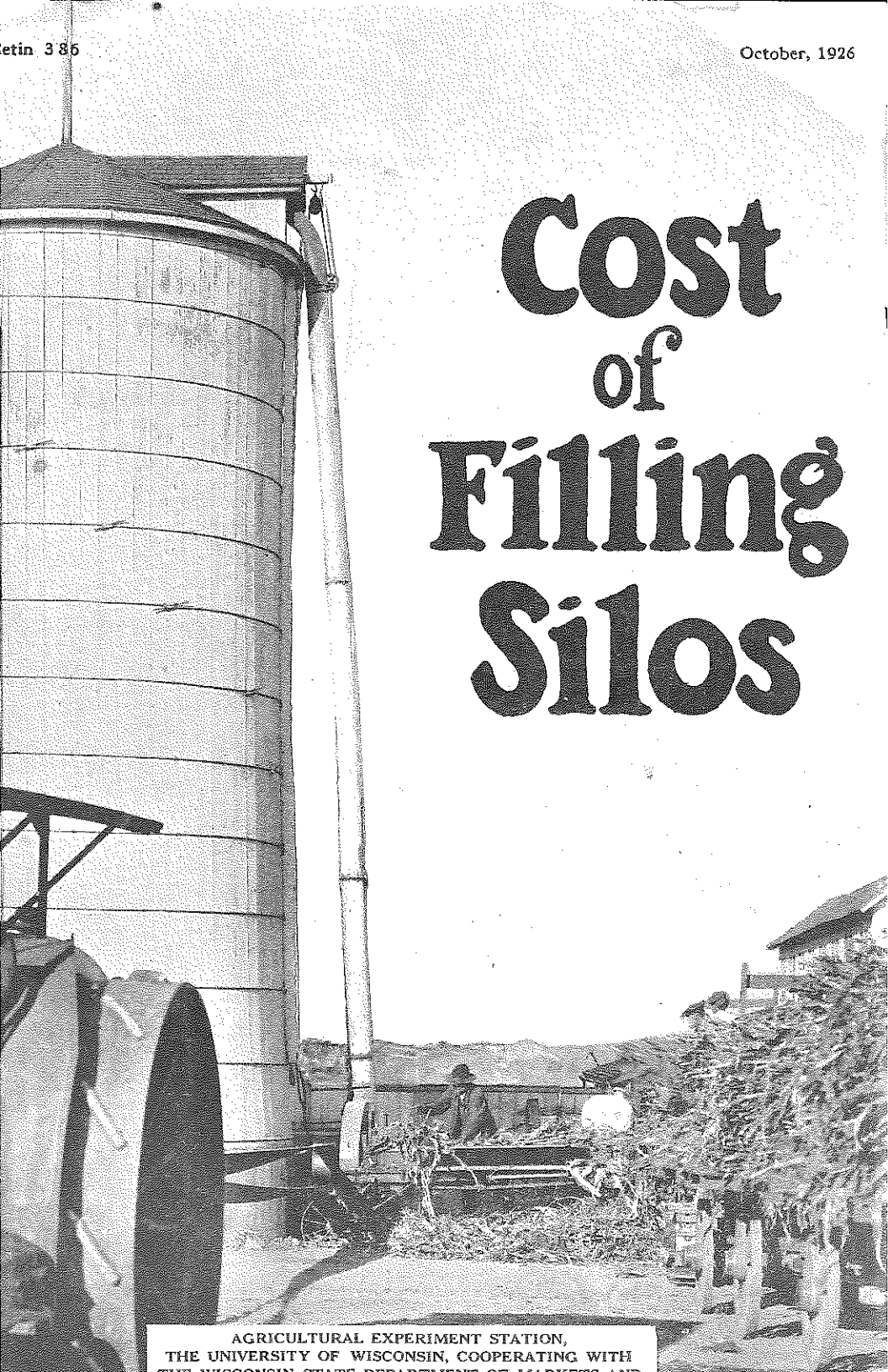
Cost of Filling Silos



AGRICULTURAL EXPERIMENT STATION,
THE UNIVERSITY OF WISCONSIN, COOPERATING WITH

Digest

Cost of Filling Silos

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WISCONSIN now has 110,000 silos. The more intensive dairy sections of the state have from 60 to 92 silos for every 100 farms, while the whole state averages 54 silos for every 100 farms.

There can be stored in these silos approximately 8,800,000 tons of dairy feed. If this feed is valued at $4.50 per ton it represents a total of $39,600,000 for feed for the dairy herds of the state.

The costs of filling silos represent more than 40 per cent of the total costs of silage. A reduction of one-eighth in the filling costs, or 25 cents per ton, will amount to an annual saving of more than $2,000,000 to Wisconsin farmers for this one item alone.

The variation in costs of filling[1] silos ranged from $1.02 to $4.65 per ton, the average cost being $2.06 per ton. (Table I.) Approximately one-fourth of the 282 farms had costs greater than $2.50 per ton, while an equal number averaged less than $1.75 per ton. This wide variation in costs is due to such factors as size of silo, length of haul, size of crew, and labor and equipment use. The factors most directly responsible for variations in costs per ton are the silo and machinery[2] costs. These two items consisting of silo, engine, ensilage cutter, corn binder and wagons constitute 68 cents, or 33 per cent of the average cost.

Types of Silos Vary Greatly

There are six types of silos more or less commonly used in Wisconsin, (Table II) and the type determines to a considerable extent the cost per ton for storing silage. The most commonly used type is the concrete silo. Nearly one-half of the farmers visited owned this type. The next in importance is the wood silo, which is found on approximately 30 per cent of the farms. The remaining 20 per cent is fairly evenly divided between the clay block, brick, and stone types.

It is interesting to note that the average capacities of the different types of silos vary greatly. The brick silos, for example, have an average capacity of 130 tons, while the wood silos average but 80 tons capacity. It will also be noticed that the average estimated total years' use varies from 23 years for the wood silos to over 50 years for the concrete and stone silos. The variation in capacities, along with the difference in total years' use, helps account for the differences in the total annual costs per silo. There is not a great difference in the estimated total years' use between the different types of stone, clay and cement silos.

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[1]The costs include all items involved in cutting and hauling the corn and filling the silo. They also include the yearly cost of the silo.

[2]Proof of statements contained in the body of the bulletin for which no substantiating figures are given were worked out by M. H. Ingraham, Assistant Professor of Mathematics, University of Wisconsin. A copy of the method used in determining the correlations will be sent upon request.

TABLE I.—AVERAGE COST OF FILLING SILOS

(282 farms in Southeast Wisconsin)

Items	Cost per ton	Per cent of total costs
Silo, depreciation and repairs	$.22	10.6
Engine, depreciation and repairs	.17	8.2
Ensilage cutter, depreciation and repairs	.18	8.8
Corn binder	.10	4.9
Wagons	.01	.5
Man work, 1.83 hours	.58	28.1
Horse work, 2.57 hours	.35	17.0
Twine, 12c per pound	.07	3.4
Fuel*	.07	3.4
Interest on silo and equipment	.31	15.1
Total cost per ton	2.06	100%

*Kerosene sold for about 11 cents per gallon and gasoline sold at approximately 15 cents per gallon.

TABLE II.—THE ANNUAL COSTS OF SILOS

(Per Silo)

Type of silo	No. of silos	Average capacity	First** cost	Total estimated years' use	Yearly				
					Depreciation	Repairs	Insurance and taxes	Interest on present valuation	Total costs per silo
		Tons							
Concrete	136	96	$430	52	$8.31	$.38	$6.30	$21.66	$36.65
Cement stave	4	101	640	46	13.98	.22	9.89	25.16	49.25
Clay block	23	80	420	50	8.31	.97	6.85	18.35	34.48
Brick	19	130	702	46	15.27	2.65	7.06	30.33	54.11
Stone	14	112	285	54	8.29	1.48	3.51	12.50	20.28
Wood	85	80	390	23	17.24	1.70	3.46	12.74	35.14
Average	281*	93	480	43	13.02	1.03	7.57	20.68	42.30

*The grouping of silos for this table eliminates those schedules which were not sufficiently complete to obtain the first cost or date of construction.

**The actual costs at the time of putting up the silo were used. This will account for any disparity between these figures and present costs of silo construction.

TABLE III.—THE ANNUAL COSTS OF SILOS

(Per Ton)

Type of silo	Capacity of silo tons	Costs per ton					
		First cost	Depreciation	Annual repairs	Insurance & taxes	Interest	Total annual cost
Concrete	96	$7.17	$.11	$----	$.06	$.23	$.40
Cement stave	101	6.33	.14	----	.10	.25	.49
Clay block	80	4.50	.11	.02	.08	.23	.44
Brick	130	5.52	.12	.02	.05	.23	.42
Stone	112	2.54	.08	.01	.03	.09	.21
Wood	80	4.87	.21	.04	.04	.16	.45
Average	93	5.16	.14	.02	.06	.23	.45

TABLE IV.—AVERAGE AGE AND AGE RANGE OF THE DIFFERENT TYPES OF SILO*

Type of silo	Average age in years	Range of age in years
Concrete	7	0-18
Cement stave	2	0- 7
Clay block	5	0-15
Brick	10	0-15
Stone	20	8-35
Wood	10	5-20

*These averages and age ranges are from the time of obtaining the data— e. g. 1921, 1922, 1923

Silo Costs per Ton Vary Slightly

The silo costs when expressed in terms of their capacities range from 40 cents for the concrete silos to 49 cents per ton for cement stave silos. (Table III). The old stone silos were constructed from eight to thirty-five years ago when construction was cheap compared with later construction. For this reason the silo costs per ton of silage are very low for this type, being only 21 cents. The largest single item of current cost is interest on the capital invested in the silo. This cost varies greatly for various types of silos being 9 cents per ton silage for the old stone silo as compared with 25 cents per ton for the cement stave silos.

The first costs (and, therefore, the interest costs) are influenced by the date of construction. The cement stave silos (Table IV.) are the newest silos in point of time of construction, and their interest charges are highest.

Most of the silos put up recently have been either of the cement stave, concrete, or the hollow tile type. Of the 282 farms visited none had put up wood silos within the last five years, and no stone silos have been erected during the last ten years. The cement stave, concrete, hollow tile and brick silos have less depreciation per ton capacity and fewer charges for repairs than the other types of silos (Table III). This is offset to some extent by interest and taxes, which are greater on silos with higher first costs. The variation in annual cost per ton is also influenced by the average capacities of the different silo types. The first cost per ton of a 130 ton silo will be less than the first cost per ton of an 80 ton silo of the same type.

Machinery Costs Important

The four items of machinery—engine, ensilage cutter, corn binder, and wagons—make up 46 cents, or 22.4 per cent of the total costs of filling silos (Table I). Binders and wagons constitute less than one-fourth of the machinery and equipment costs; the engine a little more than one-fourth, while the cutter accounts for just one-half of the equipment costs. The extreme variation in costs is from 31 cents to 88 cents, or a spread of 57 cents per ton (Table V). This variation in costs indicates the degrees of efficiency in the use of machinery. As the capacity of the silo is increased the machinery costs per ton become less. In other words, large silos use machinery more efficiently than do small silos.

Hired Engine and Cutter an Economy

Approximately one-half of the total quantity of silage—27,238 tons—was put up by hired engines and cutters. The average costs of the hired machines was 2 cents more per ton than was the average cost of the owned engine and cutter (Table VI).

As the capacity of the silos increased from the group of small silos to the group of large silos, the hired engine and cutter costs decreased from 37 cents to 33 cents per ton.

The engine and cutter costs, for those owning their engines and cutters, decreased from 43 cents per ton for the group of small silos to 24 cents for

TABLE V.—LABOR AND MACHINERY COSTS

(In Cents Per Ton)

Item	Low Cost	High Cost	Average Cost
Man labor	27	96	58
Machinery	31	88	46

TABLE VI.—COST PER TON OF HIRED AND OWNED ENGINE AND CUTTER

Silo capacity	Hired engine and cutter cost per ton	Owned engine and cutter cost per ton
	Cents	Cents
50-70 Tons	37	43
71-90 "	37	38
91-110 "	36	37
111+ "	33	24
Average	36	34

the group of large silos. The spread in this case is 17 cents per ton. These figures indicate that the men with silos of less then 100 tons capacity can hire engines and cutters for silo filling as cheaply as they can own them. On the other hand, those farmers having the large silos can fill them approximately 11 cents cheaper per ton by owning their engines and cutters than they can by hiring them, provided they use the machinery as much as is ordinarily used in a silo filling ring.

Labor Costs Variable

Labor costs vary more than do machinery costs, but because of the inefficient use of labor the correlation between this factor and the total costs is not important. The variation in the costs of man labor is from 27 cents to 96 cents with an average of 58 cents per ton (Table V). Labor costs constitute 28.1 per cent, while machinery costs represent but 22.4 per cent of the total costs.

As the capacity of the silo increases there is no definite trend of labor costs either toward a lower or higher cost per ton. Large silos use as much labor per ton as do the small silos. In other words, there is no correlation between labor costs and total costs per ton.

An average of .2 hours man labor per ton was spent in the silo. This time is for distributing and tramping silage. Many of the farmers used no men to tramp the silage and reported good silage. Should no men be placed in the silo it will reduce the cost about 6 cents per ton.

Size of Crew Affects Costs

The number of men, or crew size, used in filling silos ranges from three to twenty-three (Table VII). The farmers with the extremely small number of men per crew usually fill their silos with the use of family labor only. They exchange labor with none of their neighbors.

The customary crew is composed of neighbors and hired men who go as a unit from farm to farm and fill each silo of the group. This arrangement is spoken of as a "silo filling ring." The number of men most commonly found in the crew is seven to eight. This is true in the case of the smallest silos The five to six and eleven to twelve men crews are next in number in the

filling of these silos, each having twelve crews, while the nine to ten men crews stand next with eight crews. The seven to eight men crews were the ones most commonly used in filling the 71-90 ton silos, with the eleven to twelve men crews next in number; the crews containing five to six men are third in importance.

TABLE VII.—SIZE OF CREW USED IN SILO FILLING

Total tons silage per farm	Number of crews with the following number of men in crew									
	1—4	5—6	7—8	9—10	11—12	13—14	15—16	17—18	19—20	20—23
50—70	5	12	24	8	12	8	6	1	1	—
71—90	4	10	14	9	13	8	9	2	—	1
91—110	4	3	12	9	6	5	5	1	—	1
111+	7	9	11	17	16	12	8	7	1	—
Total	20	34	61	43	47	33	28	11	2	2

The crew size does not increase appreciably until the silo capacity reaches 110 tons.

Here the usual size of crew is the nine to ten men, with the eleven to twelve men crew next in number. The thirteen to fourteen and seven to eight men crews are next with twelve and eleven crews respectively. The size of crew is determined more by the custom of exchanging labor during silo filling—called "rings"—than by the need of the farm for men.

Length of Haul of Minor Importance

It is sometimes argued that the length of haul is an important factor in the cost of filling silos. How far can a man afford to haul silage? Should farmers continue the policy of growing corn in the one or two of the fields nearest the silo and by so doing fail to obtain the advantages of a rotation, in order to reduce the average length of haul?

Length of haul influences labor costs to some extent. If the length of haul is increased 80 rods, one-fourth mile, it will ordinarily increase the labor costs less than four cents per ton.[3] The effect of an increase of one-fourth mile in the length of haul upon the total cost of filling silos amounts to less than 9 cents per ton. For example, the additional cost of filling an 80-ton silo because of one-fourth mile longer haul, will be $7.20.

Larger Silos Are Desirable

The quantity of silage put up has some relation to the costs of filling silos. It usually costs less per ton to fill a large silo than to fill a small one. The costs of filling a silo of 147 tons capacity are $1.89 per ton, while a 56 ton silo is filled at a cost of $2.39 per ton (Table VIII). The largest part of this varia-

[3]The correlation indicates the influence on equipment and silo to be less than 1 cent per ton for each one-fourth mile increase in length of haul. The greater part of the other 4 cents per ton is probably due to increase in horse labor costs.

tion of 50 cents per ton, is in the use of equipment which costs 22 cents per ton less for the large than for the small silo. The charge for the use of the silo is ten cents less, man labor, five cents, horse labor, three cents, and twine one cent less. The remaining difference of nine cents is interest on the silo and equipment.

TABLE VIII.—MORE TONS PER FARM MEANS LOWER COSTS PER TON

Tons of silage	Average tons silage per farm	Cost per ton							
		Man labor	Horse work	Silo	Equipment	Twine	Fuel	Interest	Total
111 +	147	$.57	$.34	$.19	$.37	$.07	$.07	$.28	$1.89
91-110	101	.56	.34	.20	.50	.07	.07	.30	2.04
71—90	81	.59	.36	.23	.51	.07	.07	.34	2.17
50—70	56	.62	.37	.30	.59	.07	.07	.37	2.39
Average	98	.58	.35	.22	.46	.07	.07	.31	2.06

The outstanding points in connection with the large silos are the effective use of machinery and the ineffective use of labor. As the capacity of the silos is increased there is more efficient use of machinery. Labor costs per ton, on the other hand, do not vary with increasing capacity.

Inefficiency in the use of labor is as noticeable in the filling of large as of small silos. This is probably caused by the custom of maintaining silo rings wherein each man exchanges labor and teams with every other man of the ring. It frequently happens that farmers will have more men than they can use effectively when the engine and cutter size, the size of the silo, and other factors are taken into consideration. Again, a farm with a large silo where silage is hauled a long distance and is packed in the silo by trampers, will have the same number of men and teams as a small silo with a correspondingly shorter length of haul and no tramping of silage. In the one instance the men and teams are busy, while in the case of the smaller silo the time of both men and teams is wasted while waiting their turn for unloading to the cutter.

It costs less per ton to fill a large silo, not so much because of the direct effect of size upon costs, as its indirect effect upon machinery, silo, and labor. In other words, if the machinery and silo costs per ton were held constant an increase of one ton in the capacity of the silo would cause an increase of less than one cent per ton in the costs of filling the silo.

The greatest variation in costs are the result of the use of machinery. Engine and cutter, or machinery costs, vary as much as do their capacities for handling silage. Some of the cutters, when run at full capacity, require much more silage to keep them running than is possible for two men to supply to the cutters. The result is either a wastage of power, because of failure to completely utilize all available power, or a reduction in the speed of the cutter so the engine is not used to optimum capacity. Occasionally a unit, or engine and cutter, is found where the proper balance is maintained and

these costs are reduced to a minimum. Approximately 60 per cent of the variation in costs per ton is the result of the variation in costs of engine, cutter and silo.

When are Crews Effective?

An 80-ton silo was filled at a cost of $1.54 per ton. A 16 inch cutter driven by a 20-horse power steam engine was used to cut and blow the silage into the silo. The length of haul averaged 90 rods, or a little over one-fourth mile. Ten acres of corn were used to fill the silo. The crew consisted of thirteen men in all. One man and three horses worked 14 hours in cutting the corn Eight men and wagons hauled corn for seven hours each. No extra pitchers were used. Two men were employed with the engine and cutter, and the remaining two tramped silage. It took six hours to fill the silo. There was a total of 94 hours of man labor and 154 hours of horse work used to fill this silo. This gave an average of 1.05 hours of man labor and 1.94 hours of horse work per ton.

A second silo of 150-ton capacity was filled from 16 acres at a cost of $1.18 per ton. Eleven men composed the crew. One man and three horses worked 24 hours in cutting corn. Six men and teams, with no extra pitchers, hauled the corn an average of 60 rods in 15 hours. Two men in the silo with one engine man and one man feeding the cutter worked 15 hours. A 14-inch cutter and a gas engine were used. A total of 159 hours of man labor and 252 hours of horse work were required to fill the silo. The average per ton was 1.06 hours of man labor and 1.68 hours of horse work.

Where Material Was Obtained

Data were obtained from seven counties of the east and southeast part of the state (Table IX). Two hundred and eighty-two usable records were obtained, covering the three years, 1921 to 1923, inclusive. Sixty-seven of the farms had two silos per farm, while 215 farms had but one silo per farm.

TABLE IX.—DISTRIBUTION OF SILO RECORDS

County	Total farms	Number of farms having	
		One silo	Two silos
Dodge	51	41	10
Fond du Lac	24	17	7
Ozaukee	3	2	1
Sheboygan	29	21	8
Walworth	110	92	18
Washington	46	32	14
Waukesha	19	10	9
Total	282	215	67
Per cent	100	76.2	23.8

How Information Was Obtained

The data were obtained by personal visits to each of the farms. Each farmer was interviewed personally in order to obtain the man labor and horse work data as well as the materials used and the information concerning the equipment. Wherever the cutter and engine were owned and operated by one man who supplied them for the "ring," or series of silos filled, data concerning the costs, repairs, etc., of these machines were obtained from the owner. These costs were then distributed to all silos which had been filled by this cutter and engine in proportion to the time required to fill each silo.

The enumerators were men trained in agricultural economics and experienced in dealing with farmers. They checked the schedules in the field in order to determine the dependability of the figures obtained on each schedule. Questions concerning the records were immediately referred to the individual farmers. Whenever the questions could not be satisfactorily answered, the schedules were not used.

The schedule was adapted from a schedule used by the Bureau of Agricultural Economics, Washington, D. C.

How Costs Were Determined

1. All hired help was figured at its cost to the farmer, while $.20 per hour for man labor and $.12 per hour for horse work was used for all exchange help and the farmer's own time and teams. At the present time, horse work costs are somewhat higher than the figures used.
2. Whenever the cutter and engine were hired, an engineman was included with the unit. In this case the labor cost was charged with one man at the rate of $.20 per hour, and the amount was deducted from the machinery cost.
3. A charge of thirty-five cents per meal for the men and ten cents per feed for horses was entered as a part of the filling costs.
4. Wherever no estimate was given by the farmer, silo depreciation was figured at two per cent for concrete silos and five per cent for wood stave silos.
5. The depreciation of the silo and the machinery used in filling the silo was figured on the basis of the total years' use whenever the date of purchase and the first cost were known. To the number of years the machines had been used at the present time was added the estimated future years' use in order to obtain the total years' use. This figure was divided into the first cost in order to obtain the annual depreciation. In case the first cost or date of purchase were not known, the present estimated value divided by the estimated years' future use gave the annual depreciation. Scrap value of the machine or silo was neglected in this estimate.
6. The annual repairs on the silo and the machinery were estimated by the farmer. This figure included the various items of repair for the engine, cutter, hayrack and other machinery used for silo filling.
7. The rate charged for insurance and taxes was obtained from the local assessor.
8. A flat rate of 6 per cent interest was charged on present value of investment in equipment and silo.
9. Total annual costs consist of all the costs, except interest, on each particular machine and the silo.
10. In determining the part of the total annual cost of each machine to be charged against the cost of filling the silo, the number of days the machine was used for all purposes throughout the year was obtained from the farmer. The ratio of the number of days a machine was used in filling the silo to the total number of days it was used through the year gave the portion of the total annual cost to be charged against the costs of filling the silo. In the case of the corn binder the number of acres of corn cut each year was substituted for the number of days used.

11. Whenever a machine was hired the entire cost was charged as equipment cost against costs of filling the silo, except as noted in 2.
12. The capacity of the various silos was calculated from the tables constructed from the data published by C. H. Eckles of Missouri Experiment Station; L. W. Chase of Nebraska Experiment Station; O. E. Reed and J. B. Fitch of Kansas Experiment Station.