EXPERIMENTS WITH SILOS AND SILAGE.

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INTRODUCTION.

It is claimed that the first silo in the United States was built in Michigan in 1875. However it is only recently that their use has become general. For a long time they were considered of value only to dairymen but within the last few years many beef cattle men are feeding silage. In the last year or two there has been an enormous increase in the number of silos. The Orange Judd Farmer recently made a careful estimate of the silos in the Central Valley States and reported that the number had doubled within the last two years. They reported the total number of silos in use in Missouri on Jan 1, 1914 as 6726, the silos built during 1913 as 2679 and the average capacity as 110 tons.

Several advantages of silos are generally recognized. A large % of the food value of the corn plant is in the stalk and blades. By ensiling the whole plant the stalk and blades are saved whereas with the old custom of allowing the stalks to remain out in the shocks or standing in the field a large part of the food value was leached out. The whole plant is removed from the field as soon as it is mature leaving the field clear for other crops. Labor can be used to the best advantage in harvesting corn for the silo as the crew can be organized to good advantage and teams and machinery used to advantage. Succulent feed is provided for seasons when it is not naturally obtainable thus supplying a very important element in the ration. The labor of feeding is lessened and made more agreeable by feeding the corn plant in the form of silage.

With the increasing use of silage a number of questions have risen regarding it. For example, what is the significance of temperature? High temperatures are observed at the surface of the silage. There is a question whether this temperature prevails thruout the silage, at different depths and different distances from the wall, how the different kinds of silos and different kinds of corn affect it and what relation does it bear to the quality of the silage?

There is the question of the relation of moisture and acidity in silage to its keeping and feeding qualities, and as to the % of moisture and acidity at different sections of the silage in different kinds of silos and in different kinds of corn.

With a number of different kinds of silos in use there is a question as to the value of different kinds of silos for preserving silage.

With a need of experimental work in silage there arises the question of the reliability of small silos for experimental purposes.

Recognizing the advantage of succulent feed and of filling the silo more than once during the season and the possibility of the fodder drying out before the silo can be filled the question has arisen as to the best method of making silage of dry fodder and as to its advisability.

There is a question as to the claims made concerning a loss in weight in silage.

In order to estimate the amount of silage remaining in a silo there is a need to know the weight per cu ft at the various depths.

With the difficulty of curing the first cutting of alfalfa clover on account of wet weather during the first cutting the question has arisen as to the possibility of ensiling these crops.

The Dairy Department of the Missouri Agricultural College carried on a series of experiments with the silage during the winter of 1913- 1914, with the object in view of answering these questions as far as possible.

DESCRIPTION OF SILOS, CORN USED AND FILLING.

The iron silo used in the experiment is used for beef cattle feeding experiments and is located at the University cattle feeding sheds. It is 12 ft in diamenter and 26 ft in height and sets 4 feet in the ground. The part above ground is made of sheet iron bands about 3 ft in width riveted together.

It was filled August 28th and the morning of the 29th, 1913 with corn in about the right stage for silage so no water was added. The silage was tramped well at filling and again over the surface several times soon after it was filled.

The Concrete silo No 1 used in the experiment is the North silo at the dairy barn. It is 16 ft in diamenter and 33 ft high. The walls are made of solid concrete 6 inches thick. It has a concrete floor and sets about 5 ft in the ground. The concrete used was a mixture of crushed limestone, sand and cement. It was filled Sept. 1st, 2nd and 3rd 1913. The corn was not of good quality on account of the drouth. Some of thestalks were a little too green and some were a little too dry. Water was run into the blower all the time it was filling. The filling was properly carried out and the silage thoroughly tramped.

The concrete silo No 2 used in the experiment is the South Concrete silo at the dairy barn. It is similar in construction to concrete silo No 1 It was filled about 2/3 full Sept 4th and 5th 1913 of the same kind of corn and in the same manner as concrete silo No 1. The filling was finished Sept 9th and 10th with corn which was rather green and no water was used on it. The silage was well tramped.

The Gurler silo used in the experiment is located on a farm about 5 miles North-East of Columbia. It is 14ft in diamenter and about 30 ft high. It has been used several years and the plastering on the inside of the wall is cracked in places. The corn that was put in was quite dry and water was run into the blower but as the water had to be hauled from a pond not enough was added. The wall was kept wet down as well as possible. The silage was tramped well.

The stave silo used in the experiment was the Stave silo on the farm of the Conley dairy Co about 2 miles West of Columbia. It is 18 ft in diamenter and about 30 ft high. It is a typical stave silo. The filling was started Sept 1st and lasted several days. The corn was fairly dry, no water was added and it was tramped very slightly.

The experimental silos used were stave water tanks 3 ft in diamenter and 6 ft high and made of 2 inch white pine. They were set in the silage room of the dairy barn for protection from the cold. Tops were made of such size that they could easily settle down into the silos as the silage settled under the pressure applied to the tops. The silo on the North side of the room was designated Experimental silo No 1 and the silo on the

South, Experiment silo No 2.

TEMPERATURES IN SILAGE.

Object.

The object of this experiment was to determine the temperatures in silage under different conditions, as at different distances from the wall, at various depths, in different kinds of silos and in different kinds of silage, and to determine in general if possible the significance of temperatures in silage. The fact that high temperatures prevail at the surface of the silage has led to the general conclusion that high temperatures prevail throughout the silage and it is sometimes claimed that high temperatures are necessary to properly preserve silage. Some agents for stave silos go so far as to claim that concrete silos absorb heat from the silage and so injure it.

Literature.

Storrs experiment station (1) gives results covering 5 years time of temperatures taken with an ordinary thermometer near the top of the silage and with maximum thermometers buried in the silage. They report that high temperatures were formed only where the surface was exposed to the air and then that the high temperatures reached no further than a foot from the surface. The highest temperature found was 126 degrees F. Through the interior mass the highest temperature found was less that 86 degrees F. During one filling of the silo 5 maxium thermometers were buried in the silage. Each was separated from the other by 20 tons of silage and were all placed half way between the center and edge of the silo. Two had been recovered and registered 80.6 degrees F. and 80.4

degrees F. respectively. Above the first thermometer was about 40 tons of silage and above the second was about 60 tons.

Delaware experiment station (1) reports temperatures taken in silage made of shock corn. The silo was rectangular 7x8x28 feet. About 9000# of fodder were put into the silo Feb. 26. The next day 3570# of water at a temperature of 52 degrees were pumped on. On Mar.2nd tubes were driven thru the walls of the silo into the center of the silage at different distances from the surface of the silage and temperatures were taken with a chemical thermometer. On Mar 2nd 3070# of water were added. The silage came out in good feeding condition. The temperatures observed were as follows:

Feet below surface	Temperatures Mar 2	Mar 3	Mar 4
5	149	122	140
12	125	140	140
18	77	122	131

New Hampshire experiment station (2) took temperatures with an electrical appratus in 2 silos 13x14x30 feet. Five electrodes were used and were installed at different places during the filling. The maximum temperatures and the time after installation were as follows:

Electrode	Max. Temp	Days after Installation
No 1	118.4 degrees F.	0
No 2	105.0	26
No 2	100.4	3
No 4	103.0	44
No 5	127.4	5

The high temperatures of electrodes No 1 and 5 were due to their being near the surface.

Oregon experiment station (3) took temperatures near the top

(2) Bulletin 57, 1900 (3) Annual report 1902 (1) Report 1903

and at the center of three silos 12 x 5 feet. The maximum temperatures and time after installation were as follows:

	Max Temp			Days after installation
Silo No 1 at top	120	degrees	F.	8
.. .. ..at center	76	..	..	13
Silo No 2 at top	130	..	..	5
.. .. ..at center	80	..	..	7
Silo No 3 at top	120	..	..	5
.. .. .. at center	66	..	..	5

Wisconsin experiment station (1) took temperatures in 2 iron receptacles 1 1/2 x 4 ft. The maximum temperature of 122 degrees F. occured the 10th day after opening the receptacles.

Plan of Experiment.

The temperatures at the surface of the silage were taken by pushing the maximum thermometer down into the silage till the bulb was at the desired depth then drawing it out to read after it had registered.

The temperature down in the silage were taken with an electrical thermometer because of its accuracy. However it was expensive and a comparative test was made with an inexpensive method which consisted in taking the temperatures in pipes with a maximum thermometer. If this method is accurate it is inexpensive. The pipes used were placed in concrete silo No 1. They extended from the floor to the top of the silo, one being against the wall

(1) Report 1901. pp 177-184

and one in the center of the silo. The pipes were half inch gas pipes and had joints each 3 ft so that as the silage was fed out the three foot lengths were removed in order to keep the top of the pipe in easy reach. The maximum thermometer used was about a foot long and quite small in diamenter so that it could be quite easily raised and lowered in the pipe by a cord. The readings were taken at 8, 13 and 19 ft from the bottom so as to be comparable with the readings taken at the center of the silo by the electrical thermometer. The thermometer was suspended 10 minutes at the desired depth to register.

For taking the temperatures with the electrical apparatus a resistance bulb was buried at each place in the silage where the temperature was desired. Three wires extended from each bulb to the surface of the silage and the temperature was read on an indicator to which these wires were attached when the temperature was taken. Lest these bulbs or wires should be affected by the moisture in the silage or injured in throwing out the silage they were enclosed in half inch gas pipe. The pipe was placed against the wall extending from the top of the silo to the depth where the temperature was desired and from the lower end of this pipe a similar pipe extended to the center of the silo. One bulb was placed at the lower end of the perpendicular pipe to give the temperature at the wall, and one at the inside end of the horizontal pipe to give the temperature at the center of the silo. These pipes were put in as the silos were filed.

One pair of bulbs was put in the iron silo 8 ft below the surface of the silage. Three pairs were put in concrete silo No 1 at a distance of 23, 16 and 9 respectively below the surface of the silo. One pair was put in concrete silo No 2 about 22 feet below the surface of the silage. One pair was put in each of the experimental silos at about the middle of each silo. Two pairs were put in the Gurler silo 18 and 10 feet respectively below the surface of the silage. Two pairs were put in the stave silo 18 and 10 feet respectively below the surface of the silage. The bulbs settled with the silage, but not enough to make any perceptable difference in the readings.

Temperatures at the Surface.

The highest temperatures found were near the surface of the silage. Soon after finishing filling concrete silo No 1 Sept 3, the temperature taken at 4 inches below the surface was 130 degrees, Twelve days later temperatures taken 4 and 10 inches below the surface of the silage were 122 degrees and 128 degrees respectively. The rotten silage was thrown off the top and feeding of the silage in concrete silo No 1 began Feb 27. The silage was rotten for about one foot from the wall to a depth about 4 ft, and for about 1 1/2 feet deep over the remainder of the surface. The temperature taken about 1 1/2 feet from the west wall and 10 inches below the surface of the good silage was 87 degrees. A reading taken near the center and 9 inches below the surface of good silage was 107 degrees. Two readings taken near the center and just where the silage was rotting worst were 117 degrees and 122 degrees.

In concrete silo No 2 when the spoiled silage was taken off to finish filling, the temperature 9 inches below the surface of the good silage was 119 degrees. Some silage had been dug out from around the gas pipe and when thrown back was not packed well. The temperature a few inches below the surface of that was 128 degrees.

Table No 1

General temperature tables.

	Concrete silo No 1						Concrete		air (1)
	Bottom B.		Middle B		Top B		Silo No2		
	Wall	Cen	Wall	Cen	Wall	Cen	Wall	Cen	
Date put in	9/1	9/1	9/2	9/2	9/3	9/3	9/4	9/4	
9/3 12:30 P.M.	92	90	96	96					100
2/4 8:15 A.M.	92	92	98	100	95	9[illegible]			82
9/4 2:45 P.M.	99	95	100	98	101	96			100
9/4 6:00 P.M.	102	96	102	96	102	97			94
9/5 7:45 A.M.	97	97	99	98	98	98			81
9/6 7:45 A.M.	96	99	98	100	97	98			79
9/6 5:15 P.M.	98	100	99	100	100	99	101	99	86
9/7 7:00 A.M.	92	100	96	101	94	99	98	102	74
9/8 8:30 A.M.	92	101	96	102	94	101	98	103	78
9/8 12:00	92	101	95	102	94	100	97	103	90
9/8 5:00 P.M.	93	101	95	102	94	100	100	103	77
9/10 12:00	88	101	89	102	89	101			89
9/12 9:30 A.M.	82	102	86	102	83	102		104	64
9/13 2:30 P.M.	79	102	81	102	80	102			71
9/14 10:00 A.M.	76	102	80	102	78	102			69
9/27 2:00 P.M.	66	102	65	102	65	103			68
9/29 3:00 P.M.	74	103	72	102	72	103	78	104	77
10/3 12:00	76	103	76	102	76	102	81	104	78
10/4 2:15 P.M.	76	102	76	102	76	102	81	104	72
10/7 4:30 P.M.	78	102	80	102	80	102	85	104	75
10/12 4:00 P.M.	76	101	75	101	76	102	81	104	76
10/17 9:00 A.M.	66	101	68	100	66	101	72	104	47

(1) Temperature recorded by Weather Bureau.

	Concrete silo No 1						Concrete Silo No 2		Air
	Bottom B		Middle B		Top B				
	Wall	Cen	Wall	Cen	Wall	Cen	Wall	Cen	
Date put in	9/1	9/1	9/2	9/2	9/3	9/3	9/4	9/4	
10/31 8:30 A.M.	47	98	50	98	49	98	55	100	29
11/7 12:00 M.	59	95	60	96	60	97	66	98	55
11/17 9:00 A.M.	47	94	50	95	50	95	54	96	42
12/2 3:00 P.M.	59	88	60	89	60	91	62		61
12/14 9:00 A.M.	50	85	50	85	51	88			45
1/6 3:00 P.M.	34	77	36	80	37	84			38
1/31 12:00 M.	40	70	40	73	42	80			37
2/9 8:30 A.M.	27	68	29	68	29	75			25
2/22 8:30 A.M.	36	63	38	68	41	75			36
3/9			40	64	43	74			35
3/10	42	59	41	65	46	74			40
3/13	38	58	40	64	44	73			46
3/16	53	60	54	64	56	70			48
3/25	50	59	50	60					60
3/31	56	58	58	60					57
4/11	48	53	48	58					
4/17	66	54							

	Iron S.		Stave silo				Gurler silo				
	Bottom B.		Bottom B		Top B.		Bottom B		Top B.		air
	Wall	Cen.	Wall	Cen	Wall	Cen	Wall	Cen	Wall	Cen	
Date put in	8/29	8/29	9/3	9/3	9/5	9/5	9/4	9/4	9/5	9/5	
8/30 11:00AM	80	78									91
8/31 2:00PM	99	76									102
9/1 12:15PM	97	79									101
9/2 6:25AM	82	80									77
9/2 2:15PM	99	80									100
9/2 7:00PM	104	78									90
9/3 7:20AM	81	81									76
9/3 2:20PM	104	80									100
9/4 9:15AM	86	82									93
9/4 2:15PM	105	82									100
9/4 4:30PM			109	104							99
9/5 7:45AM	87	82									81
9/5 12:30PM			106	107							98
9/6 7:45AM	83	84									79
9/6 11:30PM							102	112	112	102	90
9/7 7:00AM	79	85									74
9/7 3:30PM							104	111	108	108	91
9/7 6:00PM			102	110	86	108					82
9/8 8:30AM	83	84									78
9/8 12:00 M	94	85									90
9/8 5:00PM	87	84									77
9/9 9:00AM			100	110	76	109					72
9/10 12:00 M	87	86									89
9/10 4:00PM							99	109	114	111	90

	Iron S		Stave silo								
	Bottom B		Bottom B		Top B		Bottom B		Top B		
	Wall	Cen	Wall	Cen	Wall	Cen	Wall	Cen	Wall	Cen	air
Date put in	8/29	8/29	9/3	9/3	9/5	9/5	9/4	9/4	9/5	9/5	
9/12 9:30 A.M.	71	86									64
9/12 4:15 P.M.			94	110	75	110					70
9/13 2:30 P.M.	81	88									71
9/1410:00 A.M.	68	89									69
9/2910:00 A.M.			78	110	71	118					68
9/29 3:00 P.M.	88	97									77
10/312:00 M.	76	93									78
10/4 2:15 P.M.	77	93									72
10/7 4:30 P.M.	88	93	81	110	84	120					75
10/123:30 P.M.							89	111	104	109	76
10/124:00 P.M.	89	92									76
10/179:00 A.M.	59	92	74	109	49	119					47
10/254:00 P.M.							79	110			68
10/318:30 A.M.	41	90									29
10/314:00 P.M.							68	110			40
11/712:00 M.			63	104	56	116					55
11/179:00 A.M.	48	85									42
11/2812:00 M.			64	99							61
12/2 3:00 P.M.	64	82									61
12/149:00 A.M.	54	80									45

Temperatures as taken with the Electrical Thermometer and in Pipes.

Table No 2 gives a comparison of the readings taken by the electricial thermometer and thosetaken in pipes under similar conditions.

Of the three readings taken at 8 ft from the bottom of the silo the maximum thermometer was 1 degree above the electrical at the first reading, 3 degrees at the second reading and 1 degree at the third reading.

Of the 5 readings taken at 13 ft from the bottom of the silo, the maximum thermometer was the same as the electrical thermometer at the first reading, 1 degree above at the second reading, 2 degrees below at the third reading, the same at the fourth reading, and 1 degree below at the 5th reading.

Of the 3 readings taken at 19 ft from the bottom of the silo, the maximum thermometer was 3 degrees below the electrical thermometer at the first reading, 3 degrees below at the

Table No 2

Comparison of electrical and maximum thermometers.

Date	2/22	3/9	3/10	3/13	3/16
8 feet from bottom Electrical			59	58	60
8 feet from bottom Maximum			60	61	61
13 feet from bottom Electrical	68	64	65	64	64
13 feet from bottom Maximum	68	65	63	64	63
19 feet from bottom Electrical			74	73	70
19 feet from bottom Maximum			71	70	68

second reading and 2 degrees below at the third reading. This last reading was taken at less than a foot from the surface of the silage when the temperature of the air was much lower than that of the silage.

The maximum thermometer was uniformly slightly above the electrical thermometer at 8 ft from the bottom of the silo, was practically the same at 13 ft from the bottom, and was uniformly slightly lower at 19 ft from the bottom, but the differences were so very slight under the same conditions that the temperatures as given by the maximum thermometer were well within the limits of expermental error and accurate enough for all practical purposes.

No readings were taken in the pipe put in against the wall because at the time the readings were taken the temperature at the wall was lower than that of the air so that the readings could not be taken with a maximum thermometer. To take the temperature in silage when it is lower than the air in the silo it would be necessary to use a mimimum thermometer or one which registers so slowly that it could be pulled up and read before the reading could change perceptably.

Maximum Temperature at the Wall and at the Center of the Silos.

Table No 3 gives the maximum temperature at the wall and at the center of the silos as the readings were taken by the electrical thermometer. These temperatures as given are probably the maximum in every case though there is a possibility that readings were not taken when the temperature was at its maximum as may be observed by a study of the general temperature table No 1. For instance the maximum temperature at the center of the iron silo is given as 97 degrees on Sept 29th which was the 31st day after the bulb was put in. The temperature may possibly have been higher than that because no reading had been taken since the 16th day when the temperature was 89 degrees, so there is a possibility that the temperature had been higher and was on the decline when the temperature was taken Sept. 29th. However the rate of rise and

Table No 3.

Maximum temperatures at wall and center.

	Wall			Center		
	Temp	Date	Day after put in	Temp	Date	Day after put in
Iron silo	105	9/4	6th	97	9/29	31st
Concrete No.1						
Bottom bulb	1o2	9/4	3rd	103	9/29	28th
Middle bulb	102	9/4	2nd	102	9/8	6th
Top bulb	102	9/4	1st	103	9/27	24th
Concrete No 2	101	9/6	2nd	104	9/12	8th
Stave silo						
Bottom bulb	109	9/4	1st	110	9/7	4th
Top bulb	86	9/7	2nd	120	10/7	32nd
Gurler silo						
Bottom bulb	104	9/7	3rd	112	9/6	2nd
Top bulb	114	9/10	5th	111	9/10	5th
Exp. silo No 1	90	9/6	1st	94	9/7	2nd
Exp. silo No 2	86	9/11	2nd	90	9/11	2nd

decline in temperature was such as to warrant the conclusion that the temperature had never been much above 97 degrees. This seems still more likely when it is compared with the temperature at the wall where there can be no doubt that 105 degrees was the maximum temperature.

The same thing is true of the temperatures at the wall and at the center of concrete silo No 2 and at the wall and at the center of the top bulb in the Gurler silo.

The temperatures given by the top bulb at the wall in the stave silo were not correct because the wire had evidently been pulled till the bulb was above the silage so that the readings were merely that of the air in the silo. All other maximum temperatures given are undoubtedly correct.

It is generally thought from the high temperatures observed at the surface of the silage that high temperatures due to fermentation must prevail all through the silage. This was not found to be the case. The temperatures in the iron and concrete silos rose only slightly above 100 degrees, about the rise that would be expected from fermentation where there was only a little air. The temperatures in the stave and Gurler silos went higher, the temperature of the top bulb at the center of the stave silo having risen as high as 120 degrees. These higher temperatures were probably due to the fact that the silage was dry and not packed well so that more air was present to cause fermentation. That much air was present in the silage of the stave silo is proven by the fact that spots of mould were found all thru the silage.

The temperatures were lower in the experimental silos than in the concrete silos which contained the same kind of silage. This was likely due to the experimental silos cooling out so much faster than the concrete silos since they were small.

The fact that the silage in the experimental silo gave the same test for acidty and moisture as the silage in the concrete silos and that the cows relished it just as well tends to show that high temperatures are not at all necessary in silage. In fact the highest temperatures were in mouldy or rotten silage.

The table shows that that maximum temperatures at the wall and in the center of each silo are about the same except where other conditions may affect the temperatures.

The table shows also that the temperatures at the wall tend to rise to their maximum in a very few days, while those in the center tend to require a longer time in several cases requiring about a month.

Temperatures at the Center of the Silo at Different Depths.

Table No 4 shows the comparative temperatures at different depths in concrete silo No 1. It shows that the three bulbs started at 90 degrees or above and in 3 days has risen to about 100 degrees. In about 23 days more they had gradually risen to about 103 degrees. After that the temperature began gradually to decline till in about a month all 3 were at 98 degrees. Then that being about Nov. 1 they began to decline faster, the bottom bulb falling fastest and the top bulb slowest till on Mar. 13th the bottom bulb was 58 degrees, the middle bulb 64 degrees and the top bulb 73 degrees. On April 11th the bottom and middle bulbs were still lower. the top bulb having been taken out.

Temperatures in the center of Concrete silo No 1 at different depths. Table No 4.

Date	Bot	Mid.	Top.
9/3 12:30 P.M.	90	96	
9/4 8:15 A.M.	92	100	98
9/4 2:45 P.M.	95	98	96
9/4 6:00 P.M.	96	96	97
9/5 7:45 A.M	97	98	98
9/6 7:45 A.M.	99	100	98
9/6 5:15 A.M.	100	100	99
9/7 7:00 A.M.	100	101	99
9/8 8:30 A.M.	101	102	101
9/8 12:00 M.	101	102	100
9/8 5:00 P.M.	101	102	100
9/10 12:00 M.	101	102	101
9/12 9:30 A.M.	102	102	102
9/13 2:30 P.M.	102	102	102
9/14 10:00 A.M.	102	102	102
9/27 2:00 P.M.	102	102	103
9/29 3:00 P.M.	103	102	103
10/3 12:00 M.	103	102	102
10/4 2:15 P.M.	102	102	102
10/7 4:30 P.M.	102	102	102
10/12 4:00 P.M.	101	101	102
10/17 9:00 A.M.	101	100	101
10/31 8:30 A.M.	98	98	98
11/7 12:00 M.	95	96	97
11/17 9:00 A.M.	94	95	95
12/2 3:00 P.M.	88	89	91
12/14 9:00 A.M.	85	85	88

Temperatures in the center of concrete silo No 1 at different depths. Table No 4.

Date	Bot	Mid	Top
1/6 3:00 P.M.	77	80	84
1/31 12:00 P.M.	70	73	80
2/9 8:30 A.M.	68	68	75
2/22 8:30 A.M.	63	68	75
3/9		64	74
3/10	59	65	74
3/13	58	64	73
3/16	60	64	70
3/25	59	60	
3/31	58	60	
4/11	53	58	
4/17	54		

In the stave silo the temperatures in the center at different depths were not so nearly paralell in their variations as in the concrete silo tho they varied in the same directinn as shown by table No 5

Table No 5. Temperatures in the center of the stave silo at different depths.

Date	Bottom B.	Top B.
9/4	104	
9/5	107	
9/7	110	108
9/9	110	109
9/12	110	110
9/29	110	118
10/7	110	120
10/17	109	119
11/7	104	116
11/28	99	

The high temperatures were probably caused by the presence of air in the silage as indicated by the spots of mould in the silage. While the bottom bulb reached its maximum temperature and held it a long time the top bulb reached its maximum on the 33rd day. As far as the readings showed the temperatures at the different depths began to decline at about the same time and rate.

The temperatures at the different depths in the center of the Gurler silo had no apparent relation.

We may conclude that the temperature, for all practical purposes, is the same at all depths except at very near the surface.

Temperatures at the Walls and at the Center of the Iron Silo and of Concrete Silo No 1.

Table No 6 shows that in the iron silo the temperature at the wall varied to a great extent with the outside temperature. While the temperature at the wall did not adjust itself quickly to a sudden change it did adjust itself to a temperature of a few hours duration. The temperature at the center of the iron silo did not vary at all with the outside temperature.

In concrete silo No 1 the temperature neither at the wall nor in the center varied with the outside temperature. The temperatures at the center continued their steady incline and the temperatures at the wall their steady decline regardless of the outside changes in temperature with the time of day.

While the outside temperature had an almost immediate effect on the temperature near the wall of the iron silo it had a very slight effect on that near the wall of the concrete silo.

Table No 6. Temperatures at the walls and at the center of the iron silo and of concrete silo No 1.

Date		Iron silo		Concrete silo No 1		air
		Wall	Cen.	Wall	Cen.	
9/1	12:15 P.M.	97	79			101
9/2	6:25 A.M.	82	80			77
9/2	2:15 P.M.	99	80			100
9/2	7:00 P.M.	104	78			90
9/3	7:20 A.M.	81	81			76
9/3	2:20 P.M.	104	80			100

Table No 6 Temperatures at the walls and at the center of the iron silo and of concrete silo No 1

Date		Ironsilo Wall	Ironsilo Cen	Middle bulb Concretesilo No 1 Wall	Middle bulb Concretesilo No 1 Cen	Air
9/6	7:45 A.M.			98	100	79
9/6	5:15 P.M.			99	100	86
9/7	7:00 A.M.			96	101	74
9/8	8:30 A.M.			96	102	78
9/8	12:00 A.M.			95	102	90
9/8	5:00 P.M.			95	102	77

Temperatures at the Walls in Different Kinds of Silos.

The claim is made by advocates of stave silos that stave silos hold the heat better than do concrete silos.

Table No. 7 shows the comparative temperatures at the walls of the concrete and stave silos from Sept 4th till Dec 2nd when the electrical bulb was removed from the stave silo. The temperatures given in the table are those of the bottom bulb in the stave silo and of the middle bulb in concrete silo No 1, concrete silo No 2 having only one bulb at the wall.

The table shows that the temperatures at the wall in the three silos varied in the same direction and in practically the same amount.

While the weather was cold enough to freeze silage a careful inspection of the silage in the stave silo and concrete

Table No 7. Temperatures at the wall of the concrete and stave silos.

Date	Concrete silo No1	Concrete silo No2	Stave silo
9/4	102		109
9/5	99		106
9/6		101	
9/7			102
9/8	95	98	
9/9			100
9/12	86		94
9/29	72	78	78
10/7	80	85	81
10/17	68	72	74
11/7	60	66	63
11/28			64
12/2	60	62	

silo No 2 showed the same amount of freezing, the freezing in neither case being serious.

The temperatures at the walls of the Gurler and iron silos showed the same general tendency as the stave and concrete silos though they do not make a good comparison because the readings in the Gurler silo were taken further apart and on different days from the other silos and the temperature at the wall of the of the iron silo fluctuated so closely with the outside temperatures that the readings are not properly comparable with the other silos.

Temperatutes of Green silage in Concrete and Experimental silos.

Table No 8 shows the comparative temperatures of green silage in experimental silos No 1 and No 2 and at the middle bulbs in concrete silo No 1.

The table shows that the temperatures both at the wall and at the center of the experimental silos varied in a general way with the temperatures at the wall of the concrete silo though they never rose as high and as a rule were a little lower till the latter part of October after which they were practically the same. The temperature in the experimental silos was always much lower than in the center of the concrete silo showing that the heat soon radiated from the experimental silos. The fact that the temperatures in the experimental silos rose slightly more at the center than at the wall at the start but in a very few days became practically the same and remained practically the same thereafter shows the same thing. However the fact that the silage in the experimental silos was similar to that in the concrete silo in percent of moisture and acidity and in apparant feeding value shows that there is no apparant injury to silage in loss of heat.

Temperatures in Shock Corn Silage in Experimental silos.

Table No 9 shows the temperatures in the experimental silos when they were filled with shock corn silage made by adding water to cut fodder. In each case the temperature rose slightly at the center for a few days after the silage was put in but there was no rise in temperature at the wall. When silo No.2 was filled Nov. 15 with silage made by adding 1 part of water to 2 parts fodder, the temperature was about 20 degrees above that of the air and this difference was maintained for several days but in 15

Table No 8.

Temperatures of green silage in concrete and experimental silos.

Date	Concrete silo No1		Exp. silo No 1		Exp. silo No 2		Air
	Wall	Cen	Wall	Cen	Wall	Cen	
9/6 7:45 AM	98	100	88	92			79
9/6 5:15 PM	99	100	90	93			86
9/7 7:00 AM	96	101	88	94			74
9/8 8:30 AM	96	102	87	94			78
9/8 12:00 M	95	102	88	93			90
9/9 5:30 PM			85	92	82	81	83
9/10 12:00 M	89	102	83	90	84	86	89
9/12 9:30 AM	86	102	76	85	82	90	64
9/14 10:00 AM	80	102	73	80	76	85	69
9/27 2:00 PM	65	102	62	65	64	66	68
9/29 3:00 PM	72	102	66	64	66	66	77
10/3 12:00 M	76	102	66	66	67	68	78
10/4 2:15 PM	76	102	68	67	69	67	72
10/7 4:30 PM	80	102	73	70	73	70	75
10/12 4:00 PM	75	101	69	70	69	70	76
10/19 9:00 AM	68	100	65	68	66	68	47
10/31 8:30 AM	50	98	49	52	49	52	29
11/7 12:00 M	60	96	56	54	58	54	55
11/17 9:00 AM	50	95	53	54			42
12/2 3:00 PM	60	89	60	60			61
12/14 9:00 AM	50	85	50	50			45
1/6 3:00 PM	36	80	40	40			38
1/31 12:00 M	40	73	44	48			37

Table No. 9

Temperatures in shock corn silage in experimental silos.

Date	Silo No 2 Wall	Silo No 2 Cen	Silo No1 Wall	Silo No1 Cen	Silo No 2 Wall	Silo No 2 Cen	Air
11/15 9:00P.M	60	62					42
11/16 8:45A.M	60	62					42
11/16 5:00P.M	59	63					47
11/17 9:00A.M	59	64					42
11/18 8:00A.M	60	63					57
11/19 5:00P.M	63	63					70
11/24 5:30P.M	61	66					52
12/1 4:00P.M	62	62					58
12/2 3:00P.M	62	62					61
12/14 9:00A.M	52	52					45
1/6 3:00P.M	40	42					38
2/25			42	46	40	40	19
2/26			41	48	39	44	34
2/27			42	46	42	44	44
3/2			40	45	40	45	29
3/5			43	43	44	44	40
3/10			44	44	42	43	40
3/13			44	44	44	44	48
3/25			50	46	52	46	60
3/31			59	57	59	57	57
4/11			48	52	48	50	
4/13			48	48	48	48	

days it had fallen to the temperature of the air. The temperature never rose above 66 degrees so very little fermentation took place. The silage came out in excellent condition without a sign of mould though rather dry, too dry for feed.

Both experimental silos were filled with shock corn silage February 25th during cold weather. The silage in experimental silo No 2 was made by adding 1 part of water to 1 part of fodder which had dried out in the loft. The silage in experimental silo No 1 was made of the same kind of fodder adding 1 3/4# water to 1# fodder. The temperatures in the two silos were practically the same. In both silos the temperature at the center was a little higher than that at the wall for a day or two, but they soon became about the same, 48 degrees was the highest temperature recorded till after the middle of March. The last of March the temperatures had risen to 59 degrees with the warm weather but had fallen to 48 degrees on April 13th when the silos were emptied. Although temperatures were very low the silage came out in good condition so it would appear that temperature has nothing to do with the keeping power of silage.

MOISTURE AND ACIDITY IN SILAGE.

Object.

The object of this experiment was to determine the % of moisture and acidity at different sections of the silage in different kinds of silos and in different kinds of corn, and to determine the relation of moisture and acidity to each other and to the keeping and feeding qualities of the silage. It is claimed by agents for stave silos that concrete silos absorbe moisture from silage. It is generally supposed that high moisture and acidity are necessary to preserve silage satisfactorily as acid preserves silage just as it preserves vinegar. It is thought by some that moisture tends to settle in silage making the drainage of silos necessary.

Literature.

No experiments appear to have been made to determine the necessary percent of moisture in silage. The analysis of the silage used in the feeding experiments of the dairy department of the Missouri Agricultural College since 1909 shows the following percents of dry matter: 29.29, 31.22, 27.56, 29.63, 29.99, 30.19, 29.82, 30.01, 30.90, 32.09, 33.45, 32.95, 31.85, and 30.95. These analyses show approximately the percentage of dry matter in average silage for 5 years.

Esten and Mason (1) tested the influence of temperature upon the fermentation of silage by using small samples placed at temperatures of 40, 50 and 70 degrees F. After 48 days the following results were obtained:

(1) Storrs Exp. Sta. Bul No. 70. 1912.

Temperature	% acidity
40 degrees	.57
50 ..	1.18
70 ..	1.89

The highest temperature favored the production of lactic and acetic acids; the medium of strong aromatic acids like propionic and butyric, the lower of destructive fermentation rather than acid production giving an unpleasant taste and odor.

They also for 2 years made acidity tests of silage taking the samples 5 feet from the bottom of the silo thru a hole in the wall. In both experiments the acidity gradually rose to about one percent in 5 days. In the first experiment it rose to 1.37% in 7 days, dropped to 1.2% on the 12th day and rose to 1.8% on the 95th day. In the other experiment it rose gradually to 1.89 % on the 17th day and dropped to 1.63% on the 35th day.

New Hampshire experiment station (1) found the following percents of acetic acid in silage made of different varieties of corn:

Sanford 1.5% in 1895 to 1.95% in 1897

Leaming 0.67% in 1896 to 1.47% in 1897

Mosby prolific 0.82% average 5 samples 1896

They also found that the acidity of the surface silage was usually lower than that of the silage 6 or 8 inches below the surface.

Oregon experiment station (2) reported the percent of acidity in steamed silage to vary from 0.30% to 0.88% with an

(1) Bulletin 56 pp 115-117

(2) Report 1905 pp 53-57

average of 0.53% while that of untreated silage varied from 1.ol % to 1.94% with an average of 1.58%

Plan of Experiment.

The moisture tests were made by taking samples of the silage at the desired sections in air tight weighed glass jars. These jars were then weighed with the silage in them to get the weight of the original silage. Then the silage was spread out in a mouse tight case where it would thoroughly air dry. The air dry silage was then weighed and the percent of air dry matter in the original silage estimated.

In making the acidity tests the samples were always taken under the same conditions as the samples for moisture tests so as to be comparative. They were usually taken in the same place and sometimes a part of the same sample was used. The same kind of sampling jar was used. Each sample was run thru a small cutter, which is used in cutting up hay for chemical analysis, till the silage was cut up fine. It was then spread out and a 100 gram portion taken for the acidity test. This portion was washed with distilled water and the washings titrated against a standard alkali till the last washing titrated the same as the blank which had been run on the distilled water. This usually required 4 washings with about 500 cc of water left on the silage for from 12 to 24 hours. Each washing was decanted into a suction filter, each filtrate usually being made to 500 cc and titrated immediately. If in titrating the end point was at all hard to determine the 500cc filtrate was divided into five 100cc portions and the average of the titrations taken. Where the washings were unusually cloudy they were washed over animal charcoal to remove the coloring matter. A molecular weight of 80 was assumed for the mixture of acids. The percentage of acids was calculated by reducing the titre obtained to normal alkali and multiplying the cc of normal alkali by .08 to obtain the weight of acids in 100 grams of silage. The weight of acids divided by the weight of silage gives the percent of acid.

Moisture and acidity tests were made at four different depths in concrete silo No. 2, near the center and at the wall. The first test was made near the top of the silo in the silage which was put in during the second filling. The second test was made 13 ft from the top of the silo where the silage was taken out to fill experimental silo No. 2. The third test was made at about 18 feet from the top of the silo. The fourth test was made about 23 feet from the top of the silo where the silage was taken out to fill experimental silo No. 1.

A moisture test was made of the green silage which was taken out of concrete silo No. 2 to fill experimental silo No. 2 and a moisture and acidity test was made of the silage at about the center of the silo as it was taken out of experimental silo No. 2.

A moisture test was made of the green silage which was taken out of concrete silo No. 2 to fill experimental silo No. 1. As the green silage was taken out of experimental silo No. 1 a moisture test was made of the rotten and mouldy silage at the top and moisture and acidity tests of the silage one foot from the top and at the bottom.

Moisture and acidity tests were made of the silage in the Gurler silo both near the center and at the wall after several feet of the silage had been fed out.

Similar tests were made in the stave silo.

A moisture test was made of the fodder which was used in making shock corn silage in experimental silo No 2 by adding 1 part of water to 2 parts of fodder and a moisture and acidity test was made of the silage as it was taken out.

A moisture test was made of the fodder which was used in making shock corn silage in experimental silo No 2 by adding 1 part of water to one part of fodder and in experimental silo No. 1 by adding 1 3/4 parts of water to 1 part of fodder. A moisture test was made as the silage was taken out of each silo.

A moisture test was made of the fodder which was used in making shock corn silage by adding different amounts of water to fodder in four iol cloth sacks which were buried in the silage in concrete silo No 2. A moisture and acidity test was made of the silage in each sack when it was taken from the silo.

A moisture test was made of the fodder which was used in a similar test, the sacks being buried in the silage in concrete silo No. 1.

When the silage was taken out of the silo a moisture test was made of the silage to which the least water was added and to which the most water was added.

A moisture test was made of green corn before it was laid on the ground to dry out in an experiment to test the effect of allowing corn to dry out on the ground before putting it into the silo.

A similar test was made of another lot of corn. A moisture test was made of silage which had been made of corn laid on the ground one day to dry and buried in an oil cloth sack in concrete silo No 1.

A moisture test was made of the silage in a tight can which was buried near the bottom of concrete silo No 2 to test the tendency of moisture to settle in silage.

A moisture test was made of alfalfa silage before it was put into an oil cloth sack to be buried in concrete silo No 2. When the silage was taken out a moisture and acidity test was made of the alfalfa silage both to which sugar had been added and to which sugar had not been added in making the silage.

Table No 10.

Total moisture and acidity determination	acidity %	Air dry Matter
Concrete silo No. 2 In second filling at center	1.83	30.6
Between 4 and 6 inches from the wall	1.79	30.2
Within 2 inches of the wall	1.64	30.7
Concrete silo No 2 13 ft from top of silo.		
Against southwest wall	2.19	29.33
Against southeast wall	2.22	33.33
Near center	2.84	31.55
Near center	2.38	30.29
Concrete silo No 2. 18 ft from top of silo		
Near center	2.16	30.64
Near center	2.24	33.58
Against wall	1.45	27.77
Against wall	1.59	35.35
Concrete silo No 2. 23 ft from top of silo		
Against wall	1.86	34.04
Near center	2.01	27.96
Experimental silo No. 2 Green silage.		
When put in		30.14
When taken out	2.19	31.88
Experimental silo No. 1 Green silage		
Rotten and mouldy silage on top		27.62
One foot from top of silage	1.71	31.02
At the bottom	1.90	30.33
When put in		32.38

	Acidity %	Air dry matter %	
Gurler silo			
Against northwest wall	.05	32.08	17 –
Against northeast wall	.0	31.29	18 –
Near center	1.04	40.23	19 –
Near center	1.02	40.75	20 –
Stave silo			
Against north wall	1.41	35.43	21 –
Against west wall	1.57	33.33	22 –
Near center	2.27	34.83	23 –
Near center	2.28	35.97	24 –
Shock corn S. 1 pt water to 2 pts fodder			
Dry fodder		79.40	25 +
Silage taken out	1.33	53.33	26 +
Shock corn S. 1 pt water to 1 pt fodder			
Dry fodder		93.51	27 +
Silage taken out near top		45.6	28 +
Silage taken out near bottom		41.3	29 +
Shock corn S. 1 3/4 pts water to 1 pt fodder			
Dry fodder		93.51	27
Silage taken out near top		38.5	30 +
Silage taken out near bottom		21.5	31 +
Shock corn silage buried in sacks			
Dry fodder		74.56	32 +
Silage 20# fodder to 6 3/4# water	.76	64.99	33 +
Silage 20# fodder to 9 1/4# water	1.19	49.88	34 +
Silage 20# fodder to 12 1/4# water	1.65	46.15	35 +
Silage 20# fodder to 20 3/4# water	1.81	37.69	36 +

	Acidity %	Air dry Matter %	
Shock corn silage buried in sacks			
Dry fodder		68.67	37 +
Silage 20# fodder to 5 1/2 water		56.6	38 +
Silage 20# fodder to 20# water		33.5	39 +
Green corn as put in silo		40.40	40 -
Green corn as put in silo		33.57	41 -
Silage from green corn laid on ground 1 day		43.80	42 +
Tight can, 28 ft from top of C. silo No 2		34.82	43 +
Alfalfa silage buried in sacks			
When put in		48.79	44 -
Alfalfa silage with sugar	1.46	42.33	45 +
Alfalfa silage without sugar	1.43	44.91	46 -
A. P James shock corn silage		64.68	47 +
C. A. Meritt shock corn silage		55.67	48 +
Say bean silage Brandt		34,47	49

Moisture and Acidity at Wall and in Center of Silos.

Table No. 11 gives the percentage of air dry matter and acidity at the wall and in the center of concrete silo No 2 at 4 different depths, of the stave silo and of the Gurler silo.

Table No. 11

Moisture and acidity at wall and in center of silos

	Acidity %		Air dry matter %	
	Wall	Cen	Wall	Cen
Concrete silo No. 2				
Near top in second filling	1.64	1.83	30.7	30.6
13 ft from top of silo	2.20	2.62	31.3	30.9
18 ft from top of silo	1.52	2.20	31.56	32.11
23 ft from top of silo	1.86	2.01	34.04	27.9
Gurler silo	.03	1.03	31.68	40.49
Stave silo	1.49	2.27	34.38	35.40

It shows in the concrete and stave silos that the per- cent of acidity was uniformly and perceptably lower at the wall than at the center of the silo though the difference was not such that it would be likely to have any effect on the keeping or feeding value of the silage. The fact that there was prac- tically no acidity at the wall of the Gurler silo was probably due to the fact that it was quite mouldy at the wall where the samples were taken.

As to the % of air dry matter it shows that at 3 depths in concrete silo No. 2 there was no perceptable difference at the wall and in the center. At one depth it was perceptably higher at the center than at the wall but the difference was not enough to be considered. In the stave silo also the percent of air dry matter at the wall and at the center was practically the same. In the Gurler silo the percent of air dry matter was much lower at the wall then in the center. This was due to the fact that the silage was quite dry when put into the silo and was wet down around the walls.

We may conclude that some acidity is lost at the wall but that practically no moisture is lost.

Green Silage in Concrete and Experimental Silos.

Table No. 12 gives the percent of acidity and of air dry matter in the green silage in the experimental silos and at the wall in concrete silo No. 2 where the silage was taken out to fill the experimental silos which was 13 feet from the top for experimental silo No. 2 and 23 ft from the top for experimental silo No. 1

Table No 12.

Green silage in concrete and experimental silos.

	% acidity		% air dry matter	
	Sample 1	Sample 2	Sample 1	Sample 2
Experimental silo No 1 at top	1.67	1.75	31.02	
Experimental silo No.1, Bottom	1.92	1.89	30.33	
Concrete silo No. 2	1.86		34.04	
Experimental silo No. 2	2.19	2.19	31.72	32.04
Concrete silo No 2 comparative	2.19	2.22	29.33	33.33

It shows that the silage in each experimental silo has practically the same % of acidity and air dry matter as the silage in the concrete silo where the silage was taken out to fill the experimental silos. So far as percent of acidity and air dry matter shows the small silos are reliable for experimental purposes.

Moisture and acidity in Shock Corn Silage.

Table No. 13 shows that silage made by adding 1 part of water to 2 parts of fodder as it came from the field had a low percent of acidity and a very high percent of air dry matter. Silage made by adding 1 part of water to 1 part of fodder which had dried out in the loft had a fair moisture content but not nearly that of normal silage. The determinations show that the water had settled to a slight extent in the silage. Silage made by adding 1 3/4 parts of water to similar fodder was, near the top of the silo, a little higher in percent of air dry matter then is normal silage, while near the bottom of the silo the percent of moisture is much higher than in normal silage showing that the water had settled in the silage to quite an extent and that the amount of water added was too great.

It shows that, of the silage made by adding varying amounts of water to fodder as it came from the field and burying it in sacks in concrete silo No 2, the silage made by adding 20 3/4# water to 20# fodder, gave practically a normal percent of acidity and of air dry matter. As less water was added the percent of acidity was decreased and the percent of air dry matter increased above that of normal silage.

The similar test where the sacks were buried in concrete silo No. 1 indicated the same thing as to percent of air dry matter.

Table No. 13.

Moisture and acidity in shock corn silage.

	Acidity %	Air dry matter %
Silage 1 part water to 2 parts fodder		
Dry fodder		79.4
Silage taken out	1.33	53.33
Silage, 1 part water to 1 part fodder		
Dry fodder		93.51
Silage taken out near top		45.6
Silage taken out near bottom		41.3
Silage 1 3/4 parts water to 1 part fodder		
Dry fodder		93.51
Silage taken out near top		38.3
Silage taken out near bottom		21.5
Silage buried in sacks		
Dry fodder		74.56
Silage, 20# fodder to 6 3/4# water	.76	64.99
Silage. 20# fodder to 9 1/4# water	1.19	48.88
Silage, 20# fodder to 12 1/4 water	1.65	46.15
Silage, 20# fodder to 20 3/4 water	1.81	37.69
Silage buried in sacks		
Dry fodder		68.67
Silage. 20# fodder to 5 1/2 water		56.6
Silage, 20# fodder to 20# water		33.5
Green corn as put in silo		33.57
Silage from green corn laid on ground one day		43.80

The silage, made by allowing green corn to lie on the ground for a day before it was buried in a sack in the silo, had 10 percent more air dry matter than that of the green corn before it was laid on the ground.

We may conclude that about 1 part of water should be added to fodder as it comes from the field to give the proper amount of moisture in silage made of shock corn and that of allowing corn to lie on the ground before ensiling materially decreases the percent of moisture in the silage.

Moisture and Acidity at Different Depths.

Table No. 14 gives the percentages of acidity and air dry matter at the wall and near the center of concrete silo No. 2, near the top of the silage in the second filling, and in the first filling at 13, 18, and 23 feet from the top of the silo. It also gives the percent of moisture in a tight can which was buried 28 feet from the top of the silo and it gives the moisture and acidity at one foot from the top and at the bottom of experimental silo No. 1 in the green silage which was taken out of concret silo No 2 to fill experimental silo.

It shows that there is no apparant variation with depth in the silo, either in percent of acidity or in percent of air dry matter.

Moisture and Acidity in Different Kinds of Silage.

Table No 15 gives the % of acidity and of air dry matter of the silage at the center of concrete silo No 2, of the Gurler silo, and of the stave silo, and that of the shock corn silage in experimental silo No 2 made of 1 part water to 2 parts fodder, and that of shock corn silage buried in sacks.

Table No. 14.

Moisture and acidity at different depths.

	Acidity %		Air dry matter%	
	Wall	Cen	Wall	Cen
Concrete silo No 2				
Near top in second filling	1.64	1.83	30.7	30.6
13 ft from top of silo	2.20	2.62	31.3	30.9
18 ft from top of silo	1.52	2.20	31.56	32.11
23 ft from top of silo	1.86	2.01	34.04	27.9
28 ft from top of silo				34.82
Exp silo No. 1 Green silage				
1 foot from top of silo	1.71		31.02	
At bottom of silo	1.90		30.33	

Table No. 15.

Moisture and acidity in different kinds of silage.

	Acidity %	Air dry matter %
Concrete silo No 2		
Near top in second filling	1.83	30.6
13 ft from top of silo	2.42	30.9
18 ft from top of silo	2.20	32.11
23 ft from top of silo	2.01	27.9
28 ft from top of silo		34.82
Gurler silo	1.03	40.49
Stave silo	2.27	35.40
Shock corn silage		
1 part water to 2 parts fodder	1.33	53.33
Shock corn silage in sacks		
20# fodder to 6 3/4# water	.76	64.99
20# fodder to 9 1/4# water	1.19	49.88
20# fodder to 12 1/4# water	1.65	46.15
20# fodder to 20 3/4# water	1.81	37.69
Shock corn silage in sacks		
20# fodder to 5 1/2# water		56.6
20# fodder to 20# water		33.5

It shows that the silage in concrete silo No. 2 which was made of fairly green corn with water added thru the blower and which was excellent feeding silage had a percentage of acidity of about 2.16 percent and a percentage of air dry matter of about 31.26 %. The silage in the stave silo, which was made of corn a little less green than that put in concrete silo No 2 and had no water added and which was only fair silage, had a percentage of acidity of 2.27 percent, which was slightly higher than that in the slightly greener and wetter silage of the concrete silo, and it had a percentage of air dry matter of 35.4 percent which was almost 4 percent higher than that in the greener and wetter silage of the concrete silo.

The silage in the Gurler silo, which was made of quite dry corn with very little water added, and was only fair silage had a percentage of acidity of 1.03 percent, which was over 1 percent less that that in the greener and wetter corn, and it had a percentage of air dry matter of 40.49%, which was more than 5% more than that in the stave silo.

The shock corn silage which was made by adding 1 part of water to 2 parts of fodder and which though bright and fresh was entirely too dry for good silage, had a percentage of acidity about .3 percent higher than that in the Gurler silo and had a very high percentage of air dry matter being about 13% above that in the Gurler silo and about 22 percent above that in the concrete silo

The shock corn silage which was made by adding different amounts of water to dry fodder and burying it in sacks in concrete silo No 2 and which was excellent silage in the sack to which the most water had been added and which though not mouldy was entirely too dry in the sack to which the least water had been added, had a percentage of acidity varying from .76 % to 1.81% increasing directly with the amount of water added, and it had a percentage of air dry matter varying from 64.99 percent to 37.69 percent decreasing directly with the amount of water added.

Similar silage buried in concrete silo No 1 was similar in percent of air dry matter.

So we may conclude that the percent of acidity and of air dry matter vary with the different conditions of the corn used.

VALUE OF DIFFERENT KINDS OF SILOS FOR PRESERVING SILAGE.

Object.

The object of this experiment was to determine if there was any difference in the efficiency of the iron, concrete, stave and Gurler silos in preserving silage. It is claimed by agents for stave silos that concrete silos do not preserve silage as well as stave silos do.

Literature.

No experiment work of value on this subject was found. Many claims for and against the different silos are made by silo agents and opinions have been expressed in experiment station bulletins but they were not based on scientific experiments and most of the opinions are out of date, because great improvments have been made in silos in the last few years.

Plan of Experiment.

A comparison was made as the silage was fed out of the different silos of the feeding condition of the silage at the walls. Temperatures were taken at the walls and at the center of the silos to determine the effect of the walls of the silos on the temperature of silage.

Acidity and moisture tests were made at the center and walls of the different silos to determine the effect of the walls on moisture and acidity.

Condition of Silage at Walls of Silos.

In the iron, concrete and stave silos the condition of the silage when it was taken out for feeding was practically the same to all apperances at the wall as in the center. In each of them slight spots of mould were left on the wall in places as the silage was removed but there was not enough to cause any loss and it was about the same in all the silos. So as far as feeding condition shows neither silo seemed to have any advantage over the other in preserving the silage. In the Gurler silo there was some mould at the wall in places but this was probably due to the walls being cracked. The loss was negligable.

In regard to the temperatures in the different silos a study of the general temperature table No. 1, the table No. 6 on temperatures at the walls and at the center of the iron silo and of the middle bulb in concrete silo No 1, and table No 7 on Temperatures at the wall in concrete and stave silos shows that in the center the temperatures rose and fell gradually depending on the kind of silage but in much the same way. At the walls the temperatures in the iron silo fluctuated with the time of day while in the concrete and stave silos the temperatures at the wall varied only with long periods and then in the same direction and about the same amount. But a study of the low temperatures in the experimental silos and the good condition of the silage in them led to the conclusion that temperatures made no difference within the limits observed in the small silos in the keeping qualities of silage so it is not of great importance how the walls of the silos transmit temperatures.

In regard to the moisture and acidity in the different silos a study of Table No 11 on Moisture and acidity at wall and in center of silos shows that in the concrete and stave silos the relation of the acidity at the wall to that at the center was about the same. At the wall of the Gurler silo there was no acidity on account of the mould. The tables also shows that in the concrete and stave silos the relation of the moisture in the center to that at the wall was practically the same. In the

Gurler silo the percent of air dry matter was much higher in the center than at the walls because much more water had been added to the silage at the wall. So this table shows that the concrete and stave silos have about the same effect on the moisture and acidity of the silage.

SMALL SILOS FOR EXPERIMENTAL PURPOSES.

Object.

There is need of an experimental silo which will provide all the conditions found in the average silo and which, while holding enough silage for a practical feeding test, will be small enough that the silage can be quickly fed out and that there will not be too great a loss in case the silage spoils. The object of this experiment is to find such a silo.

Literature.

As far as I have found no attampt has been made experimentally to find such a silo. In some experiments jars even as small as quart jars have been used. Delaware experiment station (1) in an experiment in ensiling shock corn used a specially constructed rectangular silo 7 x 8 x 28 ft. An oil barrel was also used in this same experiment. In most of the experiments ordinary commercial silos were used. None of these methods are satisfactory. A glass jar will not do because the silage will not be under the same temperature or pressure as that in a large silo. A rectangular silo like that used at the Delaware station will not do because a rectangular silo is not typical and the one used is too large. An oil barrel will not do because the walls are not thick enough to provide an even temperature and they are not straight so that the silage will settle in them evenly. The ordinary commercial silo will not do because while it gives accurate results it requires too much time and expense.

Plan of Experiment.

The plan of the experiment was to make a test of a silo which it was thought would meet the needs. It was thought that such a silo would be a stave tank 3 ft in diameter and 6 feet

(1) Report 1913 pp 38-41

high. Two silos were bought having these dimensions and made of white pine staves 2 inches thick. They had solid bottoms and tops were made of such size that they would easily slip down into the silo as the silage settled under pressure.

These experimental silos were set in a closed room with the expectation that with that protection the temperature would be the same as in the average silo. Pressure was put on the tops so as to give the silage typical pressure. Each of these silos was compared with a certain place in concrete silo No 2 in temperature, moisture, acidity and apparent feeding condition. At noon of the first day of filling concrete silo No. 2, enough silage was taken off of the surface of the silage to fill experimental silo No 1, one man tramping as it was filled. Pressure was put on with a jack screw till settling had apparently stopped. It was estimated that 10.000 lbs pressure had been applied. Experimental silo No 2 was filled Sept 9th at noon in the same way the silage being taken out near the top of concrete silo No 2. In each case the place where the silage was taken out was marked with sacks. Pressure was put on the top of this silo with rock to the amount of 1500 lbs this being estimated as the pressure over the same area in concrete silo No 2 where the silage was taken out. A pair of bulbs was put in this experimental silo at about the middle also to get the temperature as it compared with concrete silo No 2.

When the silage was fed out of the concrete silo down to the place where the silage had been taken out to fill experimental silo No 2, the experimental silo was opened and the silage taken out. An acidity and moisture test was made from the silage in the experimental silo and from a sample taken out of concrete silo

No. 2 The same plan was followed when the other experimental silo was opened

Data and Discussion.

Table No. 12 comparing the moisture and acidity of green silage in the experimental silos with that in concrete silo No 2 where the silage was taken out to fill the experimental silos shows that the difference in percent of air dry matter and acidity between the silage in the concrete silo and in the experimental silos was not more than could be accounted for by experimental error.

When the silage was taken out of the experimental silos it was in appearance, taste and smell quite similar to that in the south concrete silo several competent men having examined it. When it was fed to cows they apparently noticed no difference.

Table No. 8, shows that in the experimental silos the temteratures were much lower than in the concrete silo but the data on the temperatures show that low temperatures have nothing to do with the keeping or feeding qualities of silage. So the moisture and acidity test and feeding condition of the silage shows that the small silo is reliable for experimental purposes.

SILAGE MADE OF SHOCK CORN.

Object.

The object of this experiment is to determine the possibility of making good silage of shock corn by adding water and to determine the amount of water necessary in order to make good silage. Also to determine the effect of allowing corn to dry on the ground before it is put into the silo.

Literature.

Delaware experiment station (1) added 110 lbs of water to 114 lbs of cut fodder in a barrel. The barrel was found to contain in its upper half an aromatic agreeably smelling product well moistened but not water soaked. The fodder in the lower half of the barrel was thoroughly water soaked, cold, free from aroma but also quite free from mould.

In the same experiment two silos 7x8x28 feet were each about filled with 9000 lbs of fodder containing 53.3 percent water. Onto the silage in silo No. 1 2025 and 3070 lbs of water were pumped making the silage contain 27.5 percent dry matter. Onto the silage in silo No 2. 2025 and 3180 lbs of water were pumped making the silage contain 30.22 percent dry matter. The silage was fed to the young and old stock and eaten practically without waste. No points of excessive moisture were found. Fodder in the bottom of the silo was not as moist as that near the top. In places channels ahd formed thru which water had flown.

Vermont experiment station (2) added to eight tons of shredded corn fodder containing 60 percent dry matter on the day of shredding 3 tons of water, 5 days later 2 1/2 tons of water, 3 days later 4 tons and during the following week 15oo lbs. The

(1) Report 1913 pp 38-41 (2) Bul. No. 170 1912.

final dry matter content calculated about 25 percent. The silage was well relished, eaten with but little waste, was sweet having almost no acidity and seemed to serve every purpose of typical silage as a milk producer. The Breeders Gazette and Hoards Dairymen report instances of silage made by adding water to dry fodder.

Plan of Experiment.

Two experiments were carried on with corn silage.

Test No 1 was made by burying samples of dry fodder, to which varying amounts of water had been added, in the silage in the concrete silos at time of filling. These samples weighed 20 lbs each and were placed in cotton grain sacks which in turn were enclosed in oil cloth sacks. Duplicate sets of the samples were prepared as follows:

Sacks No	Lbs fodder	Lbs water
1	20	0
2	20	4
3	20	10
4	20	20

Test No. 2 was made by putting fodder in the experimental silos adding water in small amounts as it went in, in the following proportions: 1 part water to 2 parts fodder, 1 part water to 1 part fodder, and 1 3/4 parts water to 1 part fodder.

The first lot of silage in test No 2 was made of fodder as it was taken from the field late in the fall. In the other two lots the fodder had been stored in the loft for some time and was quite dry.

A moisture abd acidity test was made of one of the sets in test No 1 and of the silage made by adding 1 part of water to 2 parts of fodder. A moisture test was made of two of the sacks in the other set in test No 1 and of the silage in the experimental silos made by adding 1 part of water to 1 part of fodder and 1 3/4 parts of water to 1 part of fodder.

Temperatures were taken of the silage in the experimental silos and the temperatures of the silage buried in sacks would be the same as that in the concrete silos.

An experiment was made to determine the effects of allowing corn to partially dry on the ground before being put into the silo. This was done by selecting a quanity of typical silage corn. A portion to represent typical silage was run thru the cutter at once and buried in a sack in the manner described. A second portion was allowed to lie on the ground one day and a third portion for 3 days after which these samples were also run thru the cutter and buried in sacks.

Discussion of Data.

In test No. 1 the oil cloth did not prevent the silage from absorbing water as was expected.

The pounds of water and fodder as the sacks came from the silo were as follows:

First set	Sack No	Lbs fodder	Lbs water.
.. ..	1	20	6 3/4
.. ..	2	20	9 1/4
.. ..	3	20	12 1/4
.. .. .	4	20	20 3/4
Second set	1	20	5 1/2
.. ..	2	20	6
.. ..	3	20	13
.. ..	4	20	20

In regard to moisture and acidity tests in shock corn silage table No 13 shows that it is possible to make silage of shock corn by adding water and it shows the amount of water required.

Adding 1 part of water to 2 parts of fodder taken from the field did not give enough water for while the acidity was sufficient there was entirely too large a percent of dry matter. An observation of the feeding condition also showed that it was not good silage because, while it was entitely free of mould having been packed tight so that it was free of air, it was entirely too dry for good silage.

Adding 1 part of water to 1 part of fodder which had dried out in the loft made fairly good silage tho there was too large a percent of dry matter, there being 45.6 % of air dry matter near the top of the silo and 41.3 % near the bottom. Observation of the feeding condition also showed that it was fairly good silage as the cows ate it fairly well.

Adding 1 3/4 parts water to 1 part fodder made fairly good silage near the top having 38.3 % of air dry matter which is a little more than good silage has. The water had settled in the silage a good deal the silage of the bottom being very wet having 21.5 % of air dry matter, and a little water was standing in the bottom of the silo. The silage at the bottom was too wet for good feed.

Of the shock corn silage which was buried in sacks the silage made by adding 6 3/4 % water to 20# of fodder as it came from the field had a low percent of acidity and the percent of air dry matter was too high for good silage. An observation of the feeding condition showed the silage to be too dry.

The silage made by adding 9 1/4# water to 20# fodder as it came from the field had a fair percent of acidity but the percent of air dry matter was too high for good silage. Observation of the feeding condition showed the same thing.

The silage made by adding 12 1/4 # of water to 20# of fodder as it came from the field had almost normal acidity though the percent of air dry matter was a little too high for the best silage. An observation of the feeding condition showed the same thing.

The silage made by adding 20 3/4# of water to 20# of fodder as it came from the field had a typical acidity and about the percentage of air dry matter found in typical silage which is just a trif le dry. Observation of the feeding value also showed that it was good silage as the cows seemed to make no distinction between it and the green silage.

The silage made by adding 5 1/2# of water to 20# of fodder which had 68.6 % of air dry matter, had a percent of air dry matter which was entirely too low for good silage. Observation of the feeding condition also showed that the silage was too dry. There was no sign of mould but the grain seemed slightly burnt and the cows did not seem to relish it as well as they did green silage though it would make good feed.

The silage made by adding 20# of water to the fodder was excellent silage having apercent of dry matter of typical silage and was in excellent feeding condition. So these two sacks as also the other two sacks in the set gave practically the same results as the silage under similar conditions in the first set of sacks.

The silage in the sacks were under the same temperatures as the typical silage in the concrete silo. While, as Table No 9 shows the silage in the experimental silos was under very low temperature it seemed to make no difference in the silage.

So the conclusion may be drawn that good silage can be made of shock corn by adding water and that for shock corn as it comes from the field about 1 part water to 1 part of fodder is needed. This seems to be about all the water that the fodder will absorb and it must be added as the fodder is put in. The fodder cannot be wet all through by pouring water on top. While about this amount of water is needed to make good silage the silage can be made to keep with much less water as in the case of the silage made by adding 1 part of water to 2 parts of fodder. This silage was bright and perfectly kept though it was too dry for the best feed. But no doubt it was better than fodder from the field.

In the experiment of allowing silage to dry out on the ground the typical silage came out in excellent condition having increased in weight from 37.8 lbs to 41 lbs. The silage which had lain on the ground one day came out in excellent condition having increased in weight from 31 lbs to 33 lbs and as shown by Table No. 10 having 43.8 percent of air dry matter. The silage which had lain on the ground 3 days came out a little dry but in good condition there being no sign of mould so that it was satisfactory silage. It had increased in weight from 33 1/2 lbs to 37 lbs.

It seemed that typical silage corn which had laid on the ground 2 or 3 days will not be really injured for silage though the silage may be a little dry.

LOSS IN WEIGHT OF SILAGE.

Object.

The claim is made and it is generally thought that there is a considerable loss in weight of silage in the silo. The object of this experiment is to determine if there is a loss in weight and if there is how much the loss is.

Literature.

Colorado experiment station (1) reports a loss in weight of silage. The second layer of silage being under a pressure of 60 lbs per sq ft consisted of 9997 lbs of corn fodder at the time of filling. When fed out it weighed just 1000 lbs less or a loss of 10 percent. The layer next under this shrank from 9721 lbs when put in to 9409 lbs when taken out or a loss of 3 percent.

Arkansas agricultural experiment station (2) weighed corn silage and sorgum silage into and out of silos getting the following results.

Corn put in	74390 lbs
Ensilage taken out	64031 lbs
Loss in weight	13.9 %
Sorgum put in	18100 lbs
Ensilage taken out	13054 lbs
Loss in weight	27.8 %

Michigan experiment station (3) weighed the corn into 4 silos and the silage was weighed out. The losses averaged for the four silos 8.32 percent of the weight of the corn as it was put into the silo.

(1) Bulletin 57

(2) Report 1890 p 5.

(3) Bulletin 191 p 165.

Wisconsin experiment station (1) weighed 129014 lbs of fodder into the silo and weighed out 108836 lbs making a loss of 20178 lbs or 15.6 %

This station (2) also made an experiment to determine the effect of loose and tight packing on loss in silage by packing silage tightly in duplicate pint bottles and putting the same amount of silage in duplicate quart bottles. The loss found was as follows:

	pint	Quart	pint	quart
Percent lost after 33 days	.31	2.38	1.27	2.91
Percent loss after 303 days	.74	3.26	1.80	4.11

Plan of Experiment.

The green silage and shock corn silage with which the experimental silos were filled was weighed in and weighed out. Moisture tests were made of the green silage as it went in and a moisture test was made of the dry fodder with which the shock corn silage was made and the percent of air dry matter of the silage which went in was estimated. Moisture tests were also made of both the green and the shock corn silage as it was taken out.

Date and Discussion.

Table No. 16 gives the weights and percent of air dry matter of the green silage and shock corn silage in the experimental silos both as it was put in and as it was taken out.

It shows that the percent of air dry matter in four cases was about the same when it came out as when it went in, but that where a great deal of water was added to the fodder there was a perceptible gain in dry matter near the top of the silage due to the settling of the water.

(1) Eighth annual report pp 227-231

(2) Report 1901 pp 200-209

Table No. 16.

Loss of weight in silage.

	Weight as went in	Weight as Came out	%air dry matter as Went in	%air dry matter as Came out
Green silage Exp. silo No 1	921	867	32.38	30.67
Green silage Exp. silo No 2.	960	957	30.14	31.88
Shock corn silage				
1 pt water to 2 pts fodder	762	743	52.9	53.33
1 pt water to 1 pt fodder.	840	784	46.8	45.6
1 3/4 pts water to 1 pt fod	973	928	34.0	38.3

The green silage in Exp. Silo No 1 lost 54# out of 921# put in, a loss of 5.86% in weight. Besides this loss in weight there was a loss of 72# of rotten silage. This large amount of rotting may account for some of the loss in weight.

The green silage in experimental silo No 2 lost only 3# in weight out of 960#. There was a further loss of 35# rotten silage.

The shock corn silage made of 1 part of water to 2 parts fodder lost 19# out of 762# put in which was a loss of 2.49% in weight though there was a further loss of 20# from rotting. Part of this loss in weight can undoubtedly be accounted for by the fact that after 2 feet of the silage had been taken out the remainder stood open 5 days during farmens week for the farmers to observe and handle.

The shock corn silage made of 1 part water to 1 part fodder lost 65 lbs out of 840 lbs put in which was a loss of 6.66 per-cent in weight though there was a further loss of 45 lbs from rotting.

The shock corn silage made of 1 3/4 water to 1 part fodder lost 45 lbs out of 973 lbs put in which was a loss of 46.2 % in weight though there was a further loss of 70 lbs from rotting on the top.

In the five cases given the average loss of weight was 3.93 %. Of the silage which was made by adding water to shock corn and burying it in the concrete silos the air dry matter put into the silo and that taken out and the percent of gain or loss in dry matter was as follows:

	Lbs air dry matter		% loss
	Went in	Came out	or gain
20# fodder to 63/4# water	14.91	17.38	16.6
... . 91/4# ..	14.91	14.58	2.2
... . 121/4# ..	14.91	14.88	.2
... . 203/4# ..	14.91	15.35	2.95
... . 51/2# ..	13.73	14.43	5.1
... . 20 # ..	13.73	13.40	2.4

In these sacks there seem to have been more gain than loss in percent of air dry matter. The determination appears to be inaccurate.

WEIGHT OF SILAGE AT DIFFERENT DEPTHS.

Object.

The object of this experiment is to determine the weight of silage at different depths. It is important to know this for selling silage in the silo and for estimating the amount of feed remaining for feeding operations.

Literature.

Wisconsin experiment station(1) estimating from data which they pronounce unreliable give the weight of a cubic foot of silage as varying from 45 lbs at a depth of 14 feet to 63 lbs at a depth of 23 feet and remaining at 63 lbs to a depth of 36 feet.

Colorado experiment station (2) divided a silo 10 x 10 feet into 3 layers with boards to separate the layers, and rods extending from the partitions to mark the amount of settling.

The final weight per cu ft in the 3 different layers was as follows:

	Lbs of silage	Lbs pressure	Days settling	Lbs per cuft.
Bottom layer	6588	323	90	50.7
Middle layer	9721	244	77	33.3
Top layer	9997	145	8	31.5

The pressure at least on the top layer evidently was not enough to compress the silage to its limit.

Plan of Experiment.

Measured vessels were buried at different depths in the concrete silos with the expectation that the silage would settle in these vessels just as out of them and that the vessels containing

(1) Eight annual report 1891 pp 241-245

(2) Bulletin 57.

frame was a foot square on the out side and 18 inches high. The upper 6 inches of the frame was braced for strength and to this upper part was welded sharp pointed bars, one on each corner and one in the middle of each side, which were driven into the silage. Then with a hay knife the silage was cut around the sides of the frame and the silage taken out of the frame to a depth of one foot and weighed for the weight of a cubic foot of silage at that depth

Data and Discussion.

The feet from the top of the silo when put in and taken out, the amount of settling, and the weight of silage per cubic ft of the cans and wire basket in concrete silo No 2 were as follows:

	Feet from top when put in	taken out	Settling feet	Lbs per cu ft
6th can	8	10	2	27.5
5th can		15 1/2		29.3
4th can	16	19 1/2	3 1/2	22.3
3rd can	20	23	3	20.7
Basket	20	23		21.1
2nd can	24	26 1/2	2 1/2	25.3
1st can		28 1/2		28.0
Tight can		28 1/2		28.0

It is generally supposed that silage increases in weight with depth. For this reason it was expected that the weight in the 5th can would be greater than in the 6th. The fall in weight in the 4th can was accounted for by the dryer silage of the first filling. There was no way to account for the weights in the other cans on the grounds of increase in weight with depth. It was thought that the weights might be inaccurate on account of the

the silage could be weighed and the weight of the silage per cuft foot where the vessel was taken out calculated. In concrete silo No. 1 baskets made of half inch mesh wire and 18 inches high by 24 inches in diamenter were put in at each 5 feet beginning at the bottom of the silo. For fear these baskets might not withstand the pressure of the settling silage a similar basket but supported by an iron frame was buried in concrete silo No. 2 to see if an iron frame would help. To duplicate these baskets smooth tin cans, 195/8 inches high by 125/8 inches in diamenter and having holes in the bottoms so as to hold no settling moisture, were buried in concrete silo No 2. It was intended to place a can each 5 feet from the bottom to the top as with the wire baskets but the cans were forgotten when the filling started. When they were remembered a can was put in, the place not being noted, but being some where near the 7th ring from the top of the silo. The second can was put in with its bottom even with the 6th ring from the top, the 3rd even with the 5th ring and the 4th even with the 4th ring. The 5th can was put in even with the 3rd ring from the top but, when the rotten silage was thrown off of the first filling for the second filling, the can was taken out and set on the silage so that while the bottom was then below the 3rd ring from the top it was higher than it would have been if it had been left where it was placed before the settling began. The 6th can was put in with its bottom even with the 2nd ring from the top so that it had about 8 feet of silage above it.

When it was found that the wire baskets, which were to be used for getting the weights in concrete silo No 1, were useless because the pressure bent the sides down, and iron frame was made which could be driven into the silage to enclose a cuft. This silage hanging on the sides of the cans but there was no evidence of this and the cans all came out in excellent condition.

It seems possible that silage under sufficient pressure and allowed sufficient time to settle might reach a limit to its compressibility. The silage in a silo finally quits settling. This may not happen till all the airand gases are out almost to the surface and there is practically the same amount of silage at all depths.

The settling of the cans tends to show this. The 2nd can settled 2 1/2 feet. The 3rd can settled 3 feet which included 2 1/2 which it settled with the 2nd can and 1/2 foot of settling in the 4 feet between the cans. The 4th can settled 3 1/2 feet which included 3 feet which it settled with the 3rd can and 1/2 foot of settling in the 4 feet between the cans. It is not known how much the 5th can settled but likely about 4 feet because it was first put in at 12 feet from the top and was raised about half a foot or a foot when the rotten silage was thrown off the same filling. The fact that the 6th can settled only 2 feet was doubtless due to the fact that most of the settling had been done before that can was put in.

However the silage below the 2nd can seems to have been a little heavier. When that can was put in there were 9 feet of silage below it. When it was taken out there were 6 1/2 feet of silage below it. This was a settling of about 1 foot to 4 instead of 1/2 foot to 4. The first can also showed a decidedly increased weight.

It is likely that silage is a little lighter near the top but that as soon as the pressure becomes considerable that the weight per cubic foot varies much more with the percent of moisture and grain than with the depth.

The weights per cuft taken as the silage was fed out with the iron frame in concrete silo No. 1 at different distances from the top of the wall and from the top of the silage as it finally settled were as follows:

Feet from wall	top of silage	Lbs per Cubic foot
16	8	36
17	9	35 1/2
20	12	35
22	14	33

There appears to have been a gradual decrease in weight per cubic foot toward the bottom of the silo. This was doubtless due to the fact that water had been pumped onto the silage after the silo was filled and the silage became dryer toward the bottom. This condition had been noticed in feeding the silage. These determinations also show that percent of moisture may be a more important factor than the tendency of the silage to become more compact towards the bottom.

MAKING SILAGE OF LEGUMES.

Object.

When the first crop of clover and alfalfa is cut in this state the weather is usually so damp that it is hard to cure these crops. The object of this experiment was to determine the possibility of ensiling these crops as to prevent the usual loss. It is claimed that legumes contain too small an amount of sugar to ferment and make acidity enough to preserve the silage, and that it would be necessary to mix with it some crop containing a good deal of sugar. Some cheap commercial product containing much sugar might be used. On the other hand it is claimed that good silage can be made of clover or alfalfa alone.

Literature.

Colorado experiment station (1) made some careful experiments on a small scale with alfalfa and found that alfalfa run thru a cutter makes very good silage but that it is difficult to make good silage of whole alfalfa.

Oregon experiment station (2) found that silage made of whole clover or vetch was more expeditiously handled than the cut silage tho it required a larger silo space for a given weight.

Hoards Dairyman and the Breeders Gazette recommended putting alfalfa and clover in the silo but there is a difference of opinion amoung the farmers.

(1) Bulletin 57

(2) Report 1904 pp 28 & 29

Plan of Experiment.

In this experiment alfalfa was cut just before ensiling. It was run thru a silage cutter and a wheat sack covered with an oil cloth sack was filled and buried in concrete silo No. 2. A similar sack was filled with alfalfa to which 4 % of sugar was added sprinkling the sugar thru the alfalfa and this sack buried near the other one.

Date and Discussion.

Table No. 17.

	Acidity %	% Air dry matter went in	came out
Alfalfa silage with sugar	1.46	48.8	42.3
Alfalfa silage without sugar	1.43	48.8	44.9

The oil cloth sacks proved not to be moisture tight as was shown by the weights taken as the silage was put in and taken out. The loss in percent of dry matter as shown in Table No. 17 shows the same thing. The table also shows the acidity to be the same in both sacks so the sugar seemed to have no effect on the acidity and the acidity to be about that of normal silage. Although the table shows the percent of dry matter to be rather high an examination of the silage when it was taken out showed the silage to be in excellent feeding condition. The silage had a sour taste and there was no sign of putrifaction. It tasted very much like green alfalfa after the first sour taste was out. It was fed out to 4 highly fed cows and they ate it with evident relish. So as far as this experiment shows it seems quite practical to ensile alfalfa.

SUMMARY.

1. The highest temperature, 130 degrees F., was found near the surface of the silage.

2. Readings taken with an electrical thermometer and in pipes with a maximum thermometer were under similar conditions practically the same.

3. The maximum temperatures at the wall and at the center of each silo were about the same, but it comes quicker at the wall.

4. Temperatures at different depths in the silo were about the same falling toward the last slightly faster toward the bottom.

5. Temperatures at the wall of the iron silo fluctuated with the time of day while those of the stave and concrete silos at the wall fluctuated only with long periods. Temperatures at the center of the silos did not fluctuate with outside temperatures.

6. Temperatures in experimental silos were much lower than in the large silos. However as these lower temperatures appeared to have no effect on the silage it was concluded that temperatures within the range given have no effect on silage. The highest temperatures were in rotting and mouldy silage.

7. The percent of acidity in the concrete and stave silos was lower at the wall than in the center of the silo, but the percent of air dry matter was practically the same.

8. The percent of moisture and acidity was practically the same in green silage in the experimental silos as at the wall of the concrete silo.

9. Shock corn silage made by adding 1 part of water to 1 part of fodder as it came from the field gave a percent of acidity and moisture about the same as that of typical green silage.

10. Moisture and acidity did not vary with the depth of the silage.

11. The percent of moisture and acidity vary with the condition of the corn used.

12. Concrete and stave silos have equal value for preserving silage.

13. Silos 3 ft in diamenter by 6 ft high and made of 2 inch pine are reliable for experimental purposes except in temperatures.

14. Good silage may be made of shock corn by adding 1 part of water to 1 part of fodder as it comes from the shock adding the water as the fodder goes in.

15. Five weights on silage in the experimental silos give an average loss in weight of 3.93 %.

16. The weight of silage does not vary at different depths after the pressure is sufficient to force out the air but varies with the percent of moisture and grain.

17. Green alfalfa cut and buried in sacks in silage under typical temperature and pressure made excellent silage.