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AGRICULTURAL DIVISION

THE PIT SILO

By JOHN W. SJOGREN
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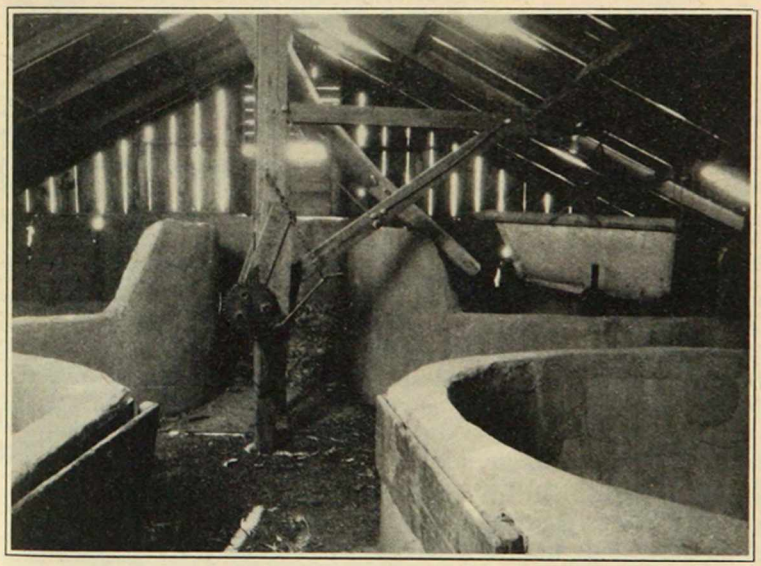

Figure 1.—Pit silos on the Plains Substation Farm at Cheyenne Wells.

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THE PIT SILO

By John W. Sjogren

Where the soil formation will permit and where the underground water is not too close to the surface, the pit silo is a very practical type to construct. The purpose of this bulletin is to give information necessary in the construction of a pit silo.

Advantages of the Pit Silo.—The pit silo has some advantages over other types.

First:—Pit silos cost less to construct.
Second:—There is no trouble from feeding frozen ensilage.
Third:—Less power is required in operating the ensilage cutter, because it is not necessary to raise the ensilage to any considerable height.

Disadvantages of the Pit Silo.—The pit silo cannot be economically constructed in regions where the soil has a tendency to cave in. If the soil will not remain in an upright position, it will be necessary to construct a heavy retaining wall, and this will require almost as much material as building a silo above ground. The ensilage is more difficult to remove from the pit silo than from the above-ground type. This objection can be largely overcome by constructing a good hoisting derrick. Another objection is the danger of the formation of a poisonous gas called carbon dioxide on the surface of the ensilage at filling time. This gas continues to form for ten days or two weeks, after which time very little is formed. No one should enter the pit at filling time, until after the ensilage cutter has been operated a few minutes. The falling ensilage will drive out the gas from the bottom of the silo.

Constructing the Retaining Wall.—After a desirable location has been decided upon, the ground should be marked off. A simple device for this purpose can be constructed as indicated in Figure 2 from a piece of 2″x4″ about fifteen inches longer than one-half the diameter of the silo. In one end, bore a hole and fasten by means of a spike or bolt to a stake driven in the ground where the center of the silo will come. Lay off and mark on this piece, the length A B which should be one-half the diameter of the silo. Nail a marker, which can be made from any piece of one-inch material, to the 2″x4″ at this point. Another marker should be placed at a distance of six inches from the first. A trench should then be dug between the two circles and as deep as can be conveniently dug with a space. A tiling spade will be better for this purpose than an ordinary spade. Care should be taken to keep the inside wall smooth.

This trench is then filled with concrete. A good mixture for this purpose is one part of cement, $2\frac{1}{2}$ parts of sand, and 5 parts of gravel. If bank-run gravel is used, 1 part of cement and 5 parts of bank-run gravel is equivalent to the above mixture. The purpose of this wall is to prevent the surface soil from caving in.

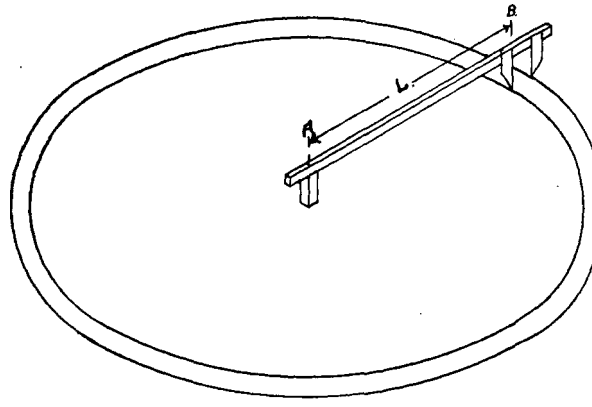

Figure 2.—Marking Off the Ground.

It is well to extend this wall three feet above the ground to prevent the danger of stock falling into the silo. The above-ground portion should be constructed before much excavating is done. The walls can be made of concrete or "adobe." If concrete is used, it should be of the same mixture as the retaining wall, but it is well to reinforce it with some good woven-wire fencing. The forms can be made of battens nailed to pieces of 2″x4″ driven into the ground every two or three feet. If "adobe" is used, the walls above the ground should be ten or twelve inches thick and plastered inside and outside with cement plaster.

Constructing the Wall.—After the concrete in the retaining wall has set properly, the soil should be removed to a depth of five or six

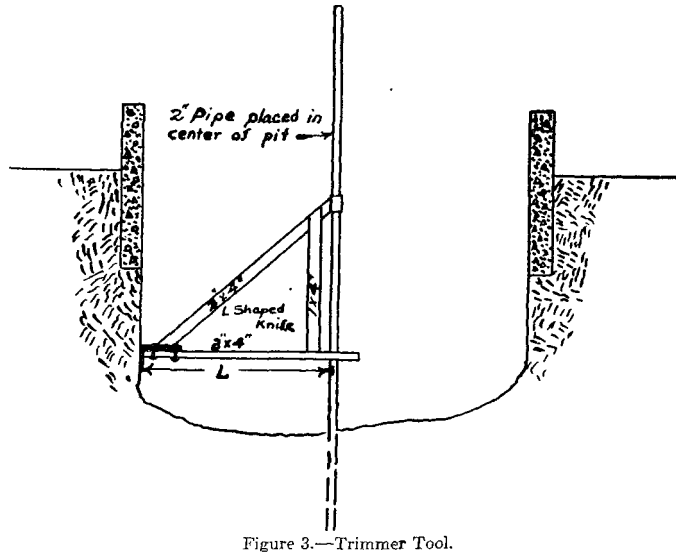

Figure 3.—Trimmer Tool.

feet below the retaining wall. Care should be taken to keep the wall smooth and plumb. Figure 3 shows a device for trimming the wall and keeping it plumb. It consists of an L-shaped knife attached to a 2″x4″. The distance from the center of the pipe to the knife should be one-half of the diameter of the pit, plus one inch to allow for the plaster. This device is held in place by means of a two-inch pipe, placed in the center of the silo. The hole for the pipe is made with a soil auger.

After the dirt has been removed, the walls should be given two or three coats of cement plaster, made by mixing one part of cement and two parts of clean sand. The sand and cement should be mixed thoroughly, then enough water added to make a good mortar. The coats of plaster can be put on as separate coats, or else plaster four or five yards, and then go over it with a second coat, before it has time to set. If the dirt wall is dry, it should be moistened with water in order to make the mortar stick to the walls better and to prevent the soil from absorbing the moisture from the plaster too rapidly. The plastered wall should be kept moist for several days while setting. After the plaster has set, it should be given a coat of cement wash, made by mixing one part of cement and one part of fine sand to a creamy con-

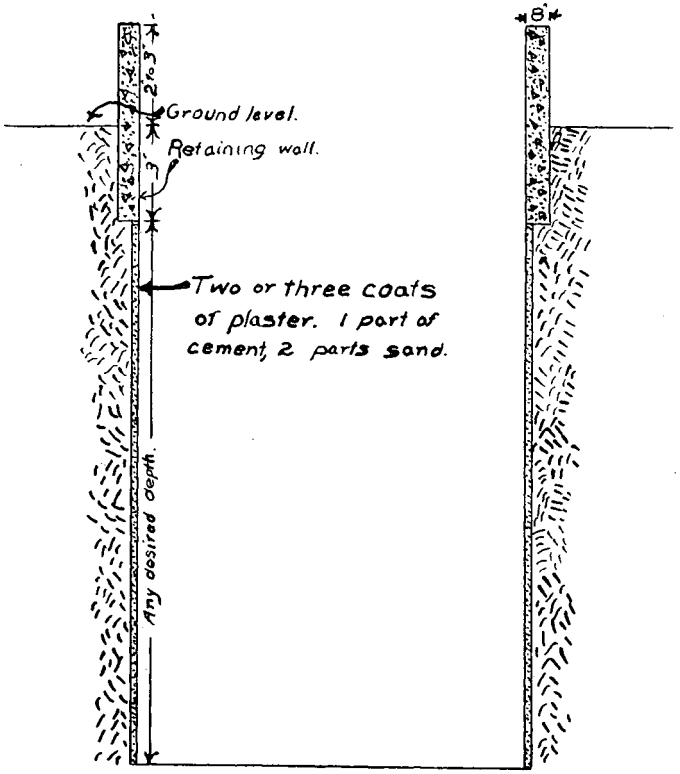

Figure 3.—Section Through Pit.

sistency. Another five or six feet of dirt is then removed and the walls plastered, as described above. This process is continued until the desired depth is reached. The bottom of the pit should not be plastered, as the dirt bottom is more desirable than a concrete one. Figure 5 shows a cross-section through the center of the pit.

Hoisting the Dirt.—There are several methods used in hoisting the dirt out of the pit. Figure 6 illustrates a method, where a common hay fork carrier is used. The rail is fastened to a 2″x8″, supported by

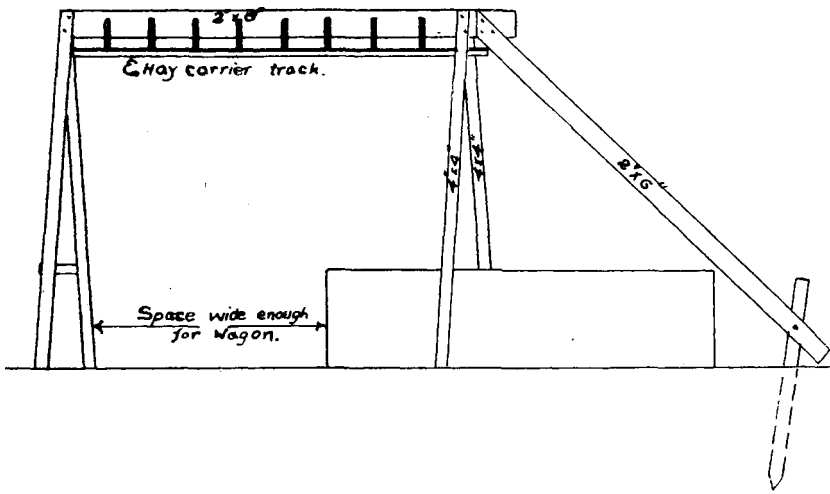

Figure 6.—Derrick For Hoisting Dirt.

tripods at each end. The 2″x8″ should extend beyond the pit far enough to allow a wagon to get between it and the tripod. The dirt is then hoisted, dumped into a wagon and hauled away. Another type of derrick is shown in Figure 1.

The container in which the dirt is hoisted can be made from a wooden oil barrel sawed in halves. The supports should be fastened below the center, as shown in Figure 7. This will make dumping easy. A square box properly braced, with a hinged bottom can also be used.

Removing the Ensilage.—The construction of an efficient hoist will reduce time and labor in removing the ensilage. Figure 1 illustrates a type of hoist that is used a great deal. The upright or mast may be made of a 4″x6″ piece or two 2″x8″ pieces. The top and bottom are made so that the crane can be turned and the upright should be securely fastened from the top by means of guy wires. A hand windlass may be placed on the upright or a set of pulleys may be used and the ensilage hoisted with a horse or team. A cart for hoisting ensilage can be made as illustrated in Figure 8. The cart is filled with ensilage and then hoisted to the top of the silo. The crane is then turned and the cart lowered to the ground and wheeled on planks to the feeding troughs.

Several companies manufacturing barn equipment make hoists which can be attached to an ordinary gas engine. By securing one of these, the gas engine can be used for hoisting ensilage providing it is three horse-power or larger.

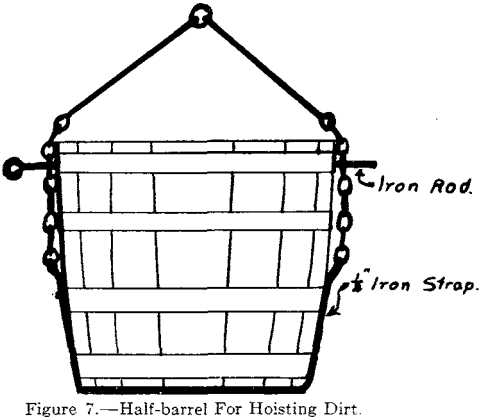

Figure 7.—Half-barrel For Hoisting Dirt.

Size of the Silo.—The size of silo to construct depends upon the number of cattle to be fed and upon the length of the feeding season. In order to keep the ensilage fresh after feeding has begun, a depth of at least two inches should be removed daily. The diameter, therefore, depends upon the amount of the ensilage to be fed each day.

Table I shows the number of animals which should be fed from the silos of various diameters in order to remove two inches of ensilage daily, when various quantities are fed.

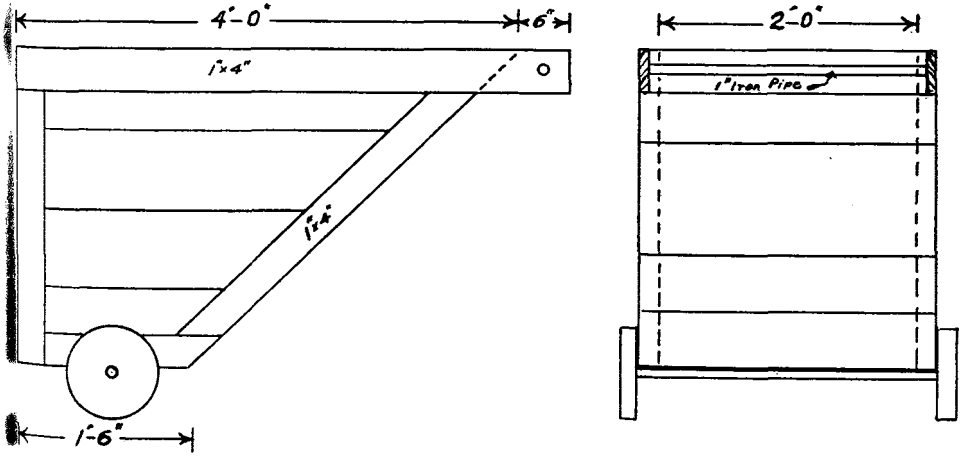

Figure 8.—Cart For Hoisting Silage.

The depth of the silo will depend upon the length of the feeding season. Table III gives the tonnage at various depths of different-sized silos.

TABLE I—Relation of Herd to Diameter of Silo

Diameter of Silo	Pounds Removed	NUMBER OF ANIMALS FEEDING VARIOUS QUANTITIES					
		40 Lb. Per Head	30 Lb. Per Head	25 Lb. Per Head	20 Lb. Per Head	15 Lb. Per Head	5 Lb. Per Head
10 Ft.	523	13	17	21	26	35	105
12 Ft.	754	19	25	30	38	38	151
14 Ft.	1,030	26	34	41	51	69	206
16 Ft.	1,340	33	44	54	67	88	268
20 Ft.	2,100	52	70	84	105	140	420

Materials Required.—Table II shows the amount of material needed for the retaining wall, six inches in thickness, and for the plastered wall, approximately one inch in thickness, for each foot in depth.

In order to find the total amount needed for any item, multiply the depth in feet by the figure found opposite the item desired and under the number representing the diameter of the silo. Suppose we wish to find the material needed for a pit silo 10 feet in diameter and 20 feet deep. The retaining wall is to extend 3 feet below the surface, leaving

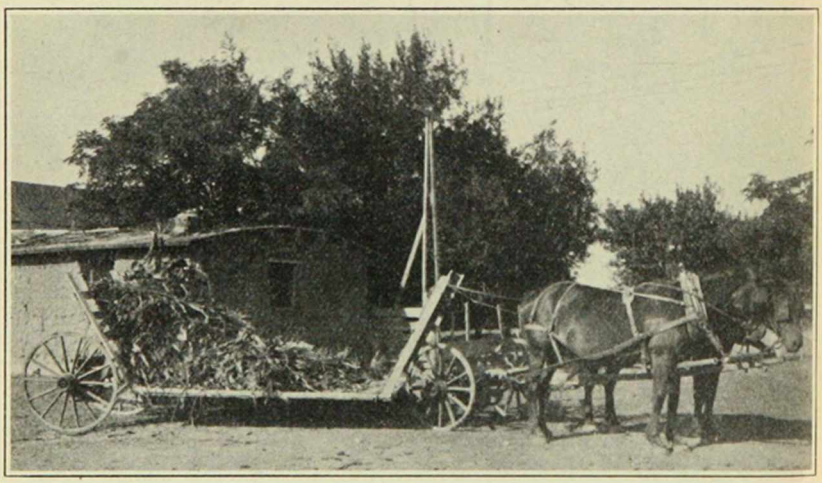

Figure 9.—Wagon For Hauling Green Corn From Field.

17 feet of the wall to be plastered. In figuring the retaining wall and referring to Table II, Column 10, representing the diameter of the silo, we find that it takes 3.3 sacks of cement, 0.30 cubic yards of sand and 0.60 cubic yards of gravel for each foot in depth. Multiplying these numbers by the depth of the retaining wall, which is 3 feet, gives the total for each of the materials in the retaining wall.

Figuring the materials for plastering, we use the figures in Table II,

under the heading "Mortar for Wall," and under Column 10. According to this Table, it takes 1.2 sacks of cement and 0.094 cubic yard of sand for each foot in depth. Multiplying these numbers by the depth of the plastered wall, which is 17 feet, gives the total for each of the materials in the plastered wall. Completing the procedure as indicated above, gives:

Materials for Retaining Wall:

Cement 3′×3.3 sacks=9.9 sacks.
Sand 3′×0.3 cu. yds.=0.9 cu. yds.
Gravel 3′×0.6 cu. yds.=1.8 cu. yds.

Materials for Plastered Wall:

Cement 17′×1.2 sacks=20.4 sacks.
Sand 17′×0.094 cu. yds.=1.59 cu. yds.

TABLE II—Amount of Material Needed for Each Foot in Depth. Retaining Wall, 6″ in Thickness; Plastered Wall, 1″ in Thickness

DIAMETER OF SILO IN FEET ☞		8	10	12	14	16	18
Retaining Wall 1:2½:5	Cement, Sacks	2.6	3.3	3.9	4.5	5.2	5.8
	Sand, Yards	0.24	0.30	0.36	0.42	0.48	0.54
	Gravel, Yards	0.49	0.60	0.72	0.84	0.96	1.08
Mortar for Wall	Cement, Sacks	0.9	1.2	1.46	1.710	1.95	2.20
	Sand, Yards	0.075	0.094	0.11	0.132	0.150	0.169

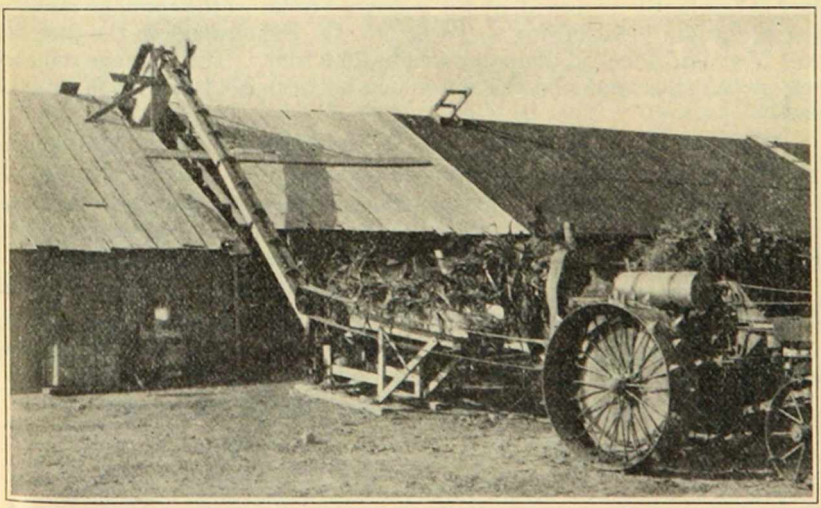

Figure 10.—Filling Pit Silos on Substation Farm, Cheyenne Wells.

Estimating Weights of Silage.—It is very difficult to estimate the capacity of a silo with any degree of accuracy, because there are so many factors involved. When filling is completed, the weight of silage per cubic foot will depend upon:

1.—Depth of silage.
2.—Moisture content.
3.—Proportion of grain to fodder.
4.—Thoroughness of packing.
5.—Rate of filling.
6.—Diameter of silo.

In 1917 the Nebraska Experiment Station published a circular which gives the average weight of a cubic foot of ensilage at different depths when filling is completed. Table No. III is taken from this circular and gives the capacity of different sized silos at different depths after filling is completed.

The Kansas Station published Bulletin No. 222 in 1919, which gives the weights of settled ensilage. The data were obtained jointly by the Missouri and the Kansas Agricultural Experiment Stations. Table No. IV is taken from this bulletin and gives the capacity of different sized silos at different depths after the ensilage had completely settled.

In either of these tables, the depth of ensilage rather than the height of the silo should be taken. If a portion of the ensilage has been removed, the best plan is to estimate the tonnage before any was removed and then the amount removed. The difference should be the amount on hand. For example, 28 feet of ensilage in a silo 14 feet in diameter is estimated by Table IV to weigh 83.4 tons. Suppose ten feet of ensilage is removed, and it is desired to know the tonnage remaining in the silo. According to Table No. IV, the ensilage in the first ten feet of a silo 14 feet in diameter weighs 26.9 tons. The tonnage remaining in the silo would be the difference between 83.4 and 26.9, or 56.5 tons.

When extreme conditions prevail, the Kansas bulletin 222 recommends that the following allowances be made.:

1.—When the corn is put into the silo in a less mature condition than usual, for example, in the milk stage, or at the beginning of the dough stage, add 10 to 15 percent to the weights given in the table.

2.—If the grain is unusually heavy in proportion to the stalk, add 5 to 10 percent to the figures as found by the table.

3.—If the corn is considerably past the usual stage of maturity and clearly contains less water than usual, deduct 10 to 15 percent.

4.—If very little or no grain is present, deduct 10 percent.

TABLE III—Estimated Tonnage of Silage at the Time Filling is Completed*

Depth of Silage	Average Weight Per Cu. Ft.	DIAMETER OF SILO IN FEET					
		10 Ft.	12 Ft.	14 Ft.	16 Ft.	18 Ft.	20 Ft.
Feet	Pounds	Tons	Tons	Tons	Tons	Tons	Tons
1	16.13	0.6	1.0	1.2	1.6	2.1	2.5
2	16.89	1.3	1.9	2.6	3.4	4.3	5.3
3	17.64	2.1	3.0	4.2	5.3	6.7	8.3
4	18.38	2.9	4.2	5.7	7.4	9.4	11.6
5	19.12	3.8	5.4	7.4	9.7	12.2	15.0
6	19.83	4.7	6.7	9.2	12.0	15.2	18.7
7	20.54	5.6	8.1	11.1	14.5	18.3	22.6
8	21.24	6.7	9.6	13.1	17.1	21.6	26.7
9	21.93	7.8	11.2	15.2	19.8	25.1	31.0
10	22.61	8.8	12.8	17.4	22.7	28.8	35.5
11	23.28	10.1	14.5	19.7	25.7	32.6	40.3
12	23.94	11.3	16.3	22.1	28.9	36.6	45.2
13	24.59	12.5	18.1	24.6	32.2	40.7	50.2
14	25.24	13.9	20.0	27.2	35.5	45.0	55.5
15	25.88	15.2	22.0	29.9	39.1	49.4	61.0
16	26.52	16.8	24.0	32.7	42.7	54.0	66.7
17	27.15	18.1	26.1	35.5	46.4	58.8	72.5
18	27.77	19.6	28.3	38.5	50.3	63.6	78.5
19	28.38	21.2	30.5	41.5	54.1	68.6	84.8
20	28.99	22.8	32.8	44.6	58.3	73.8	91.1
21	29.58	24.4	35.1	47.8	62.5	79.1	97.5
22	30.16	26.0	37.5	51.1	66.7	84.5	104.2
23	30.73	27.1	40.0	54.4	71.8	90.0	111.1
24	31.29	29.5	42.5	57.8	75.5	95.5	118.0
25	31.84	31.3	45.2	61.3	80.0	101.3	125.1
26	32.38	33.1	47.7	64.8	84.6	107.2	132.3
27	32.91	34.9	50.3	68.4	89.3	113.2	139.6
28	33.43	36.8	53.0	72.1	94.1	119.2	147.1
29	33.94	38.7	55.8	75.8	98.9	125.4	154.6
30	34.44	40.6	58.5	79.5	103.8	131.6	162.3
31	34.93	.....	61.3	83.4	108.8	137.9	170.1
32	35.41	.....	64.1	87.2	113.8	144.5	178.0
33	35.88	.....	67.0	91.1	118.9	150.8	186.0
34	36.34	.....	69.8	95.1	124.2	157.4	194.1
35	36.79	.....	.....	99.1	129.3	163.9	202.2
36	37.23	.....	.....	103.2	134.7	170.7	210.6
37	37.65	.....	.....	107.2	139.9	174.4	218.8
38	38.07	.....	.....	111.3	145.3	184.2	227.2
39	38.48	.....	.....	115.5	150.8	191.2	235.8
40	38.88	.....	.....	119.6	156.2	198.1	244.3

*Adapted from Nebraska Circular 1.

TABLE IV—Estimated Weights of Settled Silage*

Depth of Silage	Average Weight of Silage Per Cu. Ft. To This Depth	WEIGHT OF SETTLED SILAGE					
		10 Ft.	12 Ft.	14 Ft.	16 Ft.	18 Ft.	20 Ft.
Feet	Pounds	Tons	Tons	Tons	Tons	Tons	Tons
1	32.0	1.26	1.81	2.46	3.22	4.07	5.03
2	32.4	2.54	3.66	4.98	6.51	8.23	10.17
3	32.7	3.85	5.54	7.55	9.86	12.46	15.40
4	33.1	5.19	7.48	10.19	13.31	16.81	20.79
5	33.4	6.55	9.45	12.85	16.78	21.21	26.22
6	33.7	7.94	11.44	15.56	20.32	25.68	31.75
7	34.1	9.37	13.50	18.37	23.99	30.31	37.48
8	34.4	10.80	15.56	21.19	27.66	34.95	43.21
9	34.7	12.26	17.66	24.04	31.39	39.66	49.03
10	35.0	13.74	19.79	26.95	35.18	44.45	54.95
11	35.3	15.25	21.95	29.89	39.02	49.31	60.96
12	35.6	16.77	24.15	32.89	42.93	54.25	67.07
13	35.9	18.32	26.38	35.93	46.90	59.27	73.27
14	36.2	19.90	28.65	39.02	50.93	64.36	79.57
15	36.4	21.44	30.88	42.04	54.87	69.34	85.72
16	36.7	23.05	33.21	45.21	59.01	74.57	92.19
17	36.9	24.63	35.47	48.30	63.04	79.67	98.49
18	37.1	26.22	37.76	51.42	67.11	84.81	104.84
19	37.3	27.83	40.07	54.56	71.22	90.00	111.27
20	37.5	29.45	42.41	57.75	75.38	95.25	117.75
21	37.6	31.00	44.65	60.79	79.35	100.28	123.97
22	37.8	32.65	47.02	64.03	83.58	105.61	130.56
23	38.0	34.32	49.41	67.29	87.84	110.50	137.22
24	38.1	35.90	51.70	70.40	91.90	116.13	143.56
25	38.3	37.60	54.15	73.72	96.23	121.60	150.33
26	38.4	39.20	56.46	76.87	100.34	126.80	156.75
27	38.6	40.92	58.94	80.24	104.74	132.36	163.63
28	38.7	42.55	61.28	83.43	108.90	137.62	170.13
29	38.9	44.30	63.79	86.86	113.37	143.27	177.11
30	39.0	45.94	66.08	90.09	117.59	148.59	183.69
31	.....	47.63	68.51	93.40	121.90	154.06	189.94
32	.....	49.32	70.94	96.71	126.21	159.53	196.19
33	.....	51.01	73.37	100.02	130.52	165.00	202.44
34	.....	52.70	75.80	103.33	134.83	170.47	208.69
35	.....	54.39	78.23	106.64	139.14	175.94	214.94
36	.....	56.08	80.66	109.95	143.45	181.41	221.19
37	.....	57.77	83.09	113.26	147.76	186.88	227.44
38	.....	59.46	85.52	116.57	152.07	192.35	233.69
39	.....	61.15	87.95	119.88	156.38	197.82	239.94
40	.....	62.84	90.38	123.19	160.69	203.29	246.19

*Kansas Bulletin 222.