)	Average cost of hired labor per hour	Percent of man hours hired*
Binder	Corn	280	2,381	8.50	4,674.5	16.69	1.96	3,043.5	$1,085.05	$0.36	65.15
Binder	Corn and sorghum	402	3,680	9.15	8,460	21.05	2.30	6,223	1,739.10	0.28	73.56
Binder	Sorghum	11	166	15.09	380	34.55	2.28	260	130.00	0.50	68.42
Hand	Corn	71.5	612	8.56	1,596	22.33	2.60	997	298.90	0.31	61.22
Hand	Corn and sorghum	20	89	4.45	725	36.25	8.14	645	158.00	0.24	88.97
Hand	Sorghum	None									
Field harvester	Corn	20	228	11.40	270	13.50	1.17	240	72.00	0.30	88.89
Field harvester	Corn and sorghum	100	476	4.76	975	9.75	2.06	975	195.00	0.20	100.00
Field harvester	Sorghum	6	45	7.50	100	16.66	2.21	50	15.00	0.30	50.00
Field harvester	All crops	126	749	5.94	1,345	10.69	1.80	1,265	282.00	0.22	94.05
All 3 methods	All crops	910.5	7,677	8.43	17,180.5	18.87	2.24	12,413.5	$3,693.05	0.30	72.25

*Some additional labor hired by being included with contracted machinery.

rate paid for hired labor by the 78 Rutherford County farmers making silage in 1948 was 30 cents. This does not include indirect pay in the form of housing, gardens, and sometimes milk and meat provided to labor living as tenants or hired hands on the farms. The standard rate used for the operator's labor and all other unpaid labor was 36 cents per hour (Appendix Table IV). Hired labor amounted to 72 percent of all labor used in making silage on 78 Rutherford County farms in 1948. Hiring machinery for making silage proved to be an expensive method of getting the job done. Table XXIX shows that a three-plow tractor and operator cost $3.50 an hour when hired, while this same tractor and operator cost only $1.27 an hour to operate. A two-plow tractor and corn binder with operator (or operators) cost an average of $4.04 per hour when hired, but this same outfit could be owned and operated for $2.36 per hour. A three-plow tractor and binder cost slightly less to hire because those doing custom cutting with three-plow tractors charged less. A three-plow tractor and stationary silage cutter cost an average of $4.70 per hour when hired. The same outfit could be owned and operated for $2.30 an hour. Actually the difference is greater than indicated because the operator with a hired machine usually looked after the tractor and another man fed the cutter--while the operator with owned outfits usually fed the cutter and looked after the tractor too.

The practice of owning silage making equipment cooperatively seemed to be general in Rutherford County. This is a practical way

TABLE XXIX

COST OF OWNING VS. HIRING MACHINERY (RUTHERFORD COUNTY, TENNESSEE, 1948)

Machinery	Cost of hired machinery (actual)				Cost of owned machinery (theoretical)
	Number of farms hiring	Average custom rate per acre	Acres covered per hour*	Cost per hour	Cost per hour**
3-plow tractor with operator	2	***	-	$3.50	1.00 man hr. @ 36¢ = $0.36 1.00 tractor hr. @ 91¢ = 0.91 Total $1.27
2-plow tractor and corn binder with operator (or operators)	17	$5.05	0.78	4.04	1.52 man hrs. @ 36¢**** = $0.55 1.00 two-plow tractor hr. @ 68¢ = 0.68 1.00 corn binder hr. @ $1.13 = 1.13 Total $2.36
3-plow tractor and corn binder with operator (or operators)	5	4.84	0.78	3.78	1.52 man hrs. @ 36¢**** = $0.55 1.00 3-plow tractor hr. @ 85¢ = 0.85 1.00 corn binder hr. @ $1.13 = 1.13 Total $2.53

TABLE XXIX

COST OF OWNING VS. HIRING MACHINERY (RUTHERFORD COUNTY, TENNESSEE, 1948)
(Continued)

Machinery	Cost of hired machinery (actual)				Cost of owned machinery (theoretical)
	Number of farms hiring	Average custom rate per acre	Acres covered per hour*	Cost per hour	Cost per hour**
3-plow tractor and stationary silage cutter with operator	13	***	-	$4.70	1.00 man hr. @ 36¢ = $0.36 1.00 three-plow tractor hr. @ 85¢ = 0.85 1.00 stationary silage cutter hr. @ $1.09 = 1.09 Total $2.30

*Average for 61 farms cutting silage crops with binders drawn by tractors.

**Based on standard rates as tabulated in Appendix Table IV.

***Custom rate on hourly basis.

****For each machine hour there were 1.52 man hours used due to 2 operators with some outfits. Average for 61 farms cutting silage crops with binders drawn by tractors.

of cutting silage making costs for those with insufficient acreage to warrant the purchase of individual equipment.

Silage Made Per Cow and Related Factors

A tabulation of silage made on 78 Rutherford County farms when compared with the number of cows per farm reveals that 3.55 tons of silage were made per milk cow. If this silage were fed to the milking herds (with all cows in milk) in a period of 150 days each cow would have received 47 pounds of silage daily. However, some of this silage was fed to young stock and bulls. If the silage were divided equally among all dairy animals for a period of 150 days, each animal would have received 31 pounds daily. Silage fed per milking cow fell somewhere between these two figures.

Some additional silage would have been made if all of the farmers had had adequate silo capacity. Of the 78 farmers interviewed, 17 stated they would have made more silage if they had had more silo room in which to store it. Others would have made more silage except for crop failures and various other reasons which influenced 32 of 78 farmers to fill their silos to less than 100 percent of capacity. Only nine failed to fill their silos completely full because they had enough silage (Table XXXI).

Table XXXII shows (by months) when the silage was fed. In order for a farmer to be counted as having fed silage in a certain month,

TABLE XXX

DAIRY COWS PER FARM AND RELATED FACTORS (78 FARMS MAKING SILAGE, RUTHERFORD COUNTY, TENNESSEE, 1948)

Dairy cows per farm	27.50
Dairy animals per farm (cows, bulls, young stock)	41.14
Young dairy animals (males not yet in service, females not yet in milk) per farm	12.56
Tons of silage made	76.77
Tons of silage made per farm	98.42
Tons of silage fed to other than dairy animals	50.00
Tons of silage available for dairy animals	76.27
Tons of silage available per dairy cow	3.55
Tons of silage available per dairy animal	2.37
Pounds of silage available per dairy cow per day*	47.33
Pounds of silage available per dairy animal per day*	31.60
Number of farms feeding silage in morning only**	2
Number of farms feeding silage in morning and evening**	66
Number of farms feeding silage in evening only**	9
Hours required daily per farm to feed silage***	1.18
Minutes required daily per cow to feed silage***	2.58
Percent of farms with ample silo capacity****	78.21
Percent of farmers failing to fill silos to 100% of capacity	41.03

*Based on 150 day feeding period.

**One farm sold dairy herd and silage after filling silo but before opening it up to begin feeding silage.

***While silage is being fed.

****Seventeen of 78 farmers stated they would have made more silage in 1948 if they had storage space for it.

TABLE XXXI

REASONS A PORTION OF FARMS MAKING SILAGE IN 1948 DID NOT FILL SILOS TO CAPACITY (78 FARMS, RUTHERFORD COUNTY, TENNESSEE)*

Reason	Number giving reason
Didn't bother to refill after silage settled	10
Adequate silage made	9
Silage crop failure	6
Insufficient acreage on which to grow silage or knowlingly planted insufficient acreage for various reasons	5
Crop got too ripe to put in silo	2

*Thirty-two of 78 farms making silage in 1948 failed to fill silos to 100 percent of capacity.

TABLE XXXII

MONTHS IN WHICH SILAGE WAS FED (RUTHERFORD COUNTY, TENNESSEE)

Month	Number of farms feeding silage	Percent of farms feeding silage
	77 farms making silage in 1948*	
June, 1948	0	0
July	0	0
August	0	0
September	2	2.60
October	35	45.45
November	66	85.71
December	74	96.10
January, 1949	77	100.00
February	77	100.00
March	64	83.12
April	14	18.18
May	1	1.30

*One of 78 farmers making silage in 1948 sold silage and herd after silage was in silo. No information obtained from new owner.

silage had to be fed for more than half of the month. A considerable number of farmers fed silage throughout March and April. This was done in many cases in order to feed all of the silage on hand.

Information obtained from the closest weather station located at Nashville, Tennessee, indicates that the winter of 1948-49 actually was an unusually mild one. The mean temperature in January 1949 was approximately nine degrees warmer than the previous five-year average for the same month (Figure 4).

Comparison of Various Factors for Silage and No-Silage Farms

By comparing certain factors for farms making silage with those having silos but making no silage it is possible to draw some conclusions as to why 25 percent of the farmers on Rutherford County farms keeping dairy cows did not fill available silos in 1948.

Tenancy, which was mentioned as a reason for not filling one silo (Table XXXIV), evidently was not a major reason that silos stood empty. This is indicated by the fact that 34 percent of those filling silos in 1948 were tenants--while only 17 percent of those failing to fill their silos were tenants.

The age of the operator could have been a major factor. The average age of those making silage was 46 years while those not making silage averaged 56 years--a difference of 10 years.

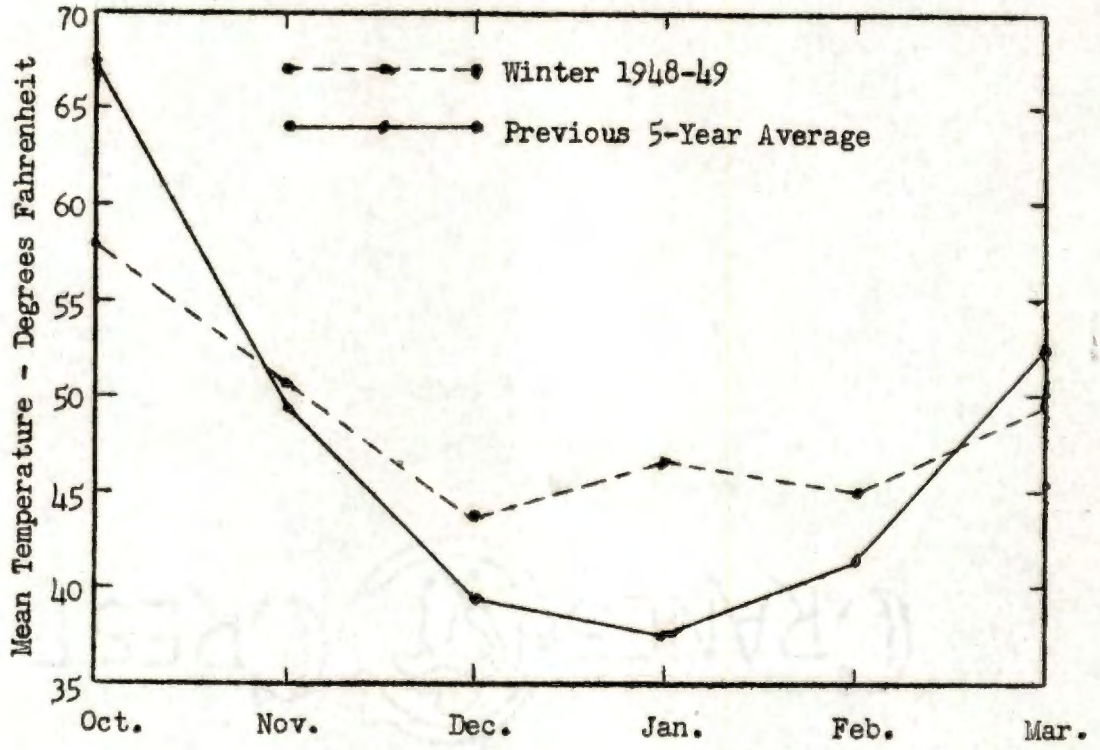

Figure 4. Comparison of Monthly Mean Temperature - Winter of 1948-49 to Previous 5-Year Average (Nashville, Tennessee)

TABLE XXXIII

SOME COMPARISONS ON FARMS MAKING SILAGE WITH FARMS HAVING SILOS BUT MAKING NO SILAGE (RUTHERFORD COUNTY, TENNESSEE, 1948)

Item	Silage farms	No-silage farms
Number of farms surveyed	78	17
Percentage of full owners (own all land operated)	55.13	64.71
Percentage of part owners (own part, rent part)	10.26	17.65
Percentage of tenants (rent all land operated)	34.62	17.65
Average age of operators in years	46.04	55.71
Tillable acres operated per farm	220.97	141.30
Years of dairy experience as manager (average)	16.15	23.41
Average number of milk cows per farm	27.50	15.03
Percent of farms selling grade "A" milk	57.69	18.75
Percent of farms selling grade "B" (mfg.) milk	35.90	62.50
Percent of farms selling cream	3.85	12.50
Percent of farms producing milk for home use only	2.56	6.25
Percent of farms receiving 50 percent or more of farm income from dairy herd	70.51	64.71
Percent of farms receiving 25 percent or less of farm income from dairy herd	17.95	17.65
Percent of farms having fewer than 20 cows	35.90	76.47
Percent of farms having fewer than 10 cows	7.69*	35.29
Percent of operators who built a new silo for themselves at sometime during their lifetime	44.87	29.41
Percent of operators who have made and fed silage one or more years during their lifetime	100.00	75.00**
Average number of silos per farm	1.33	1.06
Average capacity per silo (tons)	84.26	65.00
Average silo capacity per farm (tons)	112.35	68.82

*These farms had an average of 13 head of young dairy cattle on hand (females not yet in milk, males not yet in service) not counted as cows.

**During their lifetimes these farmers who did not fill available silos in 1948 had filled silos 158 times out of 231 opportunities (68.40 percent--based on 16 out of 17 interviews. This information not obtained from one farmer).

TABLE XXXIV

REASONS SILOS REMAINED EMPTY IN 1948
(RUTHERFORD COUNTY, TENNESSEE)

Reason for not filling	Number expressing reason
17 farms with silos but making no silage in 1948	
Scarcity of labor	6
Not enough cows	3
Silo in need of repair	3
Operator in bad health	3
Barn burned--cows kept some distance from silo	2
Tenant (might have to move and leave silage)	1
Adequate silage carried over from previous year	1
Got possession of farm too late in the year	1
Tragedy in family upset plans	1
Total	21*

*Total number of reasons exceeds the number of farms because some farmers gave more than one reason.

Those farmers making silage operated an average of 220.97 tillable acres while those not making silage operated only 141.30 tillable acres. However, those failing to make silage operated enough land to support a herd of sufficient size to warrant the use of a silo if other conditions had been satisfactory.

The number of milk cows per farm could have been a factor in determining whether to make or not to make silage. Farms making silage averaged 27.50 cows per farm. No-silage farms with silos averaged 15.03 cows. Only 35.90 percent of the silage farms had fewer than 20 cows while 76.47 percent of the no-silage farms kept fewer than 20 cows. Just 7.69 percent of the silage farms had fewer than 10 cows, but 35.29 percent of the no-silage farms kept less than 10 cows.

Only five operators of the 78 on farms making silage in 1948 missed filling a silo for even one year when a silo was available. Not enough cows was given as the major reason for failing to fill as is indicated in Table XXXV. One farmer who had access to a silo for three years (1946-7-8) and had filled every year said that he doubted if it paid to make and feed silage. Of the 95 farmers interviewed only one expressed this opinion, and he had never failed to fill a silo when one was available.

A tabulation of the information gathered in Rutherford County shows the farms that fed silage during 1948-49 had good pasture. The no-silage farms with silos provided pasture that was more nearly adequate during March 1949. The silage farms provided better pasture for

Figure 5. A Usable 10x36 Foot Solid Concrete Silo Which Has Been Abandoned (Rutherford County, Tennessee, 1948)

TABLE XXXV

REASONS AVAILABLE SILOS NOT FILLED EVERY YEAR (78 FARMS, RUTHERFORD COUNTY, TENNESSEE, 1948)

Reason	Number giving reason*
Two few cows	4
Silage crop failure	3
Adequate silage carried over from previous year	1

*Only five of 78 farmers making silage in 1948 failed to fill available silo 100 percent of years a silo was available. Some farmers gave more than one reason; hence the number of reasons total more than the number of farmers giving reasons.

Figure 6. A 12x45 Foot Roofless Concrete Stave Silo in Good Repair (Farm of D. D. Cantrell, Rutherford County, Tennessee, 1948 - Capacity 120 tons)

eight months--all of which were months when pasture is usually short. During April, May and June all farms provided adequate pasture. Figure 7 and Table XXXVI show a relative picture of the pasture available throughout a 12-months period.

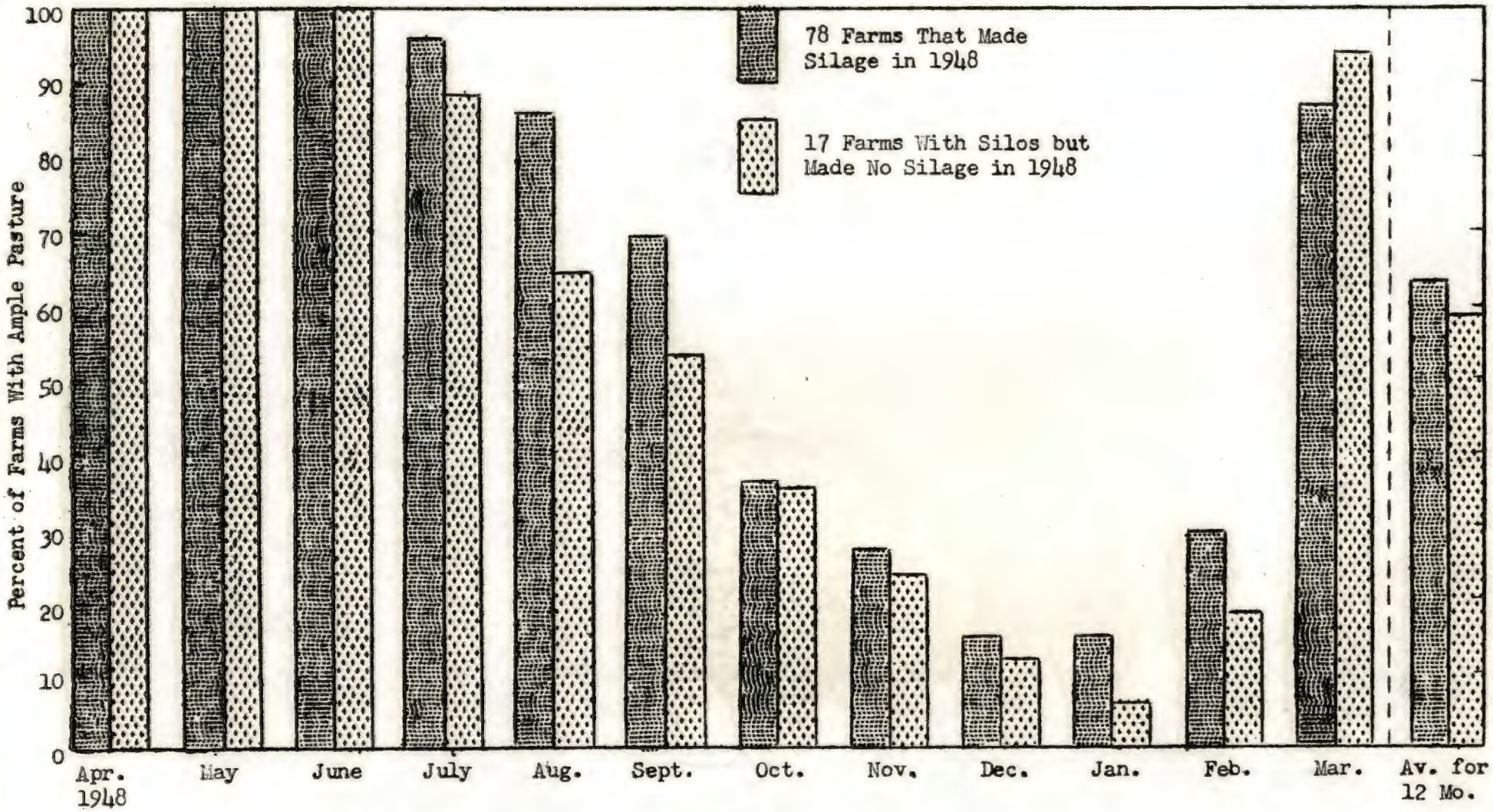

Figure 7. Percent of Farms That Fed Silage Which Had Adequate Pasture Compared With the Percent of Farms With Silos But No Silage (Rutherford County, Tennessee; April 1948 - March 1949)

TABLE XXXVI

AVAILABLE PASTURE BY MONTHS; SILAGE VS. NO-SILAGE FARMS
(RUTHERFORD COUNTY, TENNESSEE)

Months	78 farms making silage in 1948		17 farms with silos but making no silage in 1948	
	Number of farms with adequate pasture	Percent of farms with adequate pasture	Number of farms with adequate pasture	Percent of farms with adequate pasture
April, 1948	78	100.00	17	100.00
May	78	100.00	17	100.00
June	78	100.00	17	100.00
July	75	96.15	15	88.24
August	67	85.90	11	64.65
September	54	69.23	9	52.94
October	28	35.90	6	35.29
November	21	26.92	4	23.53
December	12	15.38	2	11.76
January, 1949	12	15.38	1	5.88
February	23	29.49	4	23.53
March	68	87.18	16	94.12

CHAPTER IV

CONCLUSIONS

As a result of a survey of 95 farms having silos in Rutherford County, Tennessee--78 of which made silage in 1948 and 17 which did not--coupled with a careful and extensive review of related literature, the following conclusions have been reached:

1. Twenty-five percent of the farmers with silos and dairy cows which were interviewed in Rutherford County permitted their silos to stand empty in 1948. (Based on 108 farms--whether or not silos were filled was ascertained for 13 farms on which schedules were not completed.)

2. The yields of silage crops in Rutherford County compare favorably with Tennessee as a whole.

3. The ease of harvesting, the relatively good yield, and the feeding value of corn silage make it more desirable in the opinion of those interviewed than corn and sorghum or sorghum silage for feeding dairy cows in Rutherford County.

4. Mechanization of silage harvesting may reduce the cost of making silage if the machines are locally owned and operated.

5. The field harvester saves labor and money in making silage.

6. The annual repair bill for silos filled on 78 Rutherford County farms in 1948 amounted to 9.7 cents per ton capacity and 11.1 cents per ton of silage made.

7. The annual cost for storing a ton of silage by the average farmer may run about 40 percent higher than calculated because the silo may stand empty 25 percent of the time and be filled to approximately 88 percent of rated capacity when in use.

8. The lack of a sufficient number of cows and the scarcity of labor were the leading reasons why farmers failed to fill available silos in Rutherford County.

9. Age of farmers may be a reason that farmers permit silos to remain idle.

10. A herd of approximately 10 cows is indicated to be the lower limit for which Rutherford County farmers deem it profitable to make silage.

11. Feeding silage is so interrelated with the cost factors of other feeds—especially other roughages—the availability of silage harvesting machinery, silos, size of herd, and managerial ability of the operator, that it is difficult to devise a general formula for determining whether to feed silage to dairy cows.

12. With one exception, the 78 Rutherford County farmers who made silage in 1948 are pleased with silage as a feed.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Baker, R. H., and Falconer, J. J. Costs of Producing Milk in Ohio 1945-46. Ohio Agricultural Experiment Station Research Bulletin 687, 1948.

2. Barre, H. W. Corn Silage Versus Sweet Sorghum Silage for Milk Production. South Carolina Agricultural Experiment Station Bulletin 254, 1929.

3. Barto, E. M. Annual Meterological Summary with Comparative Data for Nashville, Tennessee. United States Weather Bureau, 1947.

4. _____. Annual Meterological Summary with Comparative Data for Nashville, Tennessee. United States Weather Bureau, 1948.

5. _____. Monthly Climatological Summaries for Nashville, Tennessee. United States Weather Bureau, January, February, March, 1949.

6. Bateman, George A. Quantity of Feeds Required and Cost of Producing Butterfat. Utah Agricultural Experiment Station (mimeographed) Serial 324, 1946.

7. Bechdel, S. I. Silage Feeding Investigations for Milk Production. Pennsylvania Agricultural Experiment Station Bulletin 178, 1923.

8. Becker, R. B., et. al. Soybeans for Silage. Florida Agricultural Experiment Station Bulletin 255, 1932.

9. _____, and Gallup, W. D. "Grain Losses in Feeding Silage to Dairy Cows," Journal of Agricultural Research, 39:223-227, 1929.

10. Bennett, H. W., et. al. Production and Utilization of Silage in Mississippi. Mississippi Agricultural Experiment Station Bulletin 425, 1945.

11. Besley, Harry E., Ely, Claude, and Humphries, Walter R. Development of Machinery for Harvesting and Storing Grass Silage. New Jersey Agricultural Experiment Station Bulletin 689, 1941.

12. Bierly, Ivan R. Factors That Affect Costs and Returns in Producing Milk. Cornell Agricultural Experiment Station Bulletin 804, 1944.

13. Bohstedt, G., et. al. Proceedings of the American Society of Animal Production, November 26-28, 1937.

14. Bond, G. E., and Hitchcock, J. A. Feed As a Cost of Milk Production. Vermont Agricultural Experiment Station Bulletin 421, 1937.

15. Branaman, G. A., and Davis, G. K. "Legume Silage Versus Corn Silage Versus Legume Hay for Fattening Cattle," Michigan Agricultural Experiment Station Quarterly Bulletin, 22:34-39, 1939.

16. Callander, W. F., et. al. Crops and Markets. United States Department of Agriculture, 26:7-24, 1949.

17. Camburn, O. M., Ellenberger, H. B., and Jones, C. H. Feeding Values of Silages and Hays. Vermont Agricultural Experiment Station Bulletin 482, 1942.

18. _____, Ellenberger, H. B., Newlander, J. A., and Jones, C. H. Dry Versus Succulent Roughage in the Dairy Ration. Vermont Agricultural Experiment Station Bulletin 412, 1937.

19. _____, _____, _____, _____. Legume and Grass Silages. Vermont Agricultural Experiment Station Bulletin 434, 1938.

20. Carncross, John W., and Huck, Joseph F. Roughage Makes Milk Profits. New Jersey Agricultural Experiment Station Circular 505, 1947.

21. _____, Waller, Allen, G., and Rouchenstein, Emil. A Survey of Practices and Costs of Producing Grass Silage on Fifty New Jersey Farms. New Jersey Agricultural Experiment Station Bulletin 684, 1940.

22. Christensen, F. W., and Hooper, T. H. "Digestible Nutrients and Metabolizable Energy in Certain Silages, Hays, and Mixed Rations," Journal of Agricultural Research, 57:477-512, 1938.

23. Cunningham, L. C. The Cost of Producing Milk in Montgomery County, 1944-45. Cornell Agricultural Experiment Station Bulletin 842, 1947.

24. Davidson, J. Brownlee, and Henderson, S. Milton. Life, Service, and Cost of Service of Farm Machines on Four Hundred Iowa Farms. Iowa Agricultural Experiment Station Bulletin P 37, 1942.

25. _____, Shedd, C. K., and Collins, E. V. "Labor Duty in Harvesting of Ensilage," Agricultural Engineering, 24:293-294, 1943.

26. Dawson, J. R., and Van Horn, A. G. Comparison of a Trench Silo with an Upright Silo. United States Department of Agriculture Circular 274, 1933.

27. Downen, M. L. Seasonal Costs of Producing and Marketing Fluid Milk in Rutherford County, Tennessee, 1947-48. Tennessee Agricultural Experiment Station, Rural Research Series, Monograph 242, 1949.

28. _____. Seasonal Costs of Producing and Marketing Milk for Manufacturing Purposes in Rutherford County, Tennessee, 1947-48. Tennessee Agricultural Experiment Station Rural Research Series, Monograph 246, 1949.

29. Dunbar, John Oval. The Labor and Cost Economy of Silos. Thesis, Purdue University, 1948.

30. Eckles, C. H. Wintering Rations for Dairy Heifers. Missouri Agricultural Experiment Station Bulletin 158, 1918.

31. Elrod, J. C., and Hendrix, W. E. A Farm Management Analysis of Dairy Farming in Putnam County, Georgia, 1944. Georgia Agricultural Experiment Station Bulletin 244, 1945.

32. Elting, E. C., and La Master, J. P. "Silage As the Only Roughage for Milking Cows," Forty-Ninth Annual Report, South Carolina Agricultural Experiment Station, 57-60, 1936.

33. Ewing, John A. "Report for Middle Tennessee Experiment Station," Sixtieth Annual Report. Tennessee Agricultural Experiment Station, 128-136, 1947.

34. Forbes, E. B., Swift, F. W., and Bratzler, John W. Energy Values of a Group of Silages. Pennsylvania Agricultural Experiment Station Bulletin 453, 1943.

35. Garrigus, W. P. Grass Silage. Kentucky Agricultural Extension Circular 361, 1949.

36. Greene, R. E. L., et. al. Farm Mechanization in the Piedmont. North Carolina Agricultural Experiment Station Technical Bulletin 84, 1947.

37. Grimes, J. C., and Nichols, M. L. The Trench Silo. Alabama Agricultural Experiment Station Circular 59, 1931.

38. Hegsted, D. M., et. al. "A Comparison of Alfalfa Silages Made by the A. I. V. and Molasses Methods," Journal of Dairy Science, 22:489-500, 1939.

39. Herman, H. A., Ragsdale, A. C., and Warren, Heathman. "Trench Silos for Preserving Materials Treated with Molasses or Phosphoric Acid," Abstracted Journal of Dairy Science, 24:514-515, 1941.

40. Higgins, L. A. Trench Silos and Silage. Mississippi Agricultural Extension Bulletin 71, 1935.

41. Hinton, S. A., Wylie, C. E., and Shuey, G. A. "Comparison of Sericea Silage, Alfalfa Silage and Corn Silage for Dairy Cows," Fifty-Third Annual Report, Tennessee Agricultural Experiment Station, 30-33, 1940.

42. _____, _____, _____. Legume Silage for Dairy Cows. Tennessee Agricultural Experiment Station Circular 89, 1945.

43. Hodgson, R. E., et. al. "Comparative Efficiency of Ensiling, Barn Curing and Field Curing Forage Crops," Agricultural Engineering, 28:154-156, 1947.

44. _____, and Knott, J. C. Stack Silage. Washington Agricultural Experiment Station Bulletin 348, 1937.

45. Horwood, Ressell E., and Wells, J. G., Jr. "Alfalfa-Molasses Silage Versus Alfalfa Hay as a Roughage for Lactating Dairy Cows," Quarterly Bulletin, Michigan Agricultural Experiment Station, 19:100-104, 1936.

46. Humber, M. G., Morse, R. W. and Jackson, E. R. Making and Feeding Grass and Legume Silage in Western Oregon. Oregon State College Extension Bulletin 669, 1948.

47. Lanham, Ben T., Jr. Farm Power and Equipment Costs in Northern Alabama. Alabama Agricultural Experiment Station Bulletin 260, 1947.

48. LeCleric, J. A. "Losses in Making Hay and Silage," Yearbook of Agriculture, United States Department of Agriculture, 992-1016, 1939.

49. Lepard, O. L., and Savage, E. S. "The Feeding Value of Grass Silage in the Ration for Dairy Cows," Journal of Dairy Science, 24:549-560, 1941.

50. Lush, R. H. Cottonseed Meal Ration and Silage Versus Herd Ration, Hay and Silage. Louisiana Agricultural Experiment Station Bulletin 278, 1936.

51. _____, and Barr, H. T. Silage and Silo Construction. Louisiana Agricultural Experiment Station Circular 2, 1930.

52. Marsh, S. T., Collins, G. D., Jr., and Skinner, S. W. Agricultural Trends in Tennessee, Tennessee Department of Agriculture, 1948.

53. _____, _____, _____. Tennessee Livestock on Farms, January 1, 1949, Federal-State Crop Reporting Service, Tennessee Department of Agriculture Release 918, 1949.

54. McCalmont, J. R. Silo Types and Construction. United States Department of Agriculture Farmers Bulletin 1820, 1944.

55. Monroe, C. F., et. al. "Feeding Value of Hay Crop Silage," Bimonthly Bulletin, Ohio Agricultural Experiment Station, 23:155-165, 1938.

56. Moore, L. A. "Dairy Cows Must Have Good Roughage," Yearbook of Agriculture, United States Department of Agriculture, 120-126, 1948.

57. Morrison, Frank B. Feeds and Feeding. Ithaca, New York: The Morrison Publishing Company, 1949.

58. _____, et. al. Legume and Grass Silage. New Jersey Agricultural Experiment Station Bulletin 643, 1938.

59. Morrison, F. L. "Relative Cost of Hay Crop Silage and Corn Silage," Bimonthly Bulletin, Ohio Agricultural Experiment Station, 25:122-123, 1940.

60. Myers, Kenneth D. Methods and Costs of Filling Silos in the North Central States. United States Department of Agriculture Farmers Bulletin 1725, 1934.

61. Newlander, J. A., et. al. The Conservation of Timothy, Alfalfa and Soybean Nutrients as Silages and as Hays. Vermont Agricultural Experiment Station Bulletin 459, 1940.

62. Perry, Alvah L., and Dow, George F. Costs and Returns in Milk Production for Local Maine Markets. Maine Agricultural Experiment Station Bulletin 456, 1947.

63. Pratt, A. D. Wet Feeds Versus Dry Feeds for Milk Production. Virginia Agricultural Experiment Station Bulletin 301, 1936.

64. Reed, O. E. Report of the Chief of the Bureau of Dairy Industry. United States Department of Agriculture, 1939.

65. Robertson, Lynn, Slater, Lloyd E., and Manhart, V. C. Dairy Cattle Costs and Returns in Northern Indiana. Purdue Agricultural Experiment Station Bulletin 481, 1942.

66. Shepherd, J. B., et. al. "Ensiling Hay and Pasture Crops," Yearbook of Agriculture, United States Department of Agriculture, 178-190, 1948.

67. Simmons, L. R. Farm Economics. Cornell University, No. 121, 1940.

68. _____. Farm Economics. Cornell University, No. 138, 1943.

69. _____. Farm Economics. Cornell University, No. 167, 1949.

70. Smith, H. C. "Temporary Silos for Grass Silage," Agricultural Engineering, 21:439-440, 1940.

71. Watkins, Donald E. A Farm Management Study of Seventy Dairy Farms in Montgomery County, Maryland. Maryland Agricultural Experiment Station Bulletin 356, 1933.

72. Whatley, Thomas J. Production Practices, Costs and Returns from Cotton. Tennessee Agricultural Experiment Station Rural Research Series, Monograph 239, 1948.

73. Wilbur, J. W., and Fairchild, L. H. The Value of Silage in the Dairy Ration. Purdue Agricultural Experiment Station Bulletin 297, 1925.

74. Williams, N. K., Cannon, C. Y., and Espe, D. L. "A Soybean and Silage Ration for Dairy Cows," Journal of Dairy Science, 26:241-249, 1943.

75. Woodard, T. E. "The Viability of Seeds as Affected by the Siloing Process," Journal of Dairy Science, 23:267-271, 1940.

76. Wrigley, P. I., and Clyde, A. W. "A Cost Study of Filling Silos with the Field Ensilage Cutter," Agricultural Engineering, 14:97-98, 1933.

APPENDIX

APPENDIX

TABLE I

CAPACITY OF CYLINDRICAL SILOS WITH VARIOUS DIAMETERS AND DEPTHS OF SILAGE (54)
(USED TO DETERMINE CAPACITIES OF ALL SILOS EXCEPT THOSE OF ODD SIZE OR SHAPE)

Depth of silage (feet)	Capacity with an inside diameter of										
	10 ft.	11 ft.	12 ft.	13 ft.	14 ft.	15 ft.	16 ft.	17 ft.	18 ft.	19 ft.	20 ft.
	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
20	27	-	-	-	-	-	-	-	-	-	-
22	30	37	-	-	-	-	-	-	-	-	-
24	24	41	49	-	-	-	-	-	-	-	-
26	38	46	55	65	-	-	-	-	-	-	-
28	43	52	61	72	84	-	-	-	-	-	-
30	47	57	68	80	92	106	121	-	-	-	-
32	51	62	74	87	100	115	131	148	-	-	-
34	56	67	80	94	109	125	142	161	180	-	-
36	-	73	86	101	117	135	153	173	194	216	-
38	-	-	93	109	126	145	165	186	209	233	258
40	-	-	100	117	135	155	177	200	224	249	276
42	-	-	-	124	144	165	188	212	237	264	293
44	-	-	-	-	152	174	198	224	251	279	310
46	-	-	-	-	-	184	209	236	265	295	327
48	-	-	-	-	-	-	220	248	279	310	344
50	-	-	-	-	-	-	-	261	293	326	361

APPENDIX

TABLE II

WEIGHT OF SETTLED SILAGE PER CUBIC FOOT TO A GIVEN DEPTH AND AVERAGE WEIGHT TO THAT DEPTH (USED TO DETERMINE CAPACITIES OF SILOS OF ODD SIZES OR SHAPES)

Depth of settled silage (feet)	Weight per cubic foot at given depth (pounds)	Average weight per cubic foot (pounds)	Depth of settled silage (feet)	Weight per cubic foot at given depth (pounds)	Average weight per cubic foot (pounds)
1	18.5	18.5	21	49.4	35.6
2	20.8	19.7	22	50.5	36.3
3	23.0	20.8	23	51.6	36.9
4	24.9	21.8	24	52.5	37.6
5	26.8	22.8	25	54.0	38.2
6	28.5	23.8	26	55.0	38.9
7	30.2	24.7	27	56.0	39.5
8	31.8	25.6	28	57.0	40.2
9	33.5	26.4	29	58.0	40.8
10	35.0	27.3	30	59.0	41.4
11	36.5	28.1	31	60.0	42.0
12	38.0	28.9	32	60.9	42.7
13	39.5	29.8	33	61.9	43.2
14	40.8	30.6	34	62.8	43.7
15	42.0	31.3	35	63.5	44.3
16	43.0	32.1	36	64.3	44.9
17	44.5	32.8	37	65.1	45.4
18	45.8	33.5	38	65.9	45.9
19	47.0	34.2	39	66.6	46.5
20	48.1	34.9	40	67.4	47.0

APPENDIX

TABLE III

COST OF NEW SILOS CONSTRUCTED, 1939-1948*
(SURVEY OF 95 FARMS, RUTHERFORD COUNTY, TENNESSEE, 1948)

Year built	Dimensions (feet)	Capacity (tons)	Roof	Unpaid family labor (hours)	Cost when built (except for family labor)	Price index when built (69)	Price index in 1948 (69)	Equivalent cost 1948 (excluding family labor)	Value of family labor @ 36¢ hour	Total equivalent cost 1948	Cost per ton capacity 1948
					Concrete stave silos						
1942	10-30	47	No	60	$225.00	150	249	$373.50	$21.60	$395.10	$8.41
1943	10-35	59	No	None	562.50	162	249	864.56	None	864.56	14.65
1943	10-35	59	No	None	500.00	162	249	768.50	None	768.50	13.03
Average	10-35	59	-	None	-	-	-	816.53	None	816.53	13.84
1948	10-40	74	No	20	765.00	249	249	765.00	7.20	772.20	10.44
1948	10-40	74	No	20	875.00	249	249	875.00	7.20	882.20	11.92
Average	10-40	74	-	20	-	-	-	820.00	7.20	827.20	11.18
1941	12-30	68	No	20	600.00	132	249	1,131.84	7.20	1,139.04	16.75
1944	12-30	68	No	None	700.00	169	249	1,031.38	None	1,031.38	15.17
Average	12-30	68	-	10	-	-	-	1,081.61	3.60	1,085.21	15.96
1944	12-35	83	Yes	None	670.00	169	249	987.18	None	987.18	11.88
1942	12-35	83	No	None	725.00	150	249	1,203.50	None	1,203.50	14.50
1943	12-35	83	No	40	686.00	162	249	1,054.38	14.40	1,068.78	12.88
1945	12-35	83	No	None	820.00	172	249	1,187.11	None	1,187.11	14.30

APPENDIX

TABLE III

COST OF NEW SILOS CONSTRUCTED, 1939-1948*
(SURVEY OF 95 FARMS, RUTHERFORD COUNTY, TENNESSEE, 1948)
(Continued)

Year built	Dimensions (feet)	Capacity (tons)	Roof	Unpaid family labor (hours)	Cost when built (except for family labor	Price index when built (69)	Price index in 1948 (69)	Equivalent cost 1948 excluding family labor	Value of family labor @ 36¢ hour	Total equivalent cost 1948	Cost per ton capacity 1948
					Concrete stave silos (Continued)						
1946	12-35	83	No	20	700.00	193	249	903.14	7.20	910.34	10.97
1947	12-35	83	No	None	825.00	231	249	889.27	None	889.27	10.71
1948	12-35	83	No	None	1,075.00	249	249	1,075.00	None	1,075.00	12.95
Average	12-35	83	-	10	-	-	-	1,052.07	3.60	1,055.67	12.72
1943	12-40	100	No	None	854.00	162	249	1,312.60	None	1,312.60	13.13
1948	12-40	100	No	None	1,000.00	249	249	1,000.00	None	1,000.00	10.00
Average	12-40	100	-	None	-	-	-	1,156.30	None	1,156.30	11.56
1945	12-45	120	No	None	1,000.00	172	249	1,447.70	None	1,447.70	12.06
1946	12-45	120	No	None	850.00	193	249	1,096.67	None	1,096.67	9.14
Average	12-45	120	-	None	-	-	-	1,272.18	None	1,272.18	10.60
1946	12-50	141	Yes	40	1,175.00	193	249	1,515.98	14.40	1,530.38	10.85
1942	12-50	141	No	None	1,008.00	150	249	1,673.28	None	1,673.28	11.87
1947	12-50	141	No	None	1,000.00	231	249	1,077.90	None	1,077.90	7.64
Average	12-50	141	-	None	-	-	-	1,375.59	None	1,375.59	9.76

APPENDIX

TABLE III

COST OF NEW SILOS CONSTRUCTED, 1939-1948*
(SURVEY OF 95 FARMS, RUTHERFORD COUNTY, TENNESSEE, 1948)
(Continued)

Year built	Dimensions (feet)	Capacity (tons)	Roof	Unpaid family labor (hours)	Cost when built (except for family labor	Price index when built (69)	Price index in 1948 (69)	Equivalent cost 1948 excluding family labor	Value of family labor @ 36¢ hour	Total equivalent cost 1948	Cost per ton capacity 1948
					Concrete stave silos (Continued)						
1947	14-40	135	No	None	960.00	231	249	1,034.78	None	1,034.78	7.67
Average	All concrete stave silos	92.18	-	10	-	-	-	1,057.65	3.60	1,061.25	11.51
					Wooden stave silo (Home made)						
1948	10-10-15	23	No	50	125.00	249	249	125.00	18.00	143.00	6.22
					Temporary (wire fence) silo						
1948	11-12	14	No	**	40.00	249	249	40.00	**	40.00	2.86

*When a farmer constructed more than one silo during the period, costs were secured on only the last one constructed.
**Silo put up by sections as filled. No tangible charge for labor.

APPENDIX

TABLE IV

COST OF USING ENSILAGE HARVESTING MACHINERY

Item	Results of cost study			Index of prices of articles farmers buy (69)		1948 equivalent cost per hour
	Year of study	Cost per hour	Reference number	Index year of study	1948 index	
2-plow tractor	1947	$0.63	72	231	249	$0.68
3-plow tractor	1947	0.79	72	231	249	0.85
4-5 plow tractor	1945	0.62	47	169	249	0.91
Man labor	1947	0.33	72	231	249	0.36
Horse work	1947	0.25	72	231	249	0.27
2-horse wagon	1947	0.08	72	231	249	0.09
Tractor-drawn trailer	1947	0.12	72	231	249	0.13
1½ ton truck	1947	1.00	29	231	249	1.08
Corn binder	1941	0.60	24	132	249	1.13
Stationary ensilage cutter	1941	0.58	24	132	249	1.09
Field harvester*	1949	-	-	-	-	2.35**
Stationary ensilage blower**	1949	-	-	-	-	0.44***

*Power take-off machine equipped to handle row crops only.

**As of May 1949. Based on average machine costing $1,204.17 as determined by pricing of three machines on exhibit at 76th Annual Meeting of the East Tennessee Farmers Institute at Knoxville May 17 and 18, 1949; and assuming machine will last eight years with annual interest @ four percent of average value (one-half of cost), and annual repairs, housing and insurance costing five percent of original value (76). Also assuming machine will cut 63 acres annually at the rate of 0.63 acre per hour as was found to be the case in Rutherford County, Tennessee.

***As of May 1949. Based on average blower costing $431.25 as determined by pricing four on exhibit at 76th Annual Meeting of the East Tennessee Farmers Institute, and assuming machine will last 16 years with annual interest @ four percent of average value (one-half of cost) and repairs costing two percent of purchase price (cost) (76). Assuming machine will blow 63 acres annually at the rate of 0.63 acre per hour.

APPENDIX

TABLE V

RETAIL PRICES OF FIELD ENSILAGE HARVESTERS AND STATIONARY ENSILAGE BLOWERS (KNOXVILLE, TENNESSEE - 1949)*

Make	Equipped with** row crop attach (only) and power take-off drive	Auxiliary motor	Equipped with row crop attach (only) and auxiliary motor	Hay pick-up attachment	Cutter bar attachment	Companion blower (stationary unit)***
A	$1.041.00	Not available	Not available	Not available	Not available	-
B	1,077.50	Not available	Not available	$237.50	Not available	$350.00
C	1,494.00	$500.00	$1,994.00	94.50	Standard equip.	350.00
D	Not available	Standard equip.	2,490.00	325.00	$275.00	675.00
E	Not available	Standard equip.	1,950.00	235.00	Not available	-
F	Not available	Standard equip.	2,000.00	250.00	Not available	350.00

*Determined by interviewing salesmen with machinery on exhibit at the 76th Annual East Tennessee Farmers Institute, Knoxville, Tennessee, May 17 and 18, 1949.

**Average cost for the three machines of this type $1,204.17--used as basis for calculating cost of using per hour.

***Average cost for the four blowers $431.25--used as basis for calculating cost of using per hour.

APPENDIX

TABLE VI

INDEX OF PRICES OF ARTICLES FARMERS BUY (67) (68) (69)
(USED TO CONVERT COST STUDIES OF PREVIOUS
YEARS TO 1948 EQUIVALENT)

Year	Index	Year	Index
1915	107	1932	95*
1916	125	1933	120
1917	148	1934	129
1918	173	1935	130
1919	198	1936	127
1920	202	1937	133
1921	165	1938	126
1922	164	1939	124
1923	167	1940	125
1924	167	1941	132
1925	169	1942	150
1926	168	1943	162
1927	139*	1944	169
1928	141*	1945	172
1929	167	1946	193
1930	126*	1947	231
1931	107*	1948	249

*Index of prices of all commodities.

APPENDIX

TABLE VII

DETAILED COSTS OF MAKING CORN SILAGE WHEN CUT IN FIELD WITH BINDER (RUTHERFORD COUNTY, TENNESSEE, 1948; 30 FARMS, 280 ACRES, 2,381 TONS, 8.50 TONS PER ACRE)

	Cutting*	Loading	Hauling	Chopping	Tramping	Total
Man hours	437	1,495.5	1,526	496	720	4,674.5
Man hours per acre	1.56	5.34	5.45	1.77	2.57	16.69
Man hours per ton	0.18	0.63	0.64	0.21	0.30	1.96
Rate per hour	$0.36	$0.36	$0.36	$0.36	$0.36	
Cost per acre	$0.56	$1.92	$1.96	$0.64	$0.93	$6.01
Cost per ton	$0.07	$0.23	$0.23	$0.08	$0.11	$0.72
2-plow tractor hrs.	267.5		267.5	67		602
2-plow tractor hrs. per acre	0.96		0.96	0.24		2.16
2-plow tractor hrs. per ton	0.11		0.11	0.03		0.25
Rate per hour	$0.68		$0.68	$0.68		
Cost per acre	$0.65		$0.65	$0.16		$1.46
Cost per ton	$0.08		$0.07	$0.02		$0.17
3-plow tractor hrs.	42			293.5		335.5
3-plow tractor hrs. per acre	0.15			1.05		1.20
3-plow tractor hrs. per ton	0.02			0.12		0.14
Rate per hour	$0.85			$0.85		
Cost per acre	$0.13			$0.89		$1.02
Cost per ton	$0.02			$0.10		$0.12
4-5 plow tractor hrs.				15		15
4-5 plow tractor hrs. per acre				0.05		0.05
4-5 plow tractor hrs. per ton				0.01		0.01
Rate per hour				$0.91		
Cost per acre				$0.05		$0.05
Cost per ton				$0.01		$0.01
Horse hours	105		2,132			2,237
Horse hrs. per acre	0.38		7.61			7.99
Horse hrs. per ton	0.04		0.90			0.94
Rate per hour	$0.27		$0.27			
Cost per acre	$0.10		$2.05			$2.15
Cost per ton	$0.01		$0.24			$0.25

APPENDIX

TABLE VII

DETAILED COSTS OF MAKING CORN SILAGE WHEN CUT IN FIELD WITH BINDER
(RUTHERFORD COUNTY, TENNESSEE, 1948; 30 FARMS, 280 ACRES,
2,381 TONS, 8.50 TONS PER ACRE)
(Continued)

	Cutting	Loading	Hauling	Chopping	Tramping	Total
Wagon hours			1,066			1,066
Wagon hrs. per acre			3.81			3.81
Wagon hrs. per ton			0.45			0.45
Rate per hr.			$0.09			
Cost per acre			$0.34			$0.34
Cost per ton			$0.04			$0.04
Trailer hours			347.5			347.5
Trailer hrs. per acre			1.24			1.24
Trailer hrs. per ton			0.15			0.15
Rate per hour			$0.13			
Cost per acre			$0.16			$0.16
Cost per ton			$0.02			$0.02
Truck hours (1½T)			78			78
Truck hrs. per acre			0.28			0.28
Truck hrs. per ton			0.03			0.03
Rate per hr.			$1.08			
Cost per acre			$0.30			$0.30
Cost per ton			$0.03			$0.03
Binder hours	344.5					344.5
Binder hrs. per acre	1.23					1.23
Binder hrs. per ton	0.14					0.14
Rate per hour	$1.13					$1.13
Cost per acre	$1.39					$1.39
Cost per ton	$0.16					$0.16
Chopper hours				375.5		375.5
Chopper hrs. per acre				1.34		1.34
Chopper hrs. per ton				0.16		0.16
Rate per hr.				$1.09		
Cost per acre				$1.46		$1.46
Cost per ton				$0.17		$0.17
Total cost per acre**	$2.83	$1.92	$5.46	$3.20	$0.93	$14.34
Total cost per ton**	$0.34	$0.23	$0.63	$0.38	$0.11	$ 1.69
Actual cost per acre***	$3.91	$1.99	$5.51	$3.52	$0.90	$15.83
Actual cost per ton***	$0.46	$0.23	$0.65	$0.41	$0.11	$ 1.86

*Cost of binder twine not included in calculations.
**Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.
***Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

TABLE VIII

DETAILED COSTS OF MAKING CORN AND SORGHUM SILAGE
WHEN CUT IN FIELD WITH BINDER
(RUTHERFORD COUNTY, TENNESSEE, 1948; 32 FARMS,
402 ACRES, 3,680 TONS, 9.15 TONS PER ACRE)

	Cutting*	Loading	Hauling	Chopping	Tramping	Total
Man hours	856.5	2,346	2,661.5	801	1,795	8,460
Man hrs. per acre	2.13	5.84	6.62	1.99	4.47	21.05
Man hrs. per ton	0.23	0.64	0.72	0.22	0.49	2.30
Rate per hour	$0.36	$0.36	$0.36	$0.36	$0.36	
Cost per acre	$0.77	$2.10	$2.38	$0.72	$1.61	$7.58
Cost per ton	$0.08	$0.23	$0.26	$0.08	$0.18	$0.83
2-plow tractor hrs.	210		590.5**	180***		980.5
2-plow tractor hrs. per acre	0.52		1.47	0.45		2.44
2-plow tractor hrs. per ton	0.06		0.16	0.05		0.27
Rate per hour	$0.68		$0.68	$0.68		
Cost per acre	$0.35		$1.00	$0.31		$1.66
Cost per ton	$0.04		$0.11	$0.03		$0.18
3-plow tractor hrs.	300.5		8	453.5****		762
3-plow tractor hrs. per acre	0.75		0.02	1.13		1.90
3-plow tractor hrs. per ton	0.08		.00	0.12		0.20
Rate per hour	$0.85		$0.85	$0.85		
Cost per acre	$0.64		$0.02	$0.96		1.62
Cost per ton	$0.07		0.00	$0.10		$0.17
Horse hours	60		3,730			3,790
Horse hours per acre	0.15		9.28			9.43
Horse hours per ton	0.02		1.01			1.03
Rate per hour	$0.27		$0.27			
Cost per acre	$0.04		$2.51			$2.55
Cost per ton	$0.01		$0.27			$0.28
Wagon hours			1,865			1,865
Wagon hrs. per acre			4.64			4.64
Wagon hrs. per ton			0.51			0.51
Rate per hour			$0.09			$0.09
Cost per acre			$0.42			$0.42
Cost per ton			$0.05			$0.05

APPENDIX

TABLE VIII

DETAILED COSTS OF MAKING CORN AND SORGHUM SILAGE
WHEN CUT IN FIELD WITH BINDER
(RUTHERFORD COUNTY, TENNESSEE, 1948; 32 FARMS,
402 ACRES, 3,680 TONS, 9.15 TONS PER ACRE)
(Continued)

	Cutting*	Loading	Hauling	Chopping	Tramping	Total
Trailer hours			648.5			648.5
Trailer hrs. per acre			1.61			1.61
Trailer hrs. per ton			0.18			0.18
Rate per hour			$0.13			
Cost per acre			$0.21			$0.21
Cost per ton			$0.02			$0.02
Truck hours (1½T)			40			40
Truck hours per acre			0.10			0.10
Truck hours per ton			0.01			0.01
Rate per hour			$1.08			
Cost per acre			$0.11			$0.11
Cost per ton			$0.01			$0.01
Binder hours	525.5					525.5
Binder hours per acre	1.31					1.31
Binder hours per ton	0.14					0.14
Rate per hour	$1.13					
Cost per acre	$1.48					$1.48
Cost per ton	$0.16					$0.16
Chopper hours				465.5		465.5
Chopper hours per acre				1.16		1.16
Chopper hours per ton				0.13		0.13
Rate per hour				$1.09		
Cost per acre				$1.26		$1.26
Cost per ton				$0.14		$0.14
Total cost per acre*****	$3.28	$2.10	$6.65	$3.25	$1.61	$16.89
Total cost per ton*****	$0.36	$0.23	$0.72	$0.35	$0.18	$1.84
Actual cost per acre******	$3.82	$1.80	$6.25	$3.95	$1.33	$17.15
Actual cost per ton******	$0.42	$0.20	$0.68	$0.43	$0.15	$1.88

*Cost of binder twine not included in calculations.
**Includes eight jeep hours (used 2-plow tractor rate).
***Includes 10 jeep hours (used 2-plow tractor rate).
****Includes 20 fifty H.P. motor hours (used 3-plow tractor rate).
*****Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.
******Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

TABLE IX

DETAILED COSTS OF MAKING SORGHUM SILAGE WHEN CUT IN FIELD WITH BINDER (RUTHERFORD COUNTY, TENNESSEE, 1948; 2 FARMS, 11 ACRES, 166 TONS, 15.09 TONS PER ACRE)

	Cutting*	Loading	Hauling	Chopping	Tramping	Total
Man hours	30	130	130	30	60	380
Man hours per acre	2.73	11.82	11.82	2.73	5.45	34.55
Man hours per ton	0.18	0.78	0.78	0.18	0.36	2.28
Rate per hour	$0.36	$0.36	$0.36	$0.36	$0.36	
Cost per acre	$0.98	$4.26	$4.26	$0.98	$1.96	$12.44
Cost per ton	$0.06	$0.28	$0.28	$0.06	$0.13	$0.81
2-plow tractor hours	10					10
2-plow tractor hrs. per acre	0.91					0.91
2-plow tractor hrs. per ton	0.06					0.06
Rate per hour	$0.68					
Cost per acre	$0.62					$0.62
Cost per ton	$0.04					$0.04
3-plow tractor hrs.	10		60	10		80
3-plow tractor hrs. per acre	0.91		5.45	0.91		7.27
3-plow tractor hrs. per ton	0.06		0.36	0.06		0.48
Rate per hour	$0.85		$0.85	$0.85		
Cost per acre	$0.77		$4.63	$0.77		$6.17
Cost per ton	$0.05		$0.31	$0.05		$0.41
4-5 plow tractor hrs.				20		20
4-5 plow tractor hrs. per acre				1.82		1.82
4-5 plow tractor hrs. per ton				0.12		0.12
Rate per hour				$0.91		
Cost per acre				$1.66		$1.66
Cost per ton				$0.11		$0.11
Horse hours			40			40
Horse hrs. per acre			3.65			3.65
Horse hrs. per ton			0.24			0.24
Rate per hour			$0.27			
Cost per acre			$0.99			$0.99
Cost per ton			$0.06			$0.06

APPENDIX

TABLE IX

DETAILED COSTS OF MAKING SORGHUM SILAGE WHEN CUT IN FIELD WITH BINDER
(RUTHERFORD COUNTY, TENNESSEE, 1948; 2 FARMS, 11 ACRES,
166 TONS, 15.09 TONS PER ACRE)
(Continued)

	Cutting*	Loading	Hauling	Chopping	Tramping	Total
Wagon hour			20			20
Wagon hrs. per acre			1.82			1.82
Wagon hrs. per ton			0.12			0.12
Rate per hour			$0.09			
Cost per acre			$0.16			$0.16
Cost per ton			$0.01			$0.01
Trailer hours			100			100
Trailer hrs. per acre			9.09			9.09
Trailer hrs. per ton			0.60			0.60
Rate per hour			$0.13			
Cost per acre			$1.18			$1.18
Cost per ton			$0.08			$0.08
Binder hours	20					20
Binder hrs. per acre	1.82					1.82
Binder hrs. per ton	0.12					0.12
Rate per hour	$1.13					
Cost per acre	$2.06					$2.06
Cost per ton	$0.14					$0.14
Chopper hours				30		30
Chopper hrs. per acre				2.73		2.73
Chopper hrs. per ton				0.18		0.18
Rate per hour				$1.09		
Cost per acre				$2.98		$2.98
Cost per ton				$0.20		$0.20
Total cost per acre**	$4.43	$4.26	$11.22	$6.39	$1.96	$28.26
Total cost per ton**	$0.29	$0.28	$0.74	$0.42	$0.13	$1.86
Actual cost per acre***	$4.81	$5.91	$11.95	$6.76	$2.73	$32.16
Actual cost per ton***	$0.32	$0.39	$0.79	$0.45	$0.18	$2.13

*Cost of binder twine not included in calculations.

**Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

***Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

TABLE X

DETAILED COSTS OF MAKING CORN SILAGE WHEN CUT IN FIELD BY HAND
(RUTHERFORD COUNTY, TENNESSEE, 1948; 9 FARMS, 71.5 ACRES,
612 TONS, 8.56 TONS PER ACRE)

	Cutting	Loading	Hauling	Chopping	Tramping	Total
Man hours	626	292	406	185	87	1,596
Man hours per acre	8.76	4.08	5.68	2.59	1.22	22.33
Man hours per ton	1.02	0.48	0.66	0.30	0.14	2.60
Rate per hour	$0.36	$0.36	$0.36	$0.36	$0.36	
Cost per acre	$3.15	$1.47	$2.04	$0.93	$0.44	$8.03
Cost per ton	$0.37	$0.17	$0.24	$0.11	$0.05	$0.94
2-plow tractor hrs.			155	40		195
2-plow tractor hrs. per acre			2.17	0.56		2.73
2-plow tractor hrs. per ton			0.25	0.07		0.32
Rate per hour			$0.68	$0.68		
Cost per acre			$1.48	$0.38		$1.86
Cost per ton			$0.17	$0.05		$0.22
3-plow tractor hrs.				145		145
3-plow tractor hrs. per acre				2.03		2.03
3-plow tractor hrs. per ton				0.24		
Rate per hour				$0.85		
Cost per acre				$1.73		$1.73
Cost per ton				$0.20		$0.20
Horse hours			322			322
Horse hrs. per acre			4.50			4.50
Horse hrs. per ton			0.53			0.53
Rate per hour			$0.27			
Cost per acre			$1.22			$1.22
Cost per ton			$0.14			$0.14
Wagon hours			161			161
Wagon hrs. per acre			2.25			2.25
Wagon hrs. per ton			0.26			0.26
Rate per hour			$0.09			
Cost per acre			$0.20			$0.20
Cost per ton			$0.02			$0.02

APPENDIX

TABLE X

DETAILED COSTS OF MAKING CORN SILAGE WHEN CUT IN FIELD BY HAND
(RUTHERFORD COUNTY, TENNESSEE, 1948; 9 FARMS, 71.5 ACRES,
612 TONS, 8.56 TONS PER ACRE)
(Continued)

	Cutting	Loading	Hauling	Chopping	Tramping	Total
Trailer hours			269			269
Trailer hrs. per acre			3.76			3.76
Trailer hrs. per ton			0.44			0.44
Rate per hour			$0.13			
Cost per acre			$0.49			$0.49
Cost per ton			$0.06			$0.06
Truck hours (1½ ton)			70			70
Truck hrs. per acre			0.98			0.98
Truck hrs. per ton			0.11			0.11
Rate per hour			$1.08			
Cost per acre			$1.06			$1.06
Cost per ton			$0.12			$0.12
Chopper hours				185		185
Chopper hrs. per acre				2.59		2.59
Chopper hrs. per ton				0.30		0.30
Rate per hour				$1.09		
Cost per acre				$2.82		$2.82
Cost per ton				$0.33		$0.33
Total cost per acre*	$3.15	$1.47	$6.49	$5.86	$0.44	$17.41
Total cost per ton*	$0.37	$0.17	$0.75	$0.69	$0.05	$2.03
Actual cost per acre**	$2.86	$1.32	$6.32	$5.63	$0.43	$16.56
Actual cost per ton**	$0.33	$0.15	$0.74	$0.66	$0.05	$1.93

*Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

**Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

TABLE XI

DETAILED COSTS OF MAKING CORN AND SORGHUM SILAGE WHEN CUT IN FIELD BY HAND (RUTHERFORD COUNTY, TENNESSEE, 1948; 3 FARMS, 20 ACRES, 89 TONS, 4.45 TONS PER ACRE)

	Cutting	Loading	Hauling	Chopping	Tramping	Total
Man hours	310	135	95	60	125	725
Man hours per acre	15.50	6.75	4.75	3.00	6.25	36.25
Man hrs. per ton	3.48	1.52	1.07	0.67	1.40	8.14
Rate per hour	$0.36	$0.36	$0.36	$0.36	$0.36	
Cost per acre	$5.58	$2.43	$1.71	$1.08	$2.25	$13.05
Cost per ton	$1.25	$0.55	$0.39	$0.24	$0.50	$2.93
2-plow tractor hrs.			70	15		85
2-plow tractor hrs. per acre			3.50	0.75		4.25
2-plow tractor hrs. per ton			0.79	0.17		0.96
Rate per hour			$0.68	$0.68		
Cost per acre			$2.38	$0.51		$2.89
Cost per ton			$0.54	$0.12		$0.66
3-plow tractor hours				15		15
3-plow tractor hours per acre				0.75		0.75
3-plow tractor hours per ton				0.17		0.17
Rate per hour				$0.85		
Cost per acre				$0.64		$0.64
Cost per ton				$0.14		$0.14
Horse hours			50			50
Horse hrs. per acre			2.50			2.50
Horse hrs. per ton			0.56			0.56
Rate per hour			$0.27			
Cost per acre			$0.68			$0.68
Cost per ton			$0.15			$0.15
Wagon hours			25			25
Wagon hrs. per acre			1.25			1.25
Wagon hrs. per ton			0.28			0.28
Rate per hour			$0.09			
Cost per acre			$0.11			$0.11
Cost per ton			$0.03			$0.03

APPENDIX

TABLE XI

DETAILED COSTS OF MAKING CORN AND SORGHUM SILAGE
WHEN CUT IN FIELD BY HAND
(RUTHERFORD COUNTY, TENNESSEE, 1948; 3 FARMS,
20 ACRES, 89 TONS, 4.45 TONS PER ACRE)
(Continued)

	Cutting	Loading	Hauling	Chopping	Tramping	Total
Trailer hours			70			70
Trailer hrs. per acre			3.50			3.50
Trailer hrs. per ton			0.79			0.79
Rate per hour			$0.13			
Cost per acre			$0.46			$0.46
Cost per ton			$0.10			$0.10
Chopper hours				30		30
Chopper hrs. per acre				1.50		1.50
Chopper hrs. per ton				0.34		0.34
Rate per hour				$1.09		
Cost per acre				$1.64		$1.64
Cost per ton				$0.37		$0.37
Total cost per acre*	$5.58	$2.43	$5.34	$3.87	$2.25	$19.47
Total cost per ton*	$1.25	$0.55	$1.21	$0.87	$0.50	$4.38
Actual cost per acre**	$4.15	$1.72	$4.74	$3.53	$1.62	$15.76
Actual cost per ton**	$0.93	$0.39	$1.07	$0.79	$0.37	$3.55

*Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

**Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

TABLE XII

DETAILED COSTS OF MAKING CORN SILAGE WHEN CUT WITH FIELD HARVESTER
(RUTHERFORD COUNTY, TENNESSEE, 1948; 1 FARM,
20 ACRES, 228 TONS, 11.40 TONS PER ACRE)

	Cutting and chopping	Hauling	Blowing	Tramping	Total
Man hours	60	90	60	60	270
Man hours per acre	3.00	4.50	3.00	3.00	13.50
Man hours per ton	0.26	0.39	0.26	0.26	1.17
Rate per hour	$0.36	$0.36	$0.36	$0.36	
Cost per acre	$1.08	$1.62	$0.08	$1.08	$4.86
Cost per ton	$0.09	$0.14	$0.09	$0.09	$0.41
3-plow tractor hrs.			30		30
3-plow tractor hrs. per acre			1.50		1.50
3-plow tractor hrs. per ton			0.13		0.13
Rate per hour			$0.85		
Cost per acre			$1.28		$1.28
Cost per ton			$0.11		$0.11
4-5 plow tractor hrs.	30				30
4-5 plow tractor hrs. per acre	1.50				1.50
4-5 plow tractor hrs. per ton	0.13				0.13
Rate per hour	$0.91				
Cost per acre	$1.36				$1.36
Cost per ton	$0.12				$0.12
Horse hours		180			180
Horse hrs. per acre		9.00			9.00
Horse hrs. per ton		0.79			0.79
Rate per hour		$0.27			
Cost per acre		$2.43			$2.43
Cost per ton		$0.21			$0.21
Wagon hours		90			90
Wagon hrs. per acre		4.50			4.50
Wagon hrs. per ton		0.39			0.39
Rate per hour		$0.09			
Cost per acre		$0.40			$0.40
Cost per ton		$0.04			$0.04

APPENDIX

TABLE XII

DETAILED COSTS OF MAKING CORN SILAGE WHEN CUT WITH FIELD HARVESTER
(RUTHERFORD COUNTY, TENNESSEE, 1948; 1 FARM,
20 ACRES, 228 TONS, 11.40 TONS PER ACRE)
(Continued)

	Cutting and chopping	Hauling	Blowing	Tramping	Total
Field harvester hrs.	30				30
Field harvester hrs. per acre	1.50				1.50
Field harvester hrs. per ton	0.13				0.13
Rate per hour	$2.35				
Cost per acre	$3.52				$3.52
Cost per ton	$0.31				$0.31
Blower hours			30		30
Blower hrs. per acre			1.50		1.50
Blower hrs. per ton			0.13		0.13
Rate per hour			$0.44		
Cost per acre			$0.66		$0.66
Cost per ton			$0.06		$0.06
Total cost per acre*	$5.96	$4.45	$3.02	$1.08	$14.51
Total cost per ton*	$0.52	$0.39	$0.26	$0.09	$1.26
Actual cost per acre**	$5.79	$4.18	$2.84	$0.90	$13.71
Actual cost per ton**	$0.51	$0.37	$0.25	$0.08	$1.21

*Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

**Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

TABLE XIII

DETAILED COSTS OF MAKING CORN AND SORGHUM SILAGE WHEN CUT WITH FIELD HARVESTER
(RUTHERFORD COUNTY, TENNESSEE, 1948; 1 FARM, 100 ACRES, 476 TONS, 4.76 TONS PER ACRE)

	Cutting and chopping	Hauling	Blowing	Tramping	Total
Man hours	150	525	150	150	975
Man hours per acre	1.50	5.25	1.50	1.50	9.75
Man hours per ton	0.32	1.10	0.32	0.32	2.06
Rate per hour	$0.36	$0.36	$0.36	$0.36	
Cost per acre	$0.54	$1.89	$0.54	$0.54	$3.51
Cost per ton	$0.11	$0.40	$0.11	$0.11	$0.73
3-plow tractor hrs.			150		150
3-plow tractor hrs. per acre			1.50		1.50
3-plow tractor hrs. per ton			0.32		0.32
Rate per hour			$0.85		
Cost per acre			$1.28		$1.28
Cost per ton			$0.27		$0.27
4-5 plow tractor hrs.	150				150
4-5 plow tractor hrs. per acre	1.50				1.50
4-5 plow tractor hrs. per ton	0.32				0.32
Rate per hour	$0.91				
Cost per acre	$1.36				$1.36
Cost per ton	$0.29				$0.29
Horse hours		1,050			1,050
Horse hrs. per acre		10.50			10.50
Horse hrs. per ton		2.21			2.21
Rate per hour		$0.27			
Cost per acre		$2.84			$2.84
Cost per ton		$0.60			$0.60
Wagon hours		525			525
Wagon hrs. per acre		5.25			5.25
Wagon hrs. per ton		1.10			1.10
Rate per hour		$0.09			
Cost per acre		$0.47			$0.47
Cost per ton		$0.10			$0.10

APPENDIX

TABLE XIII

DETAILED COSTS OF MAKING CORN AND SORGHUM SILAGE WHEN CUT WITH FIELD HARVESTER
(RUTHERFORD COUNTY, TENNESSEE, 1948; 1 FARM, 100 ACRES, 476 TONS, 4.76 TONS PER ACRE)
(Continued)

	Cutting and chopping	Hauling	Blowing	Tramping	Total
Field harvester hrs.	150				150
Field harvester hrs. per acre	1.50				1.50
Field harvester hrs. per ton	0.32				0.32
Rate per hour	$2.35				
Cost per acre	$3.52				$3.52
Cost per ton	$0.75				$0.75
Blower hours			150		150
Blower hrs. per acre			1.50		1.50
Blower hrs. per ton			0.32		0.32
Rate per hour			$0.44		
Cost per acre			$0.66		$0.66
Cost per ton			$0.14		$0.14
Total cost per acre*	$5.42	$5.20	$2.48	$0.54	$13.64
Total cost per ton*	$1.15	$1.10	$0.52	$0.11	$2.88
Actual cost per acre**	$5.19	$4.36	$2.24	$0.30	$12.09
Actual cost per ton**	$1.09	$0.92	$0.47	$0.06	$2.54

*Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

**Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

TABLE XIV

DETAILED COSTS OF MAKING SORGHUM SILAGE WHEN CUT WITH FIELD HARVESTER (RUTHERFORD COUNTY, TENNESSEE, 1948; 1 FARM, 6 ACRES, 45 TONS, 7.50 TONS PER ACRE)

	Cutting and chopping	Hauling	Blowing	Tramping	Total
Man hours	20	40	20	20	100
Man hours per acre	3.33	6.67	3.33	3.33	16.66
Man hours per ton	0.44	0.89	0.44	0.44	2.21
Rate per hour	$0.36	$0.36	$0.36	$0.36	
Cost per acre	$1.20	$2.40	$1.20	$1.20	$6.00
Cost per ton	$0.16	$0.32	$0.16	$0.16	$0.80
2-plow tractor hrs.		20			20
2-plow tractor hrs. per acre		3.33			3.33
2-plow tractor hrs. per ton		0.44			0.44
Rate per hour		$0.68			
Cost per acre		$2.26			$2.26
Cost per ton		$0.30			$0.30
3-plow tractor hrs.	20		20		40
3-plow tractor hrs. per acre	3.33		3.33		6.66
3-plow tractor hrs. per ton	0.44		0.44		0.88
Rate per hour	$0.85		$0.85		
Cost per acre	$2.83		$2.83		$5.66
Cost per ton	$0.38		$0.37		$0.75
Trailer hours		20			20
Trailer hrs. per acre		3.33			3.33
Trailer hrs. per ton		0.44			0.44
Rate per hour		$0.13			
Cost per acre		$0.43			$0.43
Cost per ton		$0.06			$0.06
Truck hours (1½T)		20			20
Truck hrs. per acre		3.33			3.33
Truck hrs. per ton		0.44			0.44
Rate per hour		$1.08			
Cost per acre		$3.60			$3.60
Cost per ton		$0.48			$0.48

APPENDIX

TABLE XIV

DETAILED COSTS OF MAKING SORGHUM SILAGE WHEN CUT WITH FIELD HARVESTER (RUTHERFORD COUNTY, TENNESSEE, 1948; 1 FARM, 6 ACRES, 45 TONS, 7.50 TONS PER ACRE) (Continued)

	Cutting and chopping	Hauling	Blowing	Tramping	Total
Field harvester hrs.	20				20
Field harvester hrs. per acre	3.33				3.33
Field harvester hrs. per ton	0.44				0.44
Rate per hour	$2.35				
Cost per acre	$7.83				$7.83
Cost per ton	$1.04				$1.03
Blower hours			20		20
Blower hrs. per acre			3.33		3.33
Blower hrs. per ton			0.44		0.44
Rate per hour			$0.44		
Cost per acre			$1.47		$1.47
Cost per ton			$0.19		$0.19
Total cost per acre*	$11.86	$8.69	$5.50	$1.20	$27.25
Total cost per ton*	$1.58	$1.16	$0.72	$0.16	$3.62
Actual cost per acre**	$11.67	$8.30	$5.30	$1.00	$26.27
Actual cost per ton**	$1.56	$1.11	$0.71	$0.13	$3.51

*Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

**Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

TABLE XV

DETAILED COSTS OF MAKING SILAGES (CORN, CORN AND SORGHUM, SORGHUM) WHEN CUT WITH FIELD HARVESTER (RUTHERFORD COUNTY, TENNESSEE, 1948; 3 FARMS, 126 ACRES, 749 TONS, 5.94 TONS PER ACRE)

	Cutting and chopping	Hauling	Blowing	Tramping	Total
Man hours	230	655	230	230	1,345
Man hours per acre	1.83	5.20	1.83	1.83	10.69
Man hours per ton	0.31	0.87	0.31	0.31	1.80
Rate per hour	$0.36	$0.36	$0.36	$0.36	
Cost per acre	$0.66	$0.87	$0.66	$0.66	$3.85
Cost per ton	$0.11	$0.31	$0.11	$0.11	$0.64
2-plow tractor hrs.		20			20
2-plow tractor hrs. per acre		0.16			0.16
2-plow tractor hrs. per ton		0.03			0.03
Rate per hour		$0.68			
Cost per acre		$0.11			$0.11
Cost per ton		$0.02			$0.02
3-plow tractor hrs.	20		200		220
3-plow tractor hrs. per acre	0.16		1.59		1.75
3-plow tractor hrs. per ton	0.03		0.27		0.30
Rate per hour	$0.85		$0.85		
Cost per acre	$0.14		$1.35		$1.49
Cost per ton	$0.03		$0.23		$0.26
4-5 plow tractor hrs.	180				180
4-5 plow tractor hrs. per acre	1.43				1.43
4-5 plow tractor hrs. per ton	0.24				0.24
Rate per hour	$0.91				
Cost per acre	$1.30				$1.30
Cost per ton	$0.22				$0.22
Horse hours		1,230			1,230
Horse hrs. per acre		9.76			9.76
Horse hrs. per ton		1.64			1.64
Rate per hour		$0.27			
Cost per acre		$2.64			$2.64
Cost per ton		$0.44			$0.44

APPENDIX

TABLE XV

DETAILED COSTS OF MAKING SILAGES (CORN, CORN AND SORGHUM, SORGHUM) WHEN CUT WITH FIELD HARVESTER (RUTHERFORD COUNTY, TENNESSEE, 1948; 3 FARMS, 126 ACRES, 749 TONS, 5.94 TONS PER ACRE) (Continued)

	Cutting and chopping	Hauling	Blowing	Tramping	Total
Wagon hours		615			615
Wagon hrs. per acre		4.88			4.88
Wagon hrs. per ton		0.82			0.82
Rate per hour		$0.09			
Cost per acre		$0.44			$0.44
Cost per ton		$0.07			$0.07
Trailer hours		20			20
Trailer hrs. per acre		0.16			0.16
Trailer hrs. per ton		0.03			0.03
Rate per hour		$0.13			
Cost per acre		$0.02			$0.02
Cost per ton		$0.00			$0.00
Truck hours (1½T)		20			20
Truck hrs. per acre		0.16			0.16
Truck hrs. per ton		0.03			0.03
Rate per hour		$1.08			
Cost per acre		$0.17			$0.17
Cost per ton		$0.03			$0.03
Field harvester hrs.	200				200
Field harvester hrs. per acre	1.59				1.59
Field harvester hrs. per ton	0.27				0.27
Rate per hour	$2.35				
Cost per acre	$3.74				$3.74
Cost per ton	$0.63				$0.63

APPENDIX

TABLE XV

DETAILED COSTS OF MAKING SILAGES (CORN, CORN AND SORGHUM, SORGHUM) WHEN CUT WITH FIELD HARVESTER (RUTHERFORD COUNTY, TENNESSEE, 1948; 3 FARMS, 126 ACRES, 749 TONS, 5.94 TONS PER ACRE) (Continued)

	Cutting and chopping	Hauling	Blowing	Tramping	Total
Blower hours			200		200
Blower hrs. per acre			1.59		1.59
Blower hrs. per ton			0.27		0.27
Rate per hour			$0.44		
Cost per acre			$0.70		$0.70
Cost per ton			$0.12		$0.12
Total cost per acre*	$5.84	$5.25	$2.71	$0.66	$14.46
Total cost per ton*	$0.99	$0.87	$0.46	$0.11	$2.43
Actual cost per acre**	$5.59	$4.52	$2.48	$0.43	$13.02
Actual cost per ton**	$0.94	$0.76	$0.42	$0.07	$2.19

*Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

**Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

TABLE XVI

DETAILED COST OF MAKING SILAGE--ALL CROPS (CORN, CORN AND SORGHUM, SORGHUM), ALL METHODS OF CUTTING IN FIELD (HAND, BINDER, FIELD HARVESTER) (RUTHERFORD COUNTY, TENNESSEE, 1948; 78 FARMS, 910.5 ACRES, 7,677 TONS, 8.43 TONS PER ACRE

Hours and rates	Costs*	Hours and rates (Continued)	Costs*
Man hours	17,180.5	Trailer hours	1,455
Man hours per acre	18.87	Trailer hrs. per acre	1.60
Man hours per ton	2.24	Trailer hrs. per ton	0.19
Rate per hour	$0.36	Rate per hour	$0.13
Cost per acre	$6.79	Cost per acre	$0.21
Cost per ton	$0.81	Cost per ton	$0.02
2-plow tractor hours	1,892.5	Truck hours (1½T)	208
2-plow tractor hrs. per acre	2.10	Truck hrs. per acre	0.23
2-plow tractor hrs. per ton	0.25	Truck hrs. per ton	0.03
Rate per hour	$0.68	Rate per hour	$1.08
Cost per acre	$1.43	Cost per acre	$0.25
Cost per ton	$0.17	Cost per ton	$0.03
3-plow tractor hours	1,557.5	Binder hours	890
3-plow tractor hrs. per acre	1.71	Binder hours per acre	0.98
3-plow tractor hrs. per ton	0.20	Binder hours per ton	0.12
Rate per hour	$0.85	Rate per hour	$1.13
Cost per acre	$1.45	Cost per acre	$1.11
Cost per ton	$0.17	Cost per ton	$0.14
4-5 plow tractor hours	215	Chopper hours	1,086
4-5 plow tractor hrs. per acre	0.24	Chopper hours per acre	1.19
4-5 plow tractor hrs. per ton	0.03	Chopper hours per ton	0.14
Rate per hour	$0.91	Rate per hour	$1.09
Cost per acre	$0.22	Cost per acre	$1.30
Cost per ton	$0.03	Cost per ton	$0.15
Horse hours	7,669	Field harvester hours	200
Horse hours per acre	8.42	Field harvester hrs. per acre	0.22
Horse hours per ton	1.00	Field harvester hrs. per ton	0.03
Rate per hour	$0.27	Rate per hour	$2.35
Cost per acre	$2.27	Cost per acre	$0.52
Cost per ton	$0.27	Cost per ton	$0.07

APPENDIX

TABLE XVI

DETAILED COST OF MAKING SILAGE--ALL CROPS (CORN, CORN AND SORGHUM, SORGHUM), ALL METHODS OF CUTTING IN FIELD (HAND, BINDER, FIELD HARVESTER) (RUTHERFORD COUNTY, TENNESSEE, 1948; 78 FARMS, 910.5 ACRES, 7,677 TONS, 8.43 TONS PER ACRE)
(Continued)

Hours and rates	Costs*	Hours and rates (Continued)	Costs*
Wagon hours	3,752	Blower hours	200
Wagon hours per acre	4.12	Blower hours per acre	0.22
Wagon hours per ton	0.45	Blower hours per ton	0.03
Rate per hour	$0.09	Rate per hour	$0.44
Cost per acre	$0.37	Cost per acre	$0.10
Cost per ton	$0.04	Cost per ton	$0.01
		Total cost per acre*	$16.02
		Total cost per ton*	$1.91
		Actual cost per acre**	$16.28
		Actual cost per ton**	$1.93

*Theoretical. All labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

**Hired labor and machinery figured at actual cost. Other labor and machinery figured at standard rates as tabulated in APPENDIX TABLE IV.

APPENDIX

COPY OF SCHEDULE USED IN SILO AND SILAGE SURVEY (95 FARMS, RUTHERFORD COUNTY, TENNESSEE, 1948)

County_____ Civil Dist._____ Schedule No._____

Date_____ Enumerator_____

TENNESSEE AGRICULTURAL EXPERIMENT STATION
Agricultural Economics and Rural Sociology Department

SILO AND SILAGE SURVEY
(April 1, 1948 - March 31, 1949)

1. Name_____ Address_____
   Location_____ Age_____
2. Farm acreage: Total owned_____ Cash lease_____ Share lease_____
   Rented out_____ Total tillable acres operated_____
3. Number of years in dairy business (operating own herd)_____

4. Inventory of Dairy Cattle

Kind	April 1, 1948 Number	March 31, 1949 Number	Average Number
Milking cows			
Young stock			
Bulls (in service)			
Total			

5. Type of dairy product sold_____
6. Percent farm income from dairy herd (sale of milk products and animals)_____

7. Silo Inventory

Type	Material (Lining if a trench type)	Size	Capacity Cu.ft.	Capacity Tons-40# Cu.ft.	Roof Yes	Roof No	Chute Yes	Chute No
Total		xxx		xx				

8. Have you ever built a silo?____ Year____ Type_____
   Chute: Yes__ No__. Roof: Yes__ No__. Material_____
   Size_____ Cost: Materials $_____ Hired labor $_____
   Family labor_____ hours.

9. Cost of silo repairs last year: Materials$___ Hired labor, hours_____
Rate_____ $_____, Family labor_____ hours.
10. If you were building a silo this year, what type would you build?_____
11. What percent of years have you made silage when you had a silo?_____
12. Major reasons you did not make silage when you had a silo_____
13.

Crops Used for Silage Last Year

Crop (If corn--with or without ears)	Acres	Number of cuttings: For silage	Number of cuttings: Total	Yield: Tons per acre	Yield: Total tons
Total or average					

14. What percent of your total silo capacity did you fill last year?_____
15. Why did you not fill all silos to capacity?_____
16. Would you have made more silage if you had more silo capacity?_____
17. Which crop do you prefer for silage?_____ Why?_____
18.

Preservatives Used in Making Silage

Type of silage	Preservative	Rate used

19. Did you feed silage during (Months) A M J J A S O D J F M
20. Did you have cows on pasture during (Months) A M J J A S O N D J F M
21. Total time required daily to feed silage____ hours. Do you feed silage: Morning_____ Evening_____?
22. Cost of filling silos (Use separate table for each kind of silage).
Kind of silage_____ Acres_____. Yield per acre_____ tons
Number of cuttings_____.

Operation	No. men	Man hours	Horse hours	Trucks or Tractors (No. and size)	Truck hours	Wagon hours	Other equip. kind	Other equip. hours
Cutting								
Raking								
Leading								
Hauling								
Chopping and/ or blowing								
Tramping (in silo								
Total								

Man hours hired_____. Rate: $_____per (_____) Cost: $_____

23. Equipment Hired

Equipment	Unit (of hire)	Cost (rate per unit)	Total cost	Remarks
Total	xx	xx		xx

Total cost of hired men and equipment _____.

24. Do you own a field chopper_____Make_____Size_____
Auxiliary engine?: Size_____Make_____
Attachments_____
How old is your field chopper_____Year Original cost $_____
Cost of repairs (April 1, 1948-March 31, 1949) $_____

25. Acres harvested with field chopper last year

Own Crops

Crop	No. cuttings	Use of crop (Hay or silage)	Acres*
Total			

*(Acres covered (10 acres covered twice = 20 acres).

Custom Harvesting

Crop	No. cuttings	Use of crop (Hay or silage)	Acres*
Total			

*Acres covered (10 acres covered twice = 20 acres).

Total acreage harvested (covered)_____. Charges for custom work_____.