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ENSILING VERSUS DRYING SOFT EAR CORN

AGRICULTURAL EXPERIMENT STATION
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AND MECHANIC ARTS

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ANIMAL HUSBANDRY AND CHEMISTRY SECTIONS

Ames, Iowa

SUMMARY

Two methods of preserving soft ear corn, ensiling or drying were compared as to cost and recovery in the experiments reported in this bulletin.

Soft ear corn, representing the average product of a bad soft corn year, was sorted late in the winter into four distinct grades:

Grade A—Good; most mature corn, bright and free from mold.

Grade B—Medium to good; rather mature, with slight mold.

Grade C—Poor; about half matured, but free from mold.

Grade D—Very poor; very immature and very moldy.

Corn of all four grades was cut and run into silos with enough water to make the cut corn contain approximately 60 percent water. Ear corn of grades B and C was artificially dried at a temperature of approximately 115° F.

EXPERIMENTAL RESULTS WITH DEDUCTIONS.

1. The three best grades of soft corn, A, B, and C, produced a silage that was well preserved, palatable, clean, and bright, with a good silage aroma. The general appearance and physical condition was not quite as good in grade C as in grades A and B, but there were no apparent differences in odor or palatibility. Grade D had a slightly sharp, musty odor and was in poor condition, being mushy and soft. The dried corn, grades B and C, was in good condition, very dry, but with shrunken kernels. There was no apparent mold or rot.

2. The sugars disappeared completely during the fermentation of the silage and the development of acidity was comparable to that in ordinary corn silage. The recovery in dry matter ran as high as 99.6 percent in the poorest grade of silage, being next highest, or 93.7 percent, in the best grade of dried ear corn. The dry matter recovery was higher in grades B and C where they were dried than when ensiled. The recovery of crude protein was highest on the average in the better grades of silage, A and B, than in grade C. The very high figure found for protein recovery in grade D was probably due to experimental error, which was considerably greater in handling the immature and moldy grade D. The recovery of carbohydrate equivalent was practically the same in the ensiled and dried grains.

3. On a dry matter basis the cost of the soft ear corn purchased was less than the cost of No. 4 grade new shelled corn on the market at that time. In the case of each grade of soft corn, the cost of the dry matter was less as the quality diminished.

4. The relative costs of ensiling and drying, natural basis, per 100 pounds were: grades A, B, C, and D, ensiled, approximately 13 cents, and grades B and C dried, 21 cents. The difference in cost of preservation was actually 8.1 cents per 100 pounds in favor of ensiling.

5. The actual total costs per 100 pounds of the soft ear corn silage and dried ear corn as fed from silo or bin were:

Grade A—Ear corn silage,	$1.31	Grade D—Ear corn silage,	.54
Grade B—Ear corn silage,	1.08	Grade B—Dried ear corn,	1.96
Grade C—Ear corn silage,	.87	Grade C—Dried ear corn,	1.76

6. The total cost per 100 pounds of **corn grain** figured to a 14 percent moisture basis, making same comparable in water content to No. 2 corn grain, were:

Check No. 4 grade shelled corn	$2.48	Grade C—Ear corn silage,	2.93
		Grade D—Ear corn silage,	1.84
Grade A—Ear corn silage,	3.03	Grade B—Dried ear corn,	2.49
Grade B—Ear corn silage,	2.50	Grade C—Dried ear corn,	2.45

The only grades costing less than the regular market No. 4 corn on this comparable basis were the grade D ear corn silage, at $1.84, or 66 cents per 100 pounds less, and grade C dried ear corn, at $2.45, or 3 cents per 100 pounds less. These figures include the cost of ensiling or drying.

ENSILING VERSUS DRYING SOFT EAR CORN

By John M. Evvard, Alvin R. Lamb and E. J. Maynard*
(With the cooperation of H. D. Hughes, of the Farm Crops Section.)

In a soft corn year the most profitable use of the crop offers a serious problem, but there is a way out of it whereever the corn can be fed to livestock. It may be fed immediately, as feeders know, for no harmful results need be feared in feeding it intelligently if it has not been allowed to spoil. But it may also be ensiled for later feeding, or dried by natural or artificial heat and stored in cribs. In either case the feed resulting will give the farmer the best possible returns for his damaged crop, altho the ensiled corn will cost less per 100 pounds as feed than the dried corn. These facts are shown by the experiments reported in this bulletin. In years prior to these experiments, the Iowa Agricultural Experiment Station successfully ensiled soft corn ears, securing apparently good silage.

The experiments reported here were carried out in the winter of 1917-18, to find answers to the questions concerning ensiling and drying and their relative merits as methods of salvaging a soft corn crop, such as Iowa had in the season just preceding, and the costs and feeding values of the feeds resulting. The results of feeding the salvaged corn are to be reported in a subsequent publication.

Various methods of handling and storing soft corn, both ears and fodder, in order to preserve and feed to best advantage, were discussed in previous publications from this station[1] [2] [3] [4]. To ensile the ears alone (with or without husks) seemed the better plan, because a given amount of silo capacity will preserve a much larger proportion of the crop if the stover is left to dry in the field and the ears ensiled alone. We, therefore, worked with husked ear corn. Preliminary experiments by the authors on making this sort of silage were reported in 1916[5]. These tests, which were made in glass jars, showed that the soft corn ears, when properly cut and packed, could be preserved nicely in the small laboratory silo.

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*Now in charge of animal investigations, Colo. Agr. Exp. Sta.

[1]Kennedy, W. J., Dinsmore, Wayne, Rutherford, W. J., and Smith, W. W.: Feeding Value of Soft Corn for Beef Production. Bul. Ia. Agr. Exp. Sta. 75 (1904).

[2]Evvard, John M.: The Soft Corn Predicament. Proc. Corn Belt Meat Prod. Assoc. Dec. 1915.

[3]Evvard, John M.: The Soft Corn Problem. Cir. Ia. Agr. Exp. Sta. 40 (1917).

[4]Hughes, H. D.: Salting Soft Corn. Cir. Ia. Agr. Exp. Sta. 41 (1917).

[5]Lamb, A. R.: Silage and Silage Fermentation. Bul. Ia. Agr. Exp. Sta. 168.

At the Wisconsin Station, King studied the losses occurring in the fermentation of ordinary corn silage[6]. He found that the losses of "dry matter," or actual feeding material, disregarding evaporation of water, are reduced to a practical minimum by using corn of proper maturity and by close packing into a silo having air-tight walls. Of course, proper and effective sealing is also in order. He reported that in one typical silo where the dry matter losses were measured in eight layers of silage that the average loss was eight percent; that the loss in the surface layer was largest, 32.5 percent; and that the loss at the center was the least, or 2.1 percent. These losses are of about the same order as those observed in other cases where the silage was properly handled, and may well serve as a working basis for comparison with the losses found in ensiling soft corn ears. The losses involved in fermentation of silage are of technical importance in determining the cheapest and most efficient methods of storing silage material.

PRACTICAL CONSIDERATIONS.

The experiments were carried out under practical conditions, with large enough amounts of corn to give fairly good results, results such as might be expected under farm conditions.

Owing to the large amount of material handled in the daily weighings, and the attending difficulty in obtaining absolutely representative samples for analysis, the figures showing the chemical analysis and losses in the fermentation must be considered as approximate only, and too much importance should not be attached to a few apparent discrepancies where extraordinary figures seem to indicate them.

From a technical point of view the changes taking place in the silo are of much importance, and for this reason weights as accurate as possible were taken and complete chemical and some physical analyses were made thruout the test in order to cover the gains and losses in the ensiled or dried material.

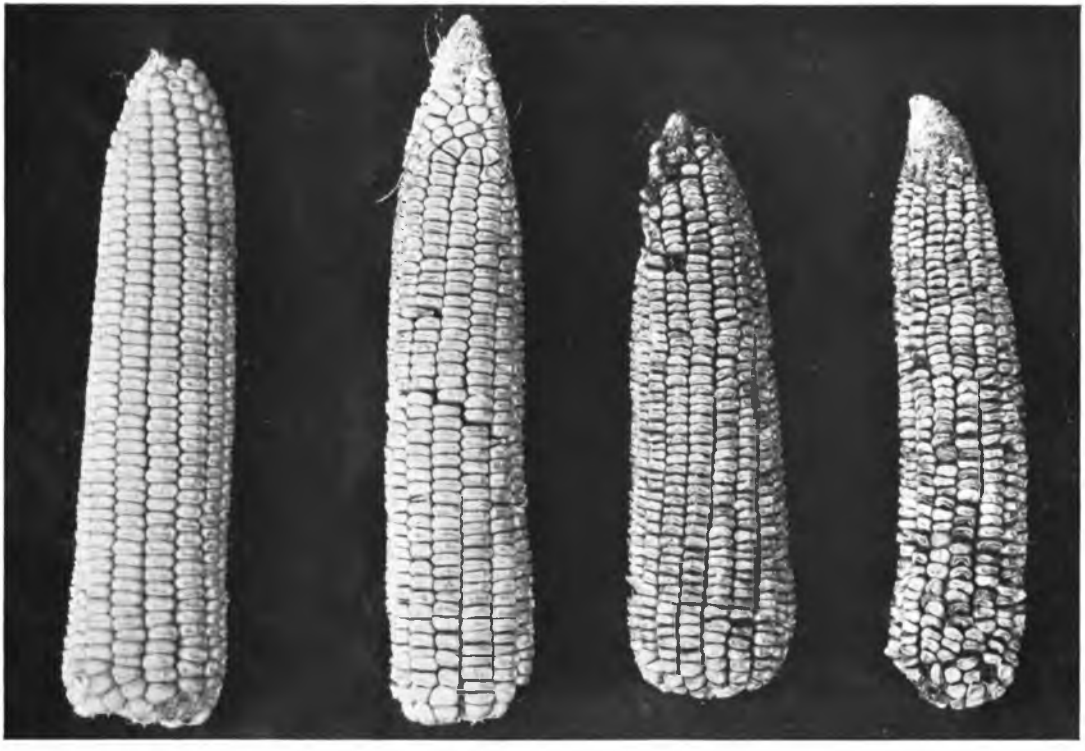
OBJECTS OF THE SOFT EAR CORN EXPERIMENT.

I. To determine the feasibility of ensiling soft ear corn of different grades, which grades may be designated in a somewhat arbitrary manner as *good, medium to good, poor,* and *very poor.*

II. To determine the advisability of ensiling versus drying soft ear corn.

III. To make careful observations on methods of filling the silo, noting especially wherein the ensiling of the soft corn will differ from the putting up of ordinary silage.

[6]King, F. H.: Silage and the Construction of Modern Silos. Bul. Wis. Agr. Exp. Sta. 83 (1900).



A B C D

FIG. 1—Typical single ears of grades A, B, C and D. One representative ear from each grade of soft corn at time of ensiling or drying.

IV. To gather data concerning the relative cost of drying and ensiling soft ear corn in order to gain some idea as to relative net costs of preservation by these two methods.

V. To discover the loss or gain of total dry matter as well as the loss or gain of the constituents of dry matter in the ensiling process, comparing same with the drying scheme.

VI. To learn the gain or loss of water during the ensiling, calculating said gain or loss on two bases, (a) natural soft ear corn before adding water thereto in ensiling, and (b) the cut soft ear corn plus water which was added to it in the silo.

VII. To study the chemical changes occurring from the time the soft ear corn is put into the silo until the time when it is taken out, contrasting these changes with those occuring in the ordinary air-drying process, particular emphasis being placed on the percentages of moisture, crude protein, nitrogen-free extract, crude fiber, ether extract, sugar, and acids, and also to emphasize the total amounts of the proximate ingredients put in at filling time, as compared to the amounts taken out when fed.

VIII. To test in a practical way the advantages of ensiling or drying the soft ear corn, and to make a study of the product resulting therefrom, considering palatibility, the presence of molds, character of odors, physical condition, quality, color, and general appearance, as the corn was taken from the silos or drying bins when fed.

DURATION OF THE EXPERIMENT PERIOD.

The ensiled soft ear corn of the fall 1917 crop was carried in the silos from March, 1918, to November, 1918, a period of about nine months. This long period, including one summer, was determined in order to test out more thoroly the keeping qualities of the silage.

The soft ear corn which was dried was stored in the drying basement in March, 1918, and was kept there until July, 1918, at which time it was removed to the tight wooden barn bins, from which it was later fed.

The experimental period, which in all extended over thirteen months, was divided into three parts:

First: The period during which the material was being secured, gathered, sorted and ensiled or dried. This was during the month of February and the first two weeks in March, 1918.

Second: The period during which the soft ear corn silage, or dried ear corn, was left as stored for future use, or from March, 1918 to November, 1918, a period of about nine months.

Third: The period during which the final feeding products were being fed out in trial, or from November 26, 1918, to March 10, 1919, a period of 100 days, the feeding results of which period of investigations are to be presented in another publication.

Had the soft corn been ensiled early in the fall, say in September, the practical results would have been more favorable, everything considered. Of course, the results of this study tell their own true story, but in actual farm practice one should be vigilant in the matter of the early ensiling of all soft corn, thus quickly getting under cover in preserved

silage form an otherwise increasingly hazardous product which becomes more and more difficult to handle as the heavy cold weather comes on.

METHODS AND MATERIALS OF EXPERIMENTATION.

EQUIPMENT FOR TEST.

For ensiling the soft ear corn, four small wooden silos, built to special order, were secured.* These were 5 feet in diameter and 14 feet high, being sufficiently large to insure results comparable to those that might ensue in ordinary farm silos. They were erected as a battery of four, paralleled on a heavy plank platform, so were under similar conditions as to location and general surroundings thruout the test.

A basement room, having a temperature ranging from 115 to 120 degrees Fahrenheit, was used in drying the soft ear corn. A constant draft was maintained thru this room so that the husked soft corn ears laid out on the floor would lose their moisture much in the same manner as if a regular furnace drying outfit such as can be built in the crib were used.

The husked soft ear corn was cut into the silos with a regular Smalley force-feed cutter No. 20, equipped with circular rotary knives and a blower. The power was supplied by a small gasoline tractor of approximately 20 horse-power. The power required to cut the soft ear corn into the silos was apparently not as great as where the entire plant (fodder) at denting time or when dried is run thru in the making of ordinary field corn silage.

The water added to the cut corn, as put into the silos, was measured thru a water meter which was attached to the hose used. The weight of the water was then figured at 62.4 pounds per cubic foot, this weight being used in computing the total weight of water introduced into the silo during the filling process.

THE SOFT EAR CORN USED.

Practically 25 tons of soft ear corn were bought during the winter of 1917** from farmers in the vicinity of the Iowa State College and represented the average product of a rather severe soft corn year. This ear corn was selling on the average at the local elevator for about .85 to $1.00 per

*These silos were purchased from the Central Unadilla Silo Company, of Des Moines, Iowa, on the basis of the actual cost of building. They were wooden stave silos made from Oregon fir, clear stock, equipped with floors and roofs. The construction was exactly the same as in the regular farm silos made by this company.

**Thru the assistance of J. M. Munsinger, a grain dealer at Ames.

100 pounds, when the best grade of corn on the market at that time, No. 4 shelled corn, containing 19.5 percent moisture, was selling for $2.32 per 100 pounds. Thus it can be seen that this soft ear corn was purchasable at less than one-half the market value of fairly good shelled corn. The varieties represented in the soft ears secured were White Silver Mine and Reid's Yellow Dent.

This 25 tons of corn, secured from a number of different sources contained corn varying greatly in moisture content, maturity and state of preservation. Some of it had been husked in the fall and stored in well-ventilated cribs, altho the greater portion of it was left on the stalks in the field thruout the greater part of the winter. The best of it was in good condition for soft corn, the ears bright, nearly mature, and free from mold, with well-filled kernels, in fact, only just a little too high in moisture content to allow for safe cribbing. From this good kind of soft corn the remainder graded down to very immature corn, with shrunken kernels, and in many cases only half-filled cobs. The good soft corn was free from mold, but much of the poorer corn was moldy and some of it was in a so-called "rotting" condition.

From the time when the corn was husked until it was sorted at the Experiment Station, it had been stored in roofed, well-ventilated cribs. Naturally, it is presumed that it deteriorated slightly. However, owing to the extremely cold weather prevalent it had been kept well preserved in its frozen condition until used.*

GRADING AND SORTING THE SOFT EAR CORN.

Early in March, 1918, the soft ear corn was hauled to the College and put in a large pile from which four distinct grades were hand-sorted ear by ear, under very close supervision, the specifications for the different grades being kept clearly in mind. A few selected representative ears of each grade were kept close at hand in clear view in order to pro-

*This practice of carrying the soft ear corn over the winter, in the field or in open cribs, is one that might prove practicable under extremely cold winter conditions in this state. In this manner it might be possible to ensile it in the early spring after the ordinary silage had been fed out and ample space in the silo provided. However, warm thawing spells in the winter would deteriorate the corn, and in very mild winters would prove a risky procedure. All would depend on the severity of the winter, for the corn would have to stay in a frozen condition to keep well.

If the ensiling of the ears, with or without the husks, could not be carried out until late winter, under average conditions the corn would be better kept in the field on the stalks until ensiled rather than husked in the fall. The tendency is for the corn ears to keep on drying out while in the field, while in the crib the lack of ventilation might cause it to mold or rot, and close packing would also hinder drying.

TABLE I—SUMMARY OF DESCRIPTIVE SORTING POINTS—SOFT CORN GRADES

Grade of soft ear corn	State of maturity	Mold present	Apparent amount dry matter in kernels	General condition of soft ear corn	State of decay	Apparent moisture content at husking time	Moisture percent when ensiled Averages	
							Grain	Cob
A	Most mature, well dented	None	Well filled	Good	None	Lowest	24.7	37.0
B	In the dimpled Glaze stage, denting or dented	Some Blue Mold at base of kernels	Well filled but creased at crown	Medium to good	None	Next to lowest	29.0	41.7
C	In the Milk stage	None	About half filled	Poor	None	Next to highest	33.8	49.3
D	Very immature	Very moldy	Relatively the smallest amount	Very poor	All decayed ears put in this lot	Highest	37.9	53.5

vide examples of what should be looked for in determining the grades. The sorters found this "sample" method of great assistance.

A brief summary of the specific points covering the grades and the designations given them as used for the sorting are included in table I.

One of the main ideas in the sorting was to grade the corn on its apparent moisture content at husking time. This basis was used in order to get the least mature corn all in one lot (grade D) regardless of whether it still carried a high percent of moisture, or whether it had dried out in the field. In other words, grade A was to have the highest percent dry matter in the kernels; Grade B next, Grade C following, and Grade D the lowest. The only variation in this "dry matter" rule was that all ears carrying noticeable mold should be put into Grade D.

A complete discussion of the specifications or points considered in sorting this typical soft ear corn into the four grades, A, B, C, and D, is here given.

GRADE A—SOFT EAR CORN.

General condition: Good, comprising the most mature ears.

The ears were not limber or discolored, but rather solid and well-filled. They showed the lowest apparent moisture content at husking time. No ears were included carrying any mold on the outside or at the base of kernels.

This grade as sorted looked like very good corn, altho when handled it did not give forth the familiar rustling sound heard when

mature ear corn is dumped into the crib. It contained too much moisture to shell very well.

This grade had the plumpest kernels, which were quite solid and of a good bright color, with normal or practically no spacing between them. No corn was included in this grade which did not have a good, bright, well filled out appearance.

All excessively heavy ears, even tho showing good denting, filling, color, etc., were put into the next grade because of their apparent higher moisture content.

Grade A included the best corn which could be selected from the material at hand. About 70 percent of this grade consisted of the White Silver Mine variety, the remaining 30 percent being Reid's Yellow Dent. See table II for further details covering characteristics of this as well as the other grades.

GRADE B—SOFT EAR CORN.

General condition: Medium to good.

Next best to Grade A, but a little off in quality and slightly less mature.

The ears of Grade B were nearly mature and of good size, but not quite as well-filled or as large as Grade A ears. Altho the ears in Grade B were slightly longer than those of Grade A, they were of somewhat less circumference.

The ears were fairly solid, altho they showed slight limberness.

The ears of this grade were not as bright as those of Grade A, altho the difference in appearance was slight.

The kernels were in nearly all cases slightly creased at the crown, giving a somewhat shrunken and immature appearance to the ear. There was little spacing between kernels as the ears were well-covered with well-filled fairly close fitting kernels. A noticeable feature of this grade was that the kernels nearly all showed a dark bluish mold at the kernel base, particularly around the germ, and were also slightly discolored in the creases formed at the crown.

The main difference between Grade B and Grade A were a slightly lower dry matter content, a less bright appearance, and the presence of slight mold in and around the germ.

Approximately 85 percent of this Grade B corn was the White Silver Mine and 15 percent Reid's Yellow Dent.

GRADE C—SOFT EAR CORN.

General condition: Poor.

The ears had in general been in the milk stage at husking time. At the time they were sorted they were in poor condition and more immature than Grades A and B.

Two kinds of ears were placed in Grade C, as follows:

(a) Ears which had been exposed to the air on the stalks during the winter and had lost most of their moisture. The kernels were shrunken, leaving much space on the cob. These ears were somewhat limber and of rather light weight.

(b) Ears which had been kept frozen thruout the winter and were still high in moisture content. These ears were still solidly frozen.

Upon thawing out, those ears carrying much moisture became very much discolored. They were distended with moisture, with no definite structure, while the former class which had dried out in the field had kernels shrunken to a thin blade-like appearance. There was no mold present, inasmuch as all moldy ears were put into Grade D.

About 60 percent of this grade was White Silver Mine and 40 percent Reid's Yellow Dent.

TABLE II—PHYSICAL CHARACTERISTICS OF THE SOFT EAR CORN AS FINALLY GRADED

Grade Maturity	A Most mature well dented	B Nearly mature denting glaze stage	C Immature, apparently in milk stage	D Very immature with few rather mature ears*
Size of Ears				
Av. circumference at center, inches	6.8	6.5	7.0	6.3
Av. length, inches	8.8	9.4	9.2	8.0
Av. weight, pounds	.63	.58	.60	.37
General Appearance	Good	Medium to good	Poor	Very poor
Solidity of Ear	Very solid	Fairly solid	Limber	Very limber
Per cent Moisture Content				
In grain	24.7	29.0	33.8	37.9
In cob	37.0	41.7	49.3	53.5
In total ear	27.8	32.5	38.7	43.9
Color of grain	Bright	Slightly discolored	Much discolored	Much discolored
Shape of kernels	Full, plump	Fairly full and plump	Shrunken or plump with considerable water	No distinct shape
Character of grain	Hard	Rather hard	Rather soft	Very soft
Spacing between kernel	None	A little	Considerable	Very large (cobs not covered as a rule)
Size of kernels				
Av. length, inches	.42	.44	.43	.45
Av. width, inches	.36	.31	.33	.30
Av. thickness, inches	.17	.15	.13	.12
Filling of kernels (Dry matter)	Well filled	Well filled except crease at top	Approximately one-half filled	Least filled
Moldiness	None	At base of kernel; slight	None apparent	Very moldy*

*The mature ears in this grade were included because they were moldy.

GRADE D—SOFT EAR CORN.

General condition: Very poor.

Into this grade was sorted all of the extremely immature corn. It comprised all the very small ears or "nubbins" and all ears only partially covered with kernels. Grade D ears weighed about 60 per cent of Grade A ears. Ears having apparent mold were included in this grade, so that some fairly well-developed corn was thus included. The ears were for the most part undersized, and only partially grown; therefore, the vast majority of them were very limber and quite soggy.

The kernels were discolored and either much shruken or "gourd shaped," extended thus because of the excessive moisture content. They had relatively so little dry matter in them that they did not have as a rule any definite shape. Just what distribution of varities existed in the grade could not very well be determined on account of the fact that all the corn was discolored so badly. However, both Reid's Yellow Dent and White Silver Mine were represented, the latter probably in the largest amount. This grade, without any doubt, easily represented the poorest of the soft corn selections.

All of the physical determinations that were taken into account in selecting the grades, as well as just what characteristics existed in each particular grade of soft corn, are shown in Table II.

TABLE III—CHEMICAL CONSTITUENTS OF GRAIN AND COB OF SOFT EAR CORN JUST BEFORE ENSILING OR DRYING

Grade of soft ear corn	Water per cent	Crude protetin percent	Carbohydrates		Fat (ether extract) percent	Ash (mineral matter)	Total sugars as dextrose percent
			Nitrogen free extract percent	Crude fiber percent			
			CORN GRAIN				
			Natural basis				
A	24.7	7.6	61.4	2.2	2.9	1.2	0.81
B	29.0	7.2	57.8	2.2	2.7	1.1	0.66
C	33.8	8.1	52.3	2.2	2.5	1.2	0.45
D	37.9	7.3	49.0	2.4	2.3	1.2	0.35
			Water free or dry matter basis				
A	.....	10.1	81.6	3.0	3.9	1.6	1.08
B	.....	10.2	81.4	3.1	3.8	1.6	0.93
C	.....	12.2	79.0	3.3	3.7	1.8	0.68
D	.....	11.7	78.9	3.9	3.7	1.9	0.56
			CORN COB				
			Natural basis				
A	37.0	1.7	36.3	23.9	0.4	0.9	1.41
B	41.7	1.8	33.6	21.8	0.3	0.8	0.48
C	49.3	2.0	28.8	19.0	0.2	0.6	0.24
D	53.5	2.3	25.5	17.6	0.2	0.9	0.19
			Water free or dry matter basis				
A	.....	2.7	57.7	38.0	0.6	1.4	2.24
B	.....	3.1	57.6	37.5	0.6	1.4	0.82
C	.....	4.0	56.9	37.6	0.4	1.2	0.47
D	.....	4.9	54.8	37.9	0.5	2.0	0.41

The amount of moisture actually contained in the various grades, both grain and cob as well as the entire ear, became greater as the poorer grades were approached, this being the expectation even tho the corn was graded several months after it was frosted. It should be remembered, however, that the moisture content would have been, relatively speaking, considerably higher in the poorer grades had these determinations been run at husking time in the fall.

Since much of the corn had dried out considerably during the winter the moisture content of these composite samples was lower than would have been characteristic of each grade at husking time.

The different grades of soft corn ears as finally sorted, preparatory to ensiling, were heaped on wooden platforms. No further treatment was given them except to cover them as protection against rain or snow, until they were ensiled. As the corn was graded it was found that on the basis of 100 pounds of the soft ear corn there were the following amounts of the respective grades as sorted:

Grade	Pounds
A	13.9
B	35.6
C	37.0
D	13.5
	100.0

As there was nearly twice enough of the intermediate grades, B and C, to fill their respective silos, it was decided to divide these lots approximately in half, ensiling one-half and artificially drying the other half of each grade, thereby

having a direct comparison in each of these grades of the effect of ensiling or drying.

COMPOSITION OF THE SOFT EAR CORN BEFORE ENSILING OR DRYING.

Table III sets forth the composition of the grain and cob of the soft ear corn as determined from composite samples of representative ears systematically taken of the different grades at the time of ensiling or drying.

In making analysis of the original soft ear corn the grain and cob were analyzed separately. Table III permits a comparison of the grain and cob from the different grades of this soft ear corn, as well as ordinary mature dent corn.

The figures given for the composition of the corn on the natural basis are also recalculated in this table to the water-free or dry matter basis on both grain and cob of all grades.

Henry and Morrison give for the average percentage composition of mature dent corn from 440 analyses the following figures:

Water	Crude protein	Carbohydrates		Fat	Ash
		Nitrogen free extract	Crude fiber		
10.5	10.1	70.9	2.0	5.0	1.5

As may be seen the soft corn contained from 2.4 to 3.6 times as much water as did this mature corn.

Calculating the above average figures to the dry matter basis we have for the mature dent shelled corn:

Crude protein	Carbohydrates		Fat	Ash
	Nitrogen free extract	Crude fiber		
11.3	79.2	2.2	5.6	1.7

By comparing these figures to the dry matter figures for the soft corn in table III it will be seen that they bear a fairly close relationship; the most noticeable difference is that the soft corn, in every instance, was higher in crude fiber and lower in fat content.

As the analyses of the resulting soft ear corn silage must of necessity be reported as on the basis of the final feeding product (it being impossible to separate satisfactorily the grain and cob of the silage, especially in the poorer grades), the dried ear corn will also be reported on this basis. This is necessary also in view of the fact that if this dried ear corn were to be fed to cattle it would doubtless be ground and fed as corn and cob meal.

Table IV, therefore, sets forth the composition of the soft ear corn calculated on the basis of the whole ear. These figures were determined by using the shelling percent of the soft ear corn as determined in the composite samples taken when ensiled. The percentage composition of the whole ear is then figured on the basis of the amounts of grain and cob there would be in 100 percent of the ear corn.

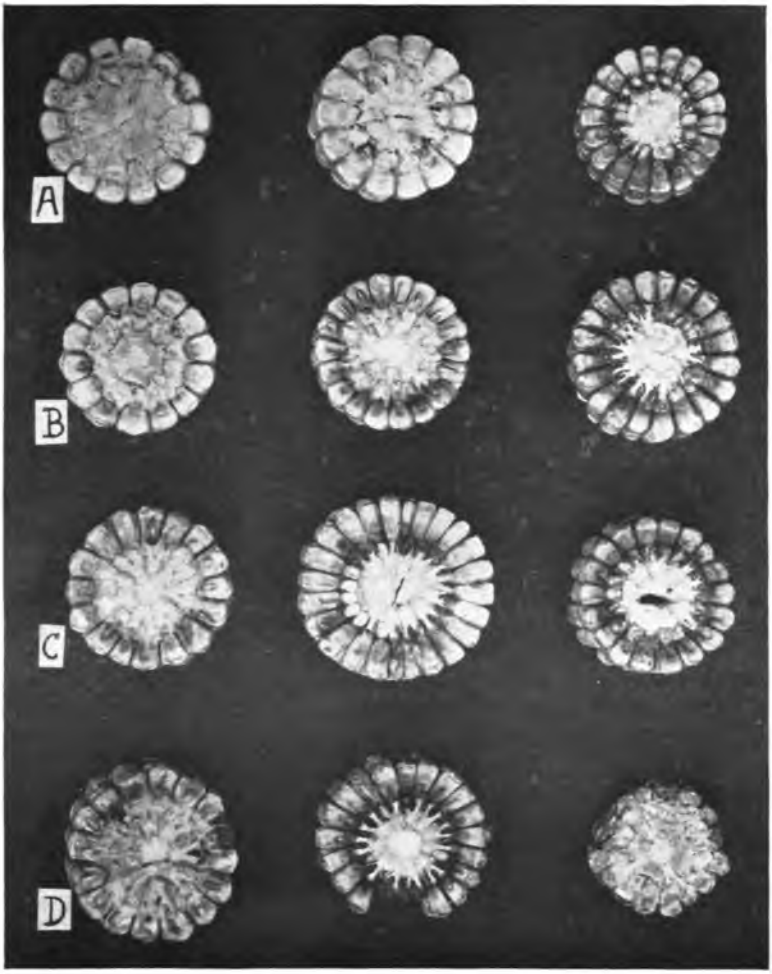


FIG. 2—Cross section of three representative ears of each grade of soft corn, showing germ side of kernel.

TABLE IV—PERCENTAGE COMPOSITION OF SOFT EAR CORN (WHOLE EAR) AT TIME IT WAS DRIED OR ENSILED
(Calculated from Table III)

Grade of soft ear corn	Water percent	Dry matter percent	Crude protein percent	Carbohydrates		Total carbohydrates percent	Fat (ether extract) per cent	Carbohydrate equivalent percent	Ash (mineral matter) percent
				Nitrogen-free extract percent	Crude fiber percent				
				Natural Basis					
A	27.8	72.2	6.1	55.0	7.7	62.8	2.3	67.8	1.1
B	32.5	67.5	5.7	51.0	7.7	58.7	2.0	63.1	1.1
C	38.7	61.3	6.2	44.8	7.6	52.4	1.7	56.2	1.0
D	43.9	56.1	5.4	39.9	8.3	48.2	1.5	51.5	1.1
				Water-Free Basis					
A	.....	100.0	8.4	76.2	10.7	87.0	3.2	93.9	1.5
B	.....	100.0	8.5	75.6	11.3	86.9	3.0	93.6	1.6
C	.....	100.0	10.0	73.2	12.3	85.5	2.8	91.7	1.6
D	.....	100.0	9.5	71.2	14.7	85.9	2.7	91.8	1.9

ENSILING AND DRYING THE SOFT EAR CORN.

Each grade was in turn cut into the silo designated for it. The cutter was set to cut the ears into about one-fourth to one-half inch pieces, which size allowed the mass to be packed readily. As the soft ear corn apparently did not contain enough water to preserve it properly a sufficient amount was added to each grade to allow the entire cut mass to approximate a content of 60 percent water and 40 percent dry matter in the silos. This is an approximate relationship to work toward in the making of good silage. To determine this water requirement moisture tests were run on samples collected before ensiling as follows:

Grade of Corn	Percent moisture	
	Grain	Cob
A	25.2	33.2
B	25.0	30.6
C	31.0	42.0
D	32.0	50.2

As no shelling percent had been determined, 75 percent was taken as an arbitrary figure in this determination.

On the basis of these figures we found that with every 100 pounds of the cut material the following number of pounds of water would be required:

Grade of Corn	Additional water required per 100 pounds
A	82
B	85
C	67
D	60

TABLE V—TOTAL AMOUNTS OF MATERIAL PUT IN SILOS AND DRYING BINS
(All weights in pounds)

Grade and designation of soft ear corn	Total soft ear corn cut into silo (natural basis)	Total soft ear corn put in drying bins (natural basis)	Total water added in silos	Total weight material put into silo or drying bin
A—Silage	5,880	....	4,817	10,697
B—Silage	6,249	....	5,341	11,590
C—Silage	6,606	....	4,421	11,027
D—Silage	5,740	....	3,451	9,191
B—Dried Ear	....	8,834	....	8,834
C—Dried Ear	....	9,060	....	9,060

This water measured thru a meter was added directly to the corn grades as they were cut into the silo. At the end of the hose there was a sprinkling device which distributed the water over the cut corn in such a manner as to insure its being absorbed evenly.

It was found that all the water could not be added at filling time, due to the fact that the cut mass of ear corn would not absorb it very readily, and unless added very slowly it would tend to seep out at the bottom. It was necessary, therefore, to add it very slowly for four or five days after filling in order to allow the required amount to become absorbed. Even with the precautions taken a small amount of water seeped thru. This was estimated as closely as possible and subtracted from the total amount added.

The portions of the two grades of corn, B and C, which were to be dried, were taken to the basement of Agricultural Hall. There, with a temperature of from 115° to 120° F., and with a constant draft passing over them, the soft corn ears were spread out on heavy paper at an average depth of from one to one and three-fourths feet. The drying process which they underwent obtained the same results as the regular crib ventilator and furnace system used on the farm, altho it was not possible to use that method in this test.

In order to determine the losses occurring during drying or ensiling, weights were taken of all the corn going into the silos or drying bins.

Table V sets forth the amounts of material as put into the silos or drying bins. The small amount of water which seeped from the silos was estimated and subtracted from the total water added so that these figures represent, as nearly as possible, the exact weight of material going in at time of ensiling or drying.

FIG. 3—Representative kernels from tip, center and butt of four representative ears of the four grades of soft corn (germ side).

The silos were refilled after a few days settling and then were all carefully sealed with tar paper. After a double thickness of paper had been put over the silage and carefully lapped against the walls, boards were fitted over it and 200 bricks were piled on the boards in each silo. This made a uniform weight of 1300 pounds on the silage in each silo. It was necessary to follow this procedure in this case in order to save all the silage, and also because the roofs on the silos prevented proper tramping when the top was reached.

The corn while being dried was turned once with a scoop, altho this would have been unnecessary had it been dried in a crib by the regular furnace-draft method where the heated air applied at the bottom works up thru. In July, 1918, this corn was removed from the drying room and was stored in cribs until fed.

From the time the soft ear corn was ensiled or dried in March, no further treatment was given it except as mentioned above until the following November, or practically nine months, when the feeding operations were begun.

EXPERIMENTAL RESULTS.

On November 26, 1918, the silos were opened and the four different grades of silage, as well as the two grades of dried soft ear corn, were fed out to swine. (The feeding data will be reported in a subsequent publication).

CHARACTER OF THE SILAGE AND DRIED EAR CORN PRODUCED.

All grades of silage had apparently kept well-preserved, as had also the two grades of dried ear corn. There had been some loss of grain in the dried corn due to rats, and some loss from the silos due to seepage, which seepage had a very bad odor, but the final feeding products themselves appeared to be good, except perhaps in the case of the poorest grade of silage.

GENERAL DESCRIPTION OF GRADES OF SILAGE.

Grade A—Soft Ear Corn Silage. This silage was light in color. The grain was white, full and hard and the cob had a firm texture and was either brown or grey in color. This grade as a whole had a clean-cut appearance, as none of the kernels were mashed and the cob was hard and firm, not mushy. The silage appeared very palatable, was clean looking and had a good distinctive silage odor, comparable to that obtained from the whole plant when properly ensiled. The odor denoted the presence of acetic and lactic acids and there was a lack of objectionable odors of any kind. The cut was well defined, and on the average one-fourth to one-half inch in thickness. There was complete absence of dirt, mold or refuse of any sort. This was apparently a good, clean, bright, palatable, appetizing concentrate.

Grade B—Soft Ear Corn Silage. This grade was in most respects very comparable to Grade A. In general appearance it did not have quite the bright color of Grade A. The kernels were not as light in color, in fact, were inclined to have a slightly dirty appearance, and a trace of dark color near the base of the kernel. The cob was also slightly darker, giving the silage a rather duller appearance than Grade A. However, this grade appeared to possess no difference in odor from Grade A. The kernels in this grade were firm, and the physical condition of the silage was good, altho the quality was a little off. There was not much difference between this grade and Grade A with regard to the final feeding product.

Grade C—Soft Ear Corn Silage. This had a browner color than Grade A or B, but no mold was apparent. It was rather immature, as the corn had been for the most part in the "milk" stage at husking time. It was cut fine, as were the others, but considerable portions of the cobs had slipped thru in large pieces, owing to their spongy consistency. Its physical condition was poor. The odor was apparently good, but it did not have the clean cut and appetizing appearance that was present in the case of the first two grades described. Its appearance was not nearly as good as Grades A and B, which were similar to each other, but it compared rather closely in general appearance to Grade D, poorest grade of all. Many of the kernels in this grade of silage were soft and badly mashed. The whole kernels had taken up considerable water, and were round and plump, altho rather discolored.

Grade D—Soft Ear Corn Silage. This silage was distinctly darker than the others in color. It was apparently not as palatable and its odor was not clean cut and pleasant, but gave a rather sharp and slightly disagreeable sensation. The physical condition was very poor, the grain and cob having been mashed considerably when cut into the silo. This silage had a distinctly mushy appearance that was not characteristic of the other grades. The poor physical condition of this grade made it extremely difficult to get definite determination on it in some of the subsequent work.

Dried Soft Ear Corn—Grade B. As this corn came from the feeding bin it appeared very dry and light in weight. It had a musty odor and was very dusty. The kernels were rather shrunken in appearance, but were fairly well-filled. No mold was apparent, altho there was a dark appearance around the germ.

Dried Soft Ear Corn—Grade C—This grade was not as good in general appearance as Grade B. The ears were lighter and it had the same musty odor. The kernels had shrunken up in most cases so that they appeared nearly flat, and there was large spacing between them on the cob. This corn was also very dusty. In quality it was easily inferior to Grade B of the dried corn.

PHYSICAL ANALYSES OF SOFT CORN SILAGE AND DRIED EAR CORN

Grade	Average percentage of corn grain in material as fed during the feeding trial (natural basis)
A—Silage	68.9
B—Silage	71.2
C—Silage	49.5*
D—Silage	49.2*
B—Dried ear	77.4
C—Dried ear	71.7

*These figures are low on account of the poorly filled kernels and the high moisture content of the cobs.

During the period that the silage and dried ear corn was being fed, samples were taken to represent the upper one-third, central one-third and lower one-third of the silage. Composite samples were taken each month from the dried ear corn. These were separated and the shelling percentage of the silage and dried ear corn was determined on the natural feeding basis.

The average of shelled corn in the different grades of feeding material as fed during the trial is shown in the accompanying table.

At the same time the moisture content of the whole ear corn silage and the dried ear corn as well as the grain and cob of all samples was also determined. The average of these determinations is given below:

Grade	Average Moisture Content During Trial		
	In grain percent	In cob percent	In whole silage or dried ear corn percent
A—Silage	45.9	52.5	48.0
B—Silage	48.1	55.5	50.2
C—Silage	48.6	63.5	56.1
D—Silage	48.2	63.0	55.7
B—Dried ear	12.8	10.7	12.4
C—Dried ear	13.7	13.2	13.6

The total weights of the final feeding products as weighed from the silos and feeding bins were as follows:

Grade	Total amount of final feeding product (pounds)
A—Silage	7,232
B—Silage	7,721
C—Silage	8,051
D—Silage	7,236
B—Dried ear	6,370
C—Dried ear	5,850

By comparing these figures with those covering the total amount of soft ear corn put into the silos, it will be seen that there was a gain in total weight of resultant silage as follows:

Grade	Gain in weight of material taken from silo over original weight of soft ear corn put in silo.	
	Pounds	Percent
A	1,352	23.0
B	1,472	23.6
C	1,445	21.9
D	1,496	26.1

On the other hand, when the weight of the total additional water put with the soft ear corn to make silage is considered in addition to the weight of the soft ear corn itself as cut into the silos, there was the following loss in total weight of material recovered from the silo:

Grade	Loss in weight: Total material taken from silo compared with original weight of soft ear corn ensiled plus water additions.	
	Pounds	Percent
A	3,465	32.4
B	3,870	33.4
C	2,976	27.0
D	1,955	21.3

In the case of the grades of soft ear corn that were dried, there was, of course, a loss in weight, this being given below:

Grade	Loss in weight of total dried material as taken from feeding bins.	
	Pounds	Percent
B	2,464	27.9
C	3,210	35.4

Table VI gives the percentage gain or loss, and percentage recovery of the total final feeding products as taken from the silos or drying bins.

TABLE VI—RECOVERY OF FINAL FEEDING PRODUCTS AS FED

Grade and designation of final feeding product	Soft corn silage (based on original weights of soft ear corn put in silo)	Soft corn silage (based on total weight of material, ear corn plus water, put in silo)	Dried ear corn (based on original weights of soft ear corn put in bin)
	Percent	Percent	Percent
A—Silage	123.0	67.6	....
B—Silage	123.6	66.6	....
C—Silage	121.9	73.0	....
D—Silage	126.1	78.7	....
B—Dried ear	.....	....	72.1
C—Dried ear	.....	....	64.6

Altho these figures on the recovery in weight of the silage and dried ear corn on a natural basis are of practical interest from the tonnage standpoint, and are also of general importance, the figures showing the changes in dry matter content will give more light on the actual food losses occurring in silo and bin storage.

Table VII shows the dry matter recovery in the soft ear corn silage and dried ear corn as fed.

This table is based on the dry matter determinations secured on the original soft ear corn as it went into the silo or bin, and on the final feeding products as fed. The total weights of the original ear corn were taken as it went into and was fed from the silos and from feeding bins. There was some loss of dry matter in all cases.

TABLE VII—DRY MATTER RECOVERY OF SOFT EAR CORN SILAGE AND DRIED EAR CORN

Grade	Percent
A—Silage	88.7
B—Silage	91.2
C—Silage	87.4
D—Silage	99.6
B—Dried ear	93.7
C—Dried ear	91.1

The loss in dry matter in the case of the dried soft ear corn takes into consideration all the natural farm loss of grain as eaten by rats and mice under the practical farm conditions of this experiment, and hence is larger than the actual dry matter lost thru the drying operation. However, corn dried on the farm would in most cases, be subject to the inroads of rodents as this was, and, therefore, the reporting of this additional loss appears justified.

The water recovery in material as fed, comparing same with the ensiled (water being added on ensiling) and binned natural soft ear corn was in percentages as follows: Silage A, 53.7; B, 52.6; C, 64.7; D, 67.5; and in Dried Ear B, 27.4; and C, 22.7.

RATIO BETWEEN COB AND GRAIN DRY MATTER.

Table VIII sets forth the ratio as it existed between the dry matter in the cob and that in the grain of the soft ear corn, and later in the final feeding products.

In the soft ear corn the proportion of grain was highest in Grade A and diminished regularly in the succeeding grades.

It is interesting to note the narrowness of this dry matter ratio between the grain and cob in the poorer grades, this being evident both in the original corn ears and in the final feeding product.

Assuming that no dry matter was lost, the calculated shelling percentage in the above table shows what the final shelling percentages would have been if the only change had been in the final moisture content. A comparison of

TABLE VIII—RATIO BETWEEN COB AND GRAIN DRY MATTER

Grade and designation	Ratio between cob dry matter and grain dry matter in material on the natural basis		Shelling percentage of final products, calculated to final moisture content, assuming no change in absolute dry matter	Actual shelling percentage of final feeding product
	In original soft ear corn before ensiling	In final feeding product		
A—Silage	1 : 3.49	1 : 2.53	75.4	68.9
B—Silage	1 : 3.14	1 : 2.88	72.9	71.2
C—Silage	1 : 2.79	1 : 1.38	66.5	49.5
D—Silage	1 : 2.14	1 : 1.36	60.4	49.2
B—Dried ear	1 : 3.14	1 : 3.34	75.0	77.4
C—Dried ear	1 : 2.79	1 : 2.52	73.7	71.7

these calculated shelling percentages with those actually determined in the final feeding products will give some idea of the changes that took place in the dry matter ratio between cob and grain. It will be noted here that the changes were much greater in the silage than in the dried ear corn.

CHEMICAL COMPOSITION OF THE FINAL FEEDING PRODUCTS.

Table IX gives the chemical composition of the final feeding products as they were determined from samples taken while the silage and dried ear corn were being fed.

TABLE IX—PROXIMATE COMPOSITION OF SOFT EAR CORN SILAGE AND DRIED EAR CORN WHEN TAKEN FROM SILOS OR DRYING BINS

Grade and designation	Water percent	Dry matter percent	Crude protein percent	Total* carbohydrates percent	Fat (ether extract) percent	Carbohydrate equivalent percent	Ash (mineral matter) percent
		Natural basis					
A—Silage	48.0	52.0	4.7	44.8	1.7	48.6	.9
B—Silage	50.2	49.8	4.6	42.5	1.8	46.5	.9
C—Silage	56.1	43.9	3.7	38.2	1.1	40.6	.9
D—Silage	55.7	44.3	4.9	36.9	1.5	40.2	1.1
B—Dried ear	12.4	87.7	7.3	73.8	2.6	79.4	4.0
C—Dried ear	13.6	86.4	7.3	72.3	2.5	77.9	4.2
		Water-free basis					
A—Silage	....	100.0	9.0	86.1	3.3	93.4	1.6
B—Silage	....	100.0	9.3	85.3	3.7	93.4	1.8
C—Silage	....	100.0	8.5	87.1	2.4	92.4	2.0
D—Silage	....	100.0	11.0	83.2	3.4	90.7	2.4
B—Dried ear	....	100.0	8.4	84.2	2.9	90.6	4.5
C—Dried ear	....	100.0	8.5	83.7	2.9	90.1	4.9

It will be noted that the ash determinations show the mineral matter as running very high in the grades of dried

*The crude fiber percentages, part of the total carbohydrates, are as follows: Natural basis, ear corn silage A, 7.3%; B, 6.2%; C, 9.4%; D, 5.8%; and ear corn dried, B, 10.5%; C, 12.8%. Water-free basis, ear corn silages, A, 14.0%; B, 12.4%; C, 21.3%; D, 13.2%; and ear corn dried, B, 12.0%; C, 14.8%. Crude fiber plus nitrogen-free extract make up the total carbohydrates.

TABLE X—AVERAGE COMPOSITION OF CORN SILAGE
(Well-matured)
From 121 Analyses (Henry and Morrison, Feeds and Feeding)
23 Analyses (Iowa Agricultural Experiment Station)

	Water percent	Dry matter percent	Crude protein percent	Total carbohydrate percent	Fat percent	Carbohydrate equivalent pct.	Ash percent
Natural basis							
Henry and Morrison	73.7	26.3	2.1	21.7 (Crude fiber 6.3)	.8	23.5	1.7
Iowa Agricultural Experiment Station	68.1	31.9	2.7	26.4 (Crude fiber 6.7)	.9	28.4	1.9
Water-free basis							
Henry and Morrison	....	100	8.0	82.5 (Crude fiber 24.0)	3.1	89.3	6.4
Iowa Agricultural Experiment Station	....	100	8.5	82.8 (Crude fiber 21.0)	2.8	89.0	5.9

ear corn. This may be explained by the fact that as these grades were dried in a very dusty place it is probable that the dust which collected on them influenced materially these determinations as they were run at the time that these grades were removed from the drying bins.

Table X gives for comparison the average composition of ordinary well-matured corn silage.

It is seen, by comparing this table with that dealing with the soft ear corn silage, that in no case did it run as high in moisture as does ordinary silage.

Altho it was given ample opportunity to absorb more water, that grade of soft ear corn silage containing the highest amount of moisture, comparing it with Henry and Morrison's analyses, contained 17.6 percent less moisture than is contained in the average silage. Compared to analyses of silage made at the Iowa station, the soft ear corn silage contained 12 percent less moisture. Grade A, soft ear corn silage, actually contained only 48 percent moisture, or 25.7 percent and 20.1 percent less, respectively, than the above averages.

Besides this, ordinary silage, which includes the stover, contained 6.3 percent and 6.6 percent crude fiber on the feeding basis, or 24 percent and 20.6 percent on the water-free basis, while the soft ear corn silage averaged only 14.8 percent crude fiber on the water-free basis.

Soft ear corn silage is a more concentrated feed than is ordinary silage and should be handled as such. It contains much less fiber in the dry matter.

Table XI presents the changes taking place during drying and ensiling. It is interesting to note that the better grades of soft ear corn absorbed and held the highest percents of moisture, while in no grade was the absorption holding as high as was allowed for, which was a 60 percent moisture, 40 percent dry matter basis.

Table XII shows the same figures on a water-free basis, It will be noticed that in the case of Grades A, B and D there is a small apparent gain in percent of crude protein, probably due to unavoidable experimental error involved in working with the relatively small quantities of soft ear corn material. Of course, the change in percentage of one constituent has its effect on the percentages of the others present. A decrease in carbohydrates due to fermentation, for instance, would cause an increase in protein percentage.

Table XIII sets forth the total weights of constituents in soft ear corn before and after ensiling or drying. In the case of Grade B soft ear corn there was a somewhat greater

TABLE—XI—COMPOSITION OF SOFT EAR CORN BEFORE AND AFTER ENSILING OR DRYING

Natural Basis

Grade of soft corn or silage	Water percent	Dry matter percent	Crude protein percent	Total carbhhydrates percent	Fat (ether extract) percent	Carbohydrate equivalent percent	Ash (mineral matter) percent
A—Soft corn ..	27.8	72.2	6.1	62.8	2.3	67.8	1.1
A—Silage	48.0	52.0	4.7	44.8	1.7	48.6	0.9
A—Gain or loss	+20.2	—20.2	—1.4	—18.0	—0.6	—19.2	—0.2
B—Soft corn ..	32.5	67.5	5.7	58.7	2.0	63.1	1.1
B—Silage	50.2	49.8	4.6	42.5	1.8	46.5	0.9
B—Gain or loss	+17.7	—17.7	—1.1	—16.2	—0.2	—16.6	—0.2
C—Soft corn ..	38.7	61.3	6.2	52.4	1.7	56.2	1.0
C—Silage	56.1	43.9	3.7	38.2	1.1	40.6	0.9
C—Gain or loss	+17.4	—17.4	—2.5	—14.2	—0.6	—15.6	—0.1
D—Soft corn ..	43.9	56.1	5.4	48.2	1.5	51.5	1.1
D—Silage	55.7	44.3	4.9	36.9	1.5	40.2	1.1
D—Gain or loss	+11.8	—11.8	—0.5	—11.3	0.0	—11.3	0.0
B—Soft corn ..	32.5	67.5	5.7	58.7	2.0	63.1	1.1
B—Dried ear ..	12.4	87.6	7.3	73.8	2.6	79.4	4.0
B—Gain or loss	—20.1	+20.1	+1.6	+15.1	+0.6	+16.3	+2.9
C—Soft corn ..	38.7	61.3	6.2	52.4	1.7	56.2	1.0
C—Dried ear ..	13.6	86.4	7.3	72.3	2.5	77.9	4.2
C—Gain or loss	—25.1	+25.1	+1.1	+19.9	+0.8	+21.7	+3.2

TABLE XII—COMPOSITION OF SOFT EAR CORN BEFORE AND AFTER ENSILING OR DRYING

Water-free Basis

In silos	Crude protein percent	Total carbohydrates percent	Fat (ether extract) percent	Carbohydrate equivalent percent	Ash (mineral matter) percent
A—Soft corn	8.4	87.0	3.2	93.9	1.5
A—Silage	9.0	86.1	3.3	93.4	1.6
A—Gain or loss	+0.6	—0.9	+0.1	—0.5	+0.1
B—Soft corn	8.5	86.9	3.0	93.6	1.6
B—Silage	9.3	85.3	3.7	93.4	1.8
B—Gain or loss	+0.8	—1.6	+0.7	—0.2	+0.2
C—Soft corn	10.0	85.5	2.8	91.7	1.6
C—Silage	8.5	87.1	2.4	92.4	2.0
C—Gain or loss	—1.5	+1.6	—0.4	+0.7	+0.4
D—Soft corn	9.5	85.9	2.7	91.8	1.9
D—Silage	11.0	83.2	3.4	90.7	2.4
D—Gain or loss	+1.5	—2.7	+0.7	—1.1	+0.5
B—Soft corn	8.5	86.9	3.0	93.6	1.6
B—Dried ear	8.4	84.2	2.9	90.6	4.5
B—Gain or loss	—0.1	—2.7	—0.1	—3.0	+2.9
C—Soft corn	10.0	85.5	2.8	91.7	1.6
C—Dried ear	8.5	83.7	2.9	90.1	4.9
C—Gain or loss	—1.5	—1.8	+0.1	—1.6	+3.3

loss of constituents when dried than when ensiled. This must be partially explained, however, by the fact that considerable of the dried corn was lost thru the attacks of rodents. In the case of Grade C soft ear corn there was a greater loss of crude protein in the dried product, and a considerably greater loss of total carbohydrates, while the loss in fat was only one-fourth as large.

Table XIV shows the recovery of constituents after ensiling or drying. Based on the original weights of water as included in the soft corn silage, it is seen that the recovery was highest in the better grades, while the opposite is true when the water recovery calculations are based on the total water that went into the silo. The dry matter recovery ran from 87.4 percent in the Grade C silage to 99.6 percent in the Grade D silage, which showed the highest recovery of all. The recoveries of constituents are fairly comparable to those of entire corn plant silage. The recovery is highest on the average in the dried grades, and no doubt this would have been still higher had rats and mice not found access to the corn, which is the condition on the average farm.

Table XV shows that there was not much material change in the nutritive ratio between crude protein and carbohy-

drate equivalent as it existed in the soft ear corn and final feeding products. It is noticeable, however, that this ratio grows narrower in the better grades, both dried and ensiled, while it widens in the poorer grades.

VALUE OF THE SOFT CORN WHEN BOUGHT

The entire lot of soft ear corn was bought at approximately 93 cents per 100 pounds. After it was graded, the market price of each grade was estimated on the basis of the average price of 93 cents. The figures in the second column in table XVI show, therefore, approximately what would have been paid for each of these four different grades of soft corn on the market. At that time regular No. 4 shelled corn, then the best on the market, was selling for $2.32 per 100 pounds.

The total cost of the soft corn delivered to the silos would have been appoximately the sums shown in this table. As will be seen, the prices of the poorer grades are very low in comparison with the better ones, and it remains to be seen if the high moisture content and the depreciation in the value of the dry matter in these grades will justify the low market valuation figures at which they are usually estimated bought and sold.

TABLE XIII—TOTAL WEIGHTS OF CONSTITUENTS IN SOFT EAR CORN BEFORE AND AFTER ENSILING OR DRYING

In silos	Water (original in soft corn) pounds	Dry matter pounds	Crude protein pounds	Total carbohydrates pounds	Fat (ether extract) pounds	Carbohydrate equivalent pounds	Ash (mineral matter) pounds
A—Soft corn—in.....	1636.4	4243.6	356.9	3690.3	134.1	3985.5	64.1
A—Silage—out	3468.5	3763.5	337.7	3239.2	125.8	3516.1	61.5
A—Gain or loss.....	+1832.1	—480.1	—19.2	—451.1	—8.3	—469.4	—2.6
B—Soft corn—in.....	2033.4	4215.6	357.4	3665.0	127.5	3945.6	65.6
B—Silage—out	3877.4	3843.4	355.2	3279.0	139.8	3586.5	68.7
B—Gain or loss.....	+1844.0	—372.2	—2.2	—386.0	+12.3	—359.1	+3.1
C—Soft corn—in.....	2559.2	4046.8	406.3	3458.9	114.3	3710.6	66.1
C—Silage—out	4515.6	3535.0	301.1	3078.6	85.3	3266.3	69.2
C—Gain or loss.....	+1956.4	—511.8	—105.2	—380.3	—29.0	—444.3	+3.1
D—Soft corn—in.....	2519.9	3220.1	307.1	2766.7	85.5	2955.0	62.0
D—Silage—out	4030.4	3205.5	352.4	2667.2	109.3	2907.5	76.7
D—Gain or loss.....	+1510.5	—14.6	+45.3	—99.5	+23.8	—47.5	+14.7
In Drying Bins							
B—Soft corn—in.....	2874.6	5959.4	505.3	5181.1	180.2	5577.8	92.8
B—Dried corn—out...	786.7	5583.3	466.9	4702.3	162.4	5059.7	251.6
B—Gain or loss.....	—2087.9	—376.1	—38.4	—478.8	—17.8	—518.1	+158.8
C—Soft corn—in.....	3509.8	5550.2	557.2	4743.8	156.7	5089.0	90.6
C—Dried corn—out...	795.6	5054.4	428.2	4230.1	147.4	4554.5	247.5
C—Gain or loss.....	—2714.2	—495.8	—129.0	—513.7	—9.3	—534.5	+156.9

TABLE XIV—RECOVERY OF CONSTITUENTS AFTER ENSILING OR DRYING

Based on total weights of constituents going into silos or drying bins, and total weights recovered therefrom.

Grade	Water		Dry matter percent	Crude protein percent	Total carbohydrates percent	Fat (ether extract) percent	Carbohydate equivalent (percent)	Ash percent	Total	
	Based on original natural weights percent	Based on original weights plus water addition percent							Based on original natural weights percent	Based on original weights plus water addition percent
A—Silage	212.0	53.7	88.7	94.6	87.8	93.9	88.2	95.9	123.0	67.6
B—Silage	190.7	52.6	91.2	99.4	89.5	109.6	90.9	104.7	123.6	66.6
C—Silage	176.5	64.7	87.4	74.1	89.0	74.7	88.0	104.8	121.9	73.0
D—Silage	160.6	67.5	99.6	114.8	96.4	127.7	98.4	123.7	126.1	78.7
B—Dried ear	27.4	....	93.7	92.4	90.8	90.1	90.7	271.3	72.1	....
C—Dried ear	22.7	....	91.1	76.9	89.2	94.1	89.5	273.1	64.6	....

If the value of the 14 percent moisture corn grain equivalent, which really means 86 pounds of grain dry matter and 14 pounds of water in the hundred pounds of corn grain, is taken as equal in all cases to that of good marketable corn, then, when No. 4, 19.5 percent moisture corn grain sells at $2.32 per 100 pounds, the value of 100 pounds of 14 percent moisture corn grain equivalent would be $2.48. However, on the basis of the actual cost of the soft corn, 100 pounds of 14 percent moisture shelled corn grain equivalent in it cost, instead of $2.48 a hundred pounds, the following amounts:

Grade	
A	$2.28
B	2.02
C	1.77
D	1.25

The difference between these figures and $2.48 is equal to the depreciation in estimation of the value of the 14 percent moisture shelled grain equivalent of the soft ear corn. Therefore, in buying the soft ear corn we purchased 100

TABLE XV—RATIO BETWEEN CRUDE PROTEIN AND CARBOHYDRATE EQUIVALENT* IN SOFT EAR CORN AND IN RESULTING SOFT CORN SILAGE AND DRIED EAR CORN

Grade and designation	Based on Original natural weights of soft ear corn before ensiling or drying	Based on Final products dried ear corn or soft ear corn silage
A—Silage	1 : 11.17	1 : 10.41
B—Silage	1 : 10.04	1 : 10.10
C—Silage	1 : 9.13	1 : 10.85
D—Silage	1 : 9.62	1 : 8.25
B—Dried ear	1 : 11.04	1 : 10.84
C—Dried ear	1 : 9.13	1 : 10.64

*The carbohydrate equivalent is determined by multiplying the fat by the factor 2.2, and adding the product to the total carbohydrates present.

TABLE XVI—ACTUAL COST OF SOFT EAR CORN SILAGE AND DRIED EAR CORN

Grade and designation	Soft corn put in silo or crib (pounds)	Estimated market value of 100 pounds soft corn of each grade (natural basis)	Total cost soft ear corn	Cost per 100 pounds to dry or ensile	Total cost of soft corn in silo or bins	Total corn fed from silo or bins (pounds)	Cost per 100 pounds silage or dried ear corn as fed	Cost of* 100 pounds of final grain fed (calculated to 14% moisture content)
A—Silage	5880.0	$1.49	$ 87.61	$ .1291	$ 95.20	7232.00	$1.31	$3.03
B—Silage	6249.0	1.20	74.99	.1291	83.06	7720.80	1.08	2.50
C—Silage	6606.0	.93	61.34	.1291	69.87	8050.60	.87	2.93
D—Silage	5740.0	.56	32.14	.1291	39.55	7235.90	.54	1.84
B—Dried ear	8834.0	1.20	106.01	.2101	124.57	6370.01	1.96	2.49
C—Dried ear	9060.0	.93	84.26	.2101	103.30	5850.00	1.76	2.45

*The No. 4 shelled corn was selling at this time, 19.5 percent moisture, for $2.32 per hundred pounds; this figures $2.48 when reduced to a 14 percent moisture basis. This figure may be compared with the figures for the costs of 100 pounds of grain in various silage and dried corn grades in the last column above.

pounds of 14 percent moisture corn grain equivalent for the following amounts less than was being paid for it in the No. 4 grade of market corn:

Grade	
A	$ .20
B	.46
C	.71
D	1.23

This difference in value then, which depends on the lower estimate placed on the soft corn on the market, mainly because of its poorer general appearance and the fact that it must usually be disposed of at once, will be favorable to the feeding of the soft corn as compared to sound marketable corn because practical tests have indicated that, whereas sound corn dry matter is somewhat superior to soft corn dry matter, the difference is not nearly so large as that usually existing in the valuations placed on the different grades in soft corn years. The soft corn grain dry matter, being accompanied with the relatively large proportion of cob and also with a preponderance of associated kernel water, and perhaps some moldiness, is naturally, sharply and strongly discriminated against in the shipping market. Livestock feeding offers the most logical practical solution of the soft corn disposal problem. Of course, artificial drying on the farm likewise has its place, but even then later livestock feeding is in order.

TABLE XVII—ESTIMATED COST OF ENSILING SOFT EAR CORN

On basis of 20 loads being ensiled daily, or 25.2 tons. Total cost of operating plus storage charge in silo.

Equipment—Cutter.	
Depreciation and repairs	$10.00
Power—	
Engine and one man to operate at $2.00 per hour	20.00
Fuel—	
Gasoline, 2½ gal. per hour at 22.9 cents	6.73
Oil, 1 gallon	.60
Labor—	
One man feeding cutter	4.50
One man shoveling	4.50
Two men in silo, trampling	8.00
Total cost of operating per day	$54.33
Total cost to ensile 100 pounds	$ .1077
Storage charge per 100 pounds	.0214
Total cost per 100 pounds to ensile and store soft ear corn	$ .1291

COST OF ENSILING SOFT EAR CORN

Table XVII presents the estimated cost of ensiling soft ear corn.

This table is prepared on the basis that approximately only 25 tons of this soft ear corn can be ensiled daily. This figure is low compared to the rate of ensiling ordinary silage, where the amount that can be cut in a day is three or four times as high, depending on conditions. On the basis of actual practice, however, it is believed that the above figure is fairly high, based as it is on 20 wagon loads of the soft ear corn being handled per day. Two wagon loads could not be unloaded into the cutter at once, and with one man unloading, this appears to be a generous estimate.

COST OF DRYING THE SOFT EAR CORN

Altho artificially drying soft ear corn in the crib, by the use of a hot air furnace, motor driven air fan and especially arranged ventilators, is a comparatively new venture, it has nevertheless proved satisfactory.

This scheme of drying corn was invented by Prof. H. D. Hughes, of the Farm Crops Department of Iowa State College, and the figures given as to cost of procedure (table XVIII) were estimated with his cooperation.

In drying corn in this manner it appears that the only new equipment necessary would be the furnace and ventilators, as the blower of the silage cutter could be made to fit into the scheme with the aid of a few sections of cutter pipes, and the small gasoline engine ordinarily used on the farm for pumping water and miscellaneous work would have sufficient power to run the fan satisfactorily.

In the accompanying table the depreciation charge on the blower is low, inasmuch as using it would not necessitate running any of the gears, and consequently the wear would be small.

The charge for use of the gasoline engine is comparatively high considering all the other work that it may be charged up with during the year on the farm.

It must be remembered that the cost of drying corn by this method will necessarily vary with—

(1) The amount of material dried.
(2) Moisture content of material.
(3) Existing weather conditions.

In this case, figures are given covering the drying of 70 tons of material, it being estimated that an ordinary double crib as found on the farm would hold this much.

The moisture content of the soft corn used in the trials in which these estimates were made was about the average found in the soft corn, and it was dried down to approximately the same moisture content as old corn.

The weather conditions were typical of winter, the temperature being approximately 32 degrees Fahrenheit while the corn was being dried.

Higher moisture content of the corn, colder weather conditions, or less material to dry, would tend to raise the cost of drying, but the figures as presented are as near as can be estimated for an average operation.

TOTAL COST OF THE SOFT EAR CORN SILAGE OR DRIED EAR CORN AS FED

The cost of the silage or dried ear corn as it came from the silos or drying bins is set forth in table XVI. The figures covering cost of 100 pounds of product as fed are not as significant as those covering the cost of the 14 percent

TABLE XVIII—ESTIMATED COST OF DRYING SOFT EAR CORN

On basis of drying 70 tons, ranging from 32.5 percent to 38 percent moisture down to 12 to 14 percent moisture.
Running 12 days.

Storage—Double crib, $600.00 (2 cribs 48x12 feet to hold 35 tons each)	
5 percent depreciation	$30.00
Interest at 6 percent	36.00
Equipment—Ventilators, $125.00	
10 percent depreciation	$12.50
Interest at 6 percent	7.50
Furnace, $150.00.	
10 percent depreciation	$15.00
Interest at 6 percent	9.00
Blower—For use of blower on silage cutter charge 1-10 regular depreciation on silage cutter (2 per cent deprecation on $400)	8.00
⅛ regular interest at 6 percent	8.00
Power—Gasoline engine $150.00	
Depreciation 20 percent (used 365 days per year charge 1-10 of total depreciation	3.00
1-10 interest at 6 percent	.90
Fuel—10 gal. gasoline per 24-hour day	
120 gal. at 22.9 cents	27.48
8 qts. of oil	1.00
Coal, 660 pounds per 24-hour run at $7.00 per ton	27.72
Labor—Two men (12 days—one for night shift—one for day shift) at $4.50	108.00
Total cost of drying 70 tons	$294.10
Cost to dry 100 pounds original soft ear corn	$ .21

moisture corn grain equivalent as fed, which show plainly where the lower grades were undervalued in the market because of their apparent bad appearance.

WEIGHTS OF THE SOFT EAR CORN SILAGE

From figures obtained during the trial, it was estimated that the average weight of silage per cubic foot in the different grades was as follows. These figures are the average for ten feet of depth.

Grade	Pounds
A	40.6
B	39.7
C	41.0
D	37.6

The average weight under similar conditions of depth of ordinary corn silage made from the whole plant is approximately 26 pounds per cubic foot. It may be seen from these figures that the ear corn silage was much heavier than silage made from the whole corn plant.

The three most logical and practical methods of handling the soft corn are—(1) Immediate feeding to livestock; (2) Ensiling as fodder or ears for later stock feeding; (3) Drying by means of natural and artificial heat to make cribbable. In any event the efficient feeding of the soft corn in whatever form salvaged appears to offer the outstanding opportunity for securing the greatest returns from this not unusual and rather trying climatic misfortune.