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Soft Corn - Feeding and Handling

O. E. Olson

G. Gastler

W. C. McCone

C. Wilson

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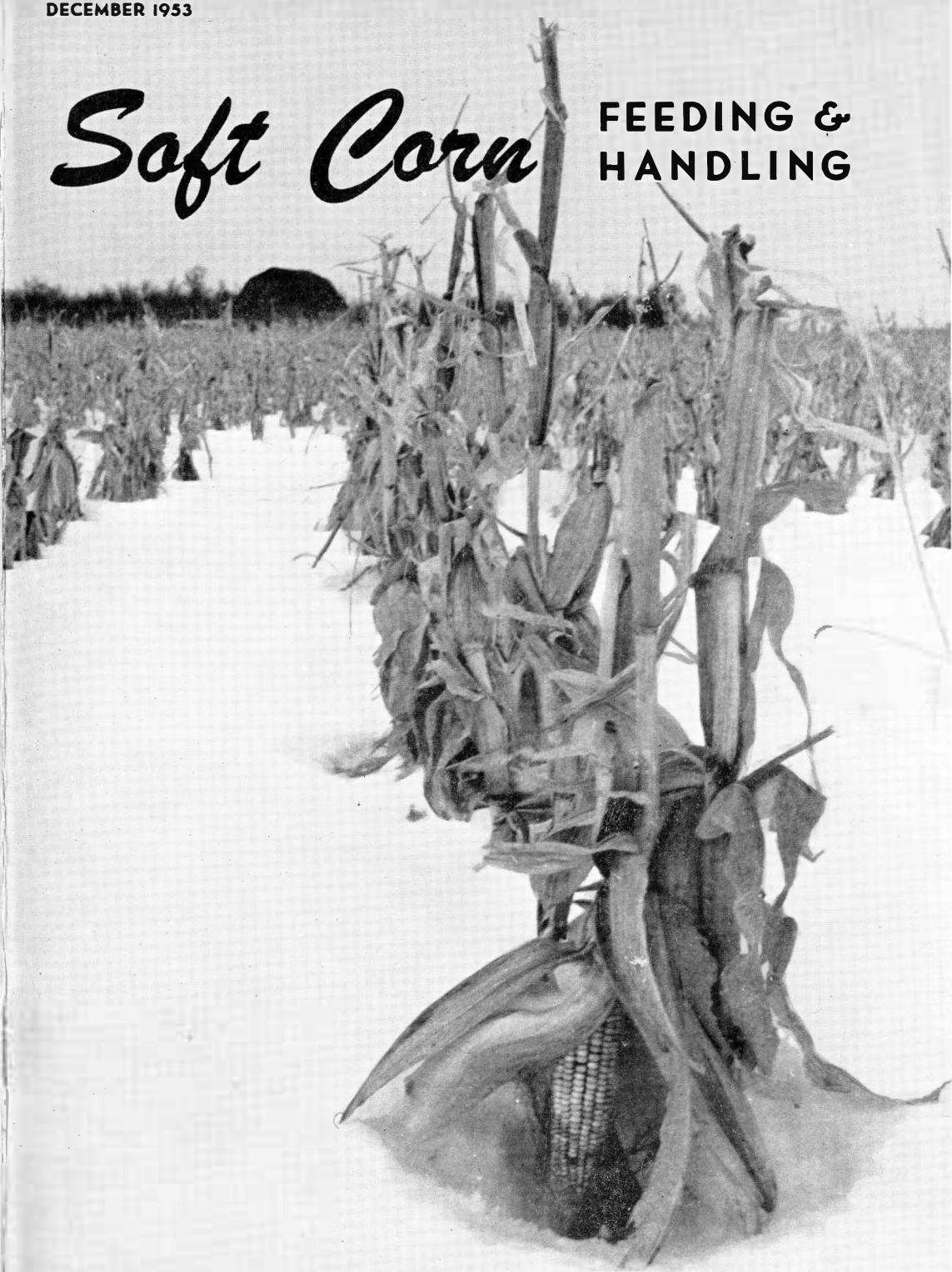

AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE • BROOKINGS

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FEEDING AND HANDLING

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Soft Corn — FEEDING AND HANDLING

Introduction

DURING the 10-year period, 1942 to 1951, South Dakota experienced five years of soft corn production (1942, 1944, 1945, 1950 and 1951). This condition of the corn crop not only raises a number of problems, such as harvesting, storing, drying, feeding and spoilage, but also reduces the income from our most productive land.

Questions frequently asked by farmers who have a soft corn crop which they are not able to convert into silage or market at a satisfactory price are: "To what class of livestock can one best feed soft corn? What is its value? In what form (ear corn, shelled, ground, or as ear corn silage) should it be fed? When should it be fed?"

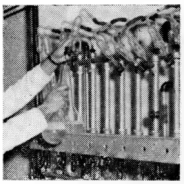
Until the time of the present study, answers to these questions were limited in Experiment Station records of experimental feeding trials. There had been previous investigations at the South Dakota station of soft corn compared with a good grade of hard corn as a feed for beef cattle or hogs, but the two grades of corn were not fed in any of the experiments at the same time and place to both cattle and hogs (Bul. 219). There were no records of experiments with the two grades of corn as feeds for other classes of livestock and poultry when this research work was started in 1942.

Consequently, in an attempt to cover problems of major concern to farmers, soft corn research was outlined by the Experiment Station as follows:

1. Suitable temporary storage.
2. The type of crib suitable for drying soft corn under South Dakota conditions
3. Effective methods of drying.
4. The extent of mold growth and its effect on the corn
5. The chemical changes that take place in the soft corn when stored
6. Its feeding value for livestock and poultry as compared with hard corn
7. The relative ability of calves, yearlings, lambs and pigs to utilize soft corn
8. Satisfactory methods of feeding soft corn.

In the feeding trials, the soft corn was fed as ear corn, shelled corn, artificially dried shelled corn, corn and cob meal, and as ear corn silage.

Soft corn may be defined as having 25 percent or more moisture and it may be moldy. The soft corn for these feeding trials was harvested with mechanical pickers and contained considerable husk. It was stored during the late fall and winter months in long uncovered piles on the ground without heating. When it was so stored, rain and snow did not appear to affect greatly its palatability or feeding value.



Estimating

THE NUTRITIVE VALUE OF SOFT CORN

O. E. Olson and G. Gastler[1]

Usually, the first step in estimating the value of a crop for feeding is the determination of its chemical composition. From the analytical results, an estimate of the nutritive value of the crop can be made. Feeding trials and digestibility studies must then be run for a more complete and accurate evaluation. Chemical studies of soft corn have been made at the South Dakota Agricultural Experiment Station and at other laboratories, and the findings of these studies are reported here as a preliminary to the discussion of the results of feeding work.

In considering either the chemical composition or the nutritive value of soft corn, it should first be well understood that much of the weight of the corn is water (Fig. 1). Corn averaging 50 percent moisture was not uncommon during the winter of 1951-52, and, as Fig. 1 illustrates, it would take almost 2 pounds of this to equal in its content of dry matter 1 pound of corn of low moisture content. Pound for pound then, it could have only about one-half the feeding value of hard corn.

The question that arises, once the moisture content has been considered, is: how does the nutritive value of the dry matter in soft corn compare with that of normal corn? In answering this question with the aid of chemical analyses, the quality that should be considered first is energy content, since this grain is generally fed because of its high content of substances that yield energy and also build fat. By determining the *nitrogen-free extract* content of the grain, a fairly reliable measure of *energy* content is obtained.

The nitrogen-free extract content of the dry matter in corn kernels is low during the early stages of ear formation, and it increases rapidly with maturity until about the early dent stage (Fig. 2). However, once the corn has started to dent, there is very litle change in the percent of nitrogen-free extract in the dry matter.

The data in Fig. 2 are not directly applicable to soft corn as it is fed, however, since the moisture content at the time of feeding has generally dropped below what it was at the time the corn was killed by frost. In December 1951, therefore, a study was undertaken in which several ears were picked for analysis from a field of corn which had failed to mature by the time of frost. Ears were selected at random throughout the field and moisture was determined on the whole ear.

The moisture content of the various ears showed an exceptionally wide range, the wettest corn having a moisture content of 81.6 percent, the driest, 16.4 percent. Several of the ears were selected on the basis of their moisture content, and the

[1]Station Chemist and Assistant Chemist, respectively, South Dakota Agricultural Experiment Station.

kernels were removed and analyzed. The results of the analysis for nitrogen-free extract are given in Table 1. In the corn of highest moisture content, the nitrogen-free extract is lowest. It gradually increases as moisture content decreases until at about 60 percent moisture it levels off and remains about constant for the remaining samples. It should be pointed out that the data in Fig. 2 and Table 1 are not strictly comparable. Although the chemical analyses were made on kernels in each case, the moisture contents in Fig. 2 are for the kernels and in Table 1 are for the whole ear.

In both cases it is clearly shown that the very high moisture content corn is relatively low in its content of nitrogen-free extract. Once the corn has reached about the denting stage, changes in the percent of this component in the kernel dry matter are small. From this it can be concluded that, on a pound for pound of dry-matter basis, most soft corn should have an energy content about equal to that of mature corn.

Protein should no doubt be considered next in evaluating the nutritive value of soft corn. The protein

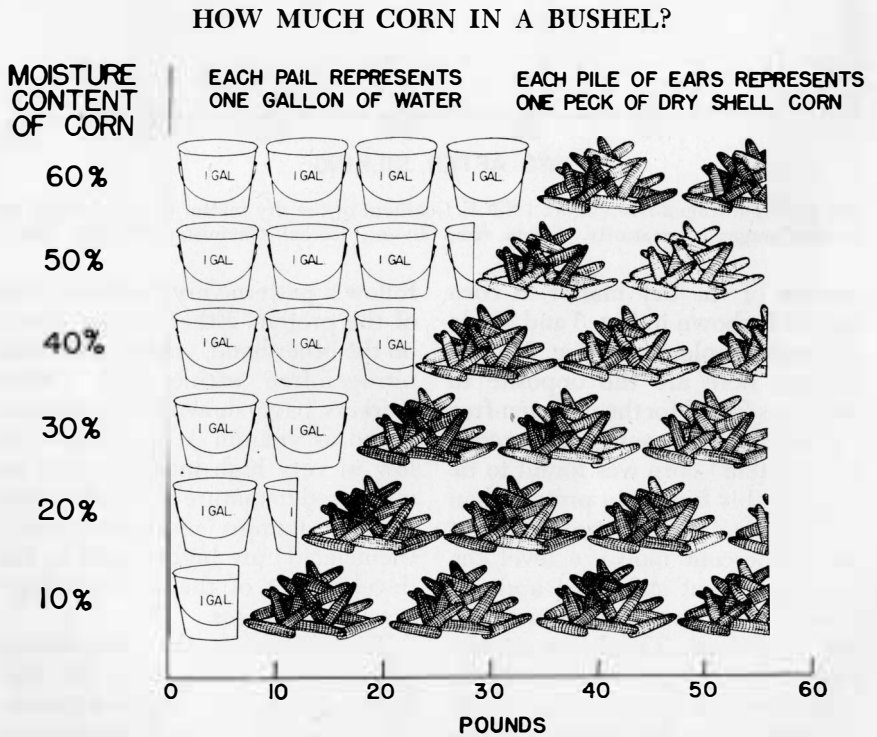


Fig. 1. The amount of water and dry matter contained in each bushel (56 pounds) of shelled corn with moisture contents of 10, 20, 30, 40, 50 and 60 percent.

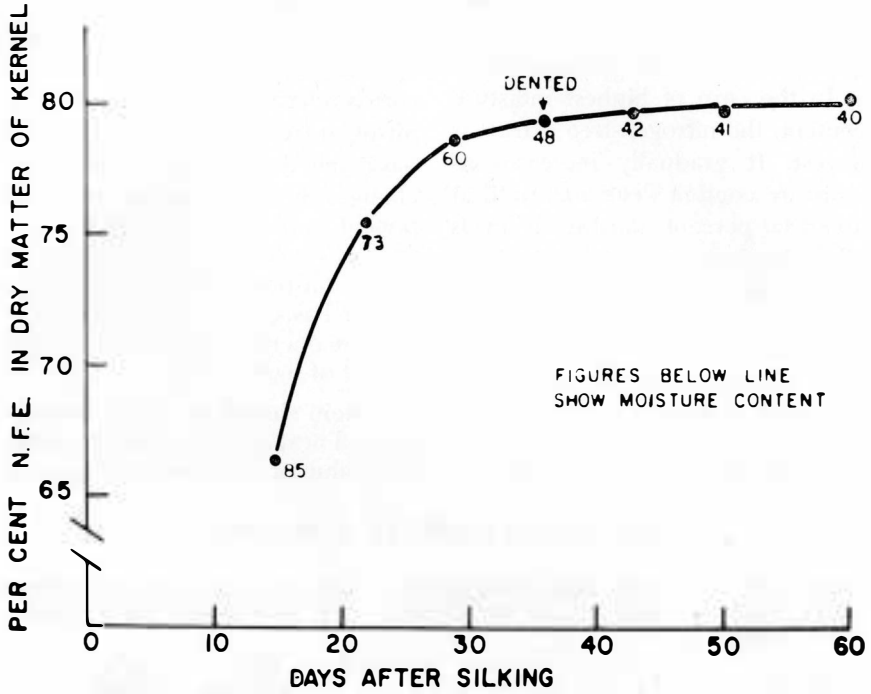


Fig. 2. The nitrogen-free extract (N.F.E.) content of the dry matter of corn kernels at various stages of maturity. (Data from Evans, Cereal Chemistry 18:468, 1941)

content of the dry matter in corn kernels is shown in Fig. 3 and Table 1 (same samples as for Fig. 2). The findings here are the opposite to what was found for the nitrogen-free extract. The very young (high moisture content) corn was found to be considerably higher in protein than was the more mature corn. At about the 60 percent moisture level the protein content stabilized and decreased very slowly as moisture content decreased. The lower energy content of the very immature corn may therefore be somewhat compensated for by its increased protein content.

Ash and crude fiber were found to follow a pattern very similar to that of the protein. Ether extract (fat), on the other hand, varied much like nitrogen-free extract did. Other workers have shown that carotene (used as vitamin A by animals) is low in very high moisture corn as compared to mature corn, while two of the B vitamins (niacin and pantothenic acid) are higher early in the development of the ear than they are at later stages.

To summarize the information now available, it appears that the dry matter in soft corn has a chemical composition closely resembling that of mature corn, except where the moisture content at the time of

Table 1. Nitrogen-Free Extract and Protein Contents of the Dry Matter of Corn Kernels from Ears of Different Moisture Contents (Ears Harvested in December)

Moisture contents of ears, %	16.4	23.4	33.6	43.7	53.5	64.0	74.4	81.6
Nitrogen-free extract in the dry matter of kernels, %	81.7	80.9	80.2	79.5	80.0	75.9	74.7	66.6
Protein in the dry matter of kernels %	10.1	11.4	11.9	12.5	12.2	13.1	15.3	18.2

frost is over approximately 60 percent (less mature than early dent stage). In the very immature corn (over 60 percent moisture) the nitrogen-free extract, ether extract and carotene contents of the dry matter are low while crude fiber is high. In some respects, therefore, the dry matter in this very immature corn is less nutritious than in mature corn, but this is at least partially compensated for by its higher protein, ash and B vitamin content. In general, the same can be said for ear corn that has been said for the grain itself.

According to chemical analysis, soft corn that is dried should be expected to give about the same results in feeding (on a pound for pound basis) as mature corn. On a measured bushel basis, however, the

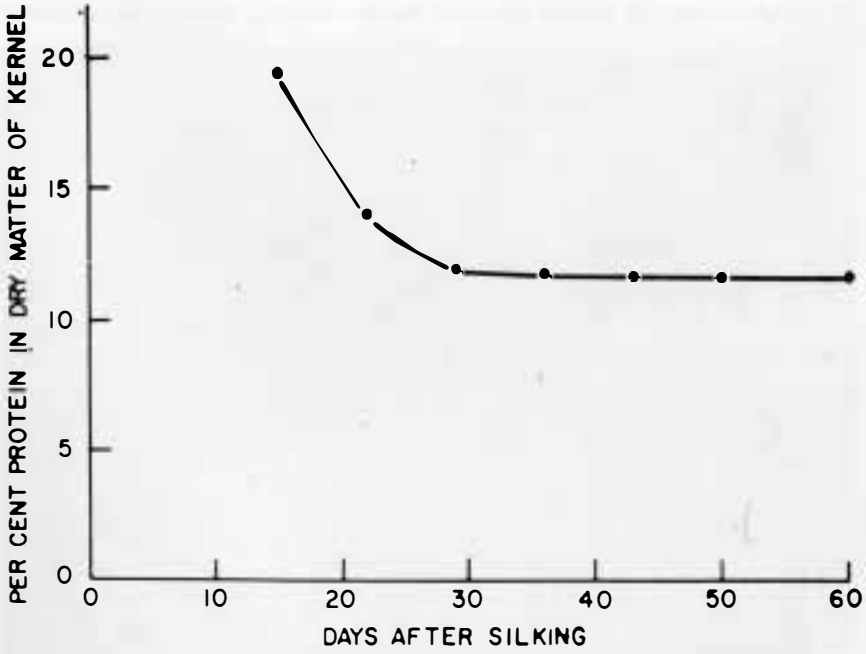


Fig. 3. Protein content of dry matter of corn kernels at various stages of maturity, for same samples as in Fig. 2. (Data from Evans, Cereal Chemistry 18:468, 1941)

dried soft corn is much lighter than mature corn.

As shown in Table 2, corn having a moisture content of from 60 to 69 percent has about half the test weight after drying as corn from the same field with 15 to 19 percent moisture. The corn used for this work was picked in mid-winter and it had dried out to some extent since frost. This difference in corn of high and low moisture contents illustrates again the importance of considering the weight of dry matter in soft corn in comparing its feeding value with that of normal, mature corn.

Table 2. Test Weights of Dried Shelled Corn from Ears of Various Moisture Contents

Moisture Content of Ears, %	Number of Test Weights Made	Average Test Weight (15% Moisture Basis) Lbs./Bu.
60 to 69	2	25.3
50 to 59	4	31.0
40 to 49	7	38.2
30 to 39	7	38.2
20 to 29	5	43.8
15 to 19	3	49.2

W. C. McCone and I. B. Johnson discussing the ear corn silage feeding trials at feedlot.

Beef Cattle

. . . . MAKE GOOD USE OF SOFT CORN

W. C. McCone[2]

BEEF CATTLE made good use of soft corn in feeding trials undertaken in 1943, '45, '51, and '52. This was true whether it was fed as ear corn or as ear corn silage. The corn varied considerably in moisture content in the different years, but it was found that the feeding value of the soft corn was equal to that of mature corn if calculated on a dry-matter basis.

To find out how different age groups utilize soft corn, yearlings and calves were included in the trials. The results showed that age was not a limiting factor in the utilization of the feed and that yearling steers as well as calves made good gains.

Feeding Trials—1943 and 1945

The rations were made up of alfalfa hay, steamed bonemeal, salt and ground limestone, with either hard or soft corn. The alfalfa hay was grown locally and graded U. S. No. 1, extra leafy. The hard yellow corn was also grown locally, graded No. 3, and was cribbed.

The soft corn had an average moisture content of 25 to 32 percent at the time of purchase (samples of shelled corn were taken from the soft ear corn). It was stored in long, uncovered piles on the ground and was field run, including all moldy, rotten, soft, or husk-covered ears. During the winter months, some snow and ice were present in the soft corn when it was fed.

Both hard and soft corn were hauled from a central storage and fed to the lots of cattle as needed. The corn and alfalfa hay were hand-fed twice daily. The salt, steamed bonemeal, and ground limestone were offered free choice to all cattle, and were self-fed separately. They are shown combined in Table 3, since they were consumed in similar proportions in all lots. The broken ear corn was full-fed, with alfalfa hay being offered in amounts that would be eaten readily after the corn had been consumed.

No difficulty was experienced in getting the steers on a full feed of the soft corn. In both years they were started on feed in December.

A protein concentrate was omitted from the ration of these first two feeding trials after an attempt to feed it during the first trial caused some scouring. However, observation tests made on other steers during 1945, indicated that protein concentrates can be fed with the soft ear corn. Also, the 1951 and 1952 trials indicated that protein supplements can be fed with desirable results.

The yearling steers and calves getting the soft corn made slightly faster gains than those fed hard corn (Table 3), but the differences were

[2]Assistant Animal Husbandman. Also assisting in this research were: I. B. Johnson and L. E. Johnson, both of whom were former heads of the Animal Husbandry department, and F. U. Fenn, former Assistant Animal Husbandman.

too small to be of significance. There was a tendency for the cattle on soft corn to make faster gains during the first part of the feeding period.

In the 1943 feeding trial the cattle fed soft corn excelled those fed hard corn in rate of gain and finish throughout the experiment. In 1945, however, the cattle fed hard corn excelled those fed soft corn by market time, and the cattle on soft corn were definitely more growthy and had less finish. On the basis of the two years' work, the carcasses from both groups were very similar in grade.

Yearling Steers Used in 1951 Trials

In the 1951 trials, yearling steers were used. Feeding methods were similar to those of previous years with the exception that soybean oil meal was added as a protein supplement. No difficulty was observed in keeping these cattle on feed when the supplement was gradually added until the steers were getting 1 pound per head daily. Table 4 gives the results of the 1951 feeding test where soft ear corn was compared to hard ear corn and matured shelled corn, with the addition of alfalfa hay and soybean oil meal in the rations.

Table 3. Soft Ear Corn Compared with Hard Ear Corn for Fattening Yearling Steers and Steer Calves (1942-43 and 1944-45)

	Yearlings (Fed 159 Days)		Calves (Fed 239 Days)	
	Hard Ear Corn	Soft Ear Corn	Hard Ear Corn	Soft Ear Corn
Number steers	20	20	19	20
Average weight per steer, lbs.				
Initial	733	732	405	400
Final	1,076	1,084	868	872
Total gain	343	352	463	472
Daily gain	2.16	2.21	1.94	1.97
Feed per cwt. gain lbs.				
Ear corn	1,004.4	1,387.2	770.2	1,347.0
Alfalfa hay	247.5	239.8	210.2	199.5
Minerals	3.5	2.8	3.2	3.0
Total dry matter in feed	1,021.6	1,019.7	815.6	917.6
Pork gains per steer, lbs.	36.6	35.2	56.9	50.9
Initial cost per steer	$97.15	$97.02	$49.57	$49.02
Feed costs and net profit, dollars				
Feed cost per cwt. of gain*	13.15	10.28	10.22	9.79
Marketing cost per steer	3.10	3.14	3.01	3.03
Selling price per cwt.	15.55	15.45	14.95	14.75
Profit per head†	15.48	24.67	25.32	25.69
Average carcass grade	Top good	Top good	Low choice	Low choice
Average shrink, lbs.	41.8	42.0	30.1	31.8
Average dressing percent	59.7	59.5	57.9	58.2

*Feed prices: Hard ear corn, $.80 per bu. ($1.43 per cwt.); soft ear corn, $.63 per cwt.; alfalfa hay, $12.50 per ton; salt, $.90 per cwt.; ground limestone, $1.00 per cwt.; bonemeal, $3.40 per cwt.

†Labor, overhead expenses and credit for manure and pork gains not included.

Table 4. Soft Corn for Fattening Yearling Beef Cattle, 1951 (Fed 173 Days)

	Lot I Shelled Corn Alfalfa Hay Soybean Oilmeal	Lot II Hard Ear Corn Alfalfa Hay Soybean Oilmeal	Lot III Soft Ear Corn Alfalfa Hay Soybean Oilmeal
Number Steers	9	9	10
Average weight per steer, lbs.			
Initial	857	854	862
Final	1172	1175	1217
Total gain	315	321	355
Daily gain	1.82	1.86	2.05
Average daily ration, lbs.			
Shelled corn	14.17		
Hard ear corn		16.41	
Soft ear corn			24.31
Oats	0.86	0.86	0.87
Alfalfa hay	6.58	6.91	6.60
Soybean meal	0.78	0.78	0.78
Minerals	0.08	0.09	0.07
Feed per cwt. gain, lbs.			
Shelled corn	778.4		
Hard ear corn		884.2	
Soft ear corn			1184.2
Oats	47.3	46.4	42.2
Alfalfa hay	361.3	372.1	321.7
Soybean meal	42.8	42.0	37.9
Minerals	4.5	4.5	3.3
Selling price per cwt.	$35.50	$35.50	$35.50
Feed cost per cwt. of gain*	$28.69	$26.17	$17.00
Average carcass grade	Prime	Prime	Prime
Average shrink, lbs.	32.8	33.1	28.8
Average dressing percent	61.2	60.4	60.4

*Feed prices: Shelled corn, $1.50 per bushel; hard ear corn, $1.45 per bushel; soft ear corn, $.85 per cwt.; oats, $.90 per bushel; alfalfa hay, $25 per ton; soybean meal, $85 per ton; salt, $1.35 per cwt.; bonemeal, $5.25 per cwt.; and limestone, $1.30 per cwt.

The Lot III cattle fed on soft ear corn, alfalfa hay and soybean oil meal made the greatest daily gain of 2.05 pounds. Cattle fed hard ear corn in Lot II made daily gains of 1.86 pounds, while the Lot I cattle fed shelled corn gained 1.82 pounds daily. The greater gain of the cattle fed soft corn was due largely to more rapid gains in the early part of the feeding trial.

There was no noticeable difference between lots as to appearance and finish. Each lot was sold as a group; all brought the same price per hundredweight and all carcasses graded prime. There was no marked difference between lots in regard to dressing percentage or shrink during marketing process.

1952 Feeding Trials with Soft Ear Corn Silage

In the fall of 1951, South Dakota farmers experienced one of the years in which corn was caught with early frosts and the moisture content of most corn was exceedingly high. Work previously done at this Station involved the use of this kind of feed as soft ear corn. That year an experiment was conducted in which the feeding value of ear corn silage for cattle was measured.

The corn was picked in October, then put through an ensilage cutter and blown into a temporary silo made of corn cribbing and lined with sisalkraft paper. A stack 16 feet in diameter and about 10 feet high was ensiled. Since the corn had 58 percent moisture at the time of ensiling, no water was added. The corn was cut relatively fine so that it would pack well and the cobs would not be sorted out in feeding.

Two lots of 10 yearling steers each were fed. Lot I received a full feed of ground ear corn and Lot II was full-fed on ear corn silage. Both lots were fed equal amounts of alfalfa hay and linseed meal. All cattle were offered salt, bonemeal and limestone, free choice.

Feeding the silage to 10 steers presented a problem in that the rate of feeding was not considered sufficient in relation to the top surface of the silo. The silage was fed from the side rather than from the top in order to expose as little surface as possible. This method was successful, as relatively little spoilage resulted throughout the feeding period.

The results of this feeding trial, which ran from January 31 to May 29, of 1952, are given in Table 5. Lot I, fed on ground ear corn, made daily gains of 2.40 pounds per head and the Lot II steers, fed silage, made daily gains of 2.21 pounds. The higher daily gain of the steers in Lot I was a result of rapid gains during the latter part of the feeding trial. The steers fed the ear corn silage in Lot II made greater daily gains during the first eight weeks of the trial. These steers ate about 30 pounds per head daily of ear corn silage, whereas the steers in Lot I were on a full feed with 18 pounds of ground ear corn.

The Lot II steers required 1,358 pounds of ear corn silage to produce 100 pounds of gain, while 748 pounds of ground ear corn produced an equal gain in Lot I. Considering that the ear corn silage had 57 percent moisture at the time of feeding and the ground ear corn had 15 percent moisture, the steers on ear corn silage made their gains on slightly less dry matter than did the steers on ground ear corn.

Very little difference was noted in the selling price, shrinkage, or dressing percentage of the two lots. Under feed prices which prevailed at the time, it was possible to produce beef most economically on the ear corn silage.

Review of Beef Cattle Feeding Results

In these feeding trials, soft corn proved to be equal to mature corn for producing gains in calves and yearling feeder cattle. Due to the higher moisture content, it was necessary to feed larger amounts of soft corn to produce cattle gains, but

when calculated on a dry-matter basis, the different moisture content corns were of equal value. This was true when soft ear corn was stored in long narrow piles and fed during winter months. The warm weather in spring and summer caused increased spoilage and shrinkage of the soft corn which resulted in decreased feeding value. Yearling steers were more efficient utilizers of soft corn than were calves.

No bad effects occurred in shifting cattle from a full feed of good quality grain to a full feed of soft, moldy ear corn. In an observation test, 29 steers on a full feed of shelled corn and barley were shifted in five days to a full feed of the soft ear corn without going off feed or showing any bad effects. The steers were fed the soft corn ration for four weeks and continued to make good gains over the period.

Table 5. Soft Ear Corn Silage Compared to Ground Ear Corn for Fattening Yearling Beef Cattle, 1952 (Fed 119 Days)

	Lot I Ground Ear Corn Alfalfa Hay Linseed Meal	Lot II Ear Corn Silage Alfalfa Hay Linseed Meal
Number steers	10	10
Average weight per steer, lbs.		
Initial	815	817
Final	1100	1080
Total gain	285	263
Daily gain	2.40	2.21
Average daily ration, lbs.		
Ground ear corn	17.94	
Ear corn silage		29.96
Alfalfa hay	7.75	7.75
Linseed meal	0.90	0.90
Feed per cwt. gain, lbs.		
Ground ear corn	748.4	
Ear corn silage		1357.8
Alfalfa hay	323.3	351.1
Linseed meal	37.7	40.9
Feed costs and net profit, dollars		
Feed cost per cwt. of gain*	23.07	14.38
Marketing cost per steer	2.61	2.56
Selling price per cwt.	32.40	32.31
Profit per head†	11.33	31.17
Carcass grade:		
Number of choice carcasses	6	6
Number of good carcasses	4	4
Average shrink, lbs.	24.4	23.8
Average dressing percent	59.32	59.12

*Feed prices: Ground ear corn, $1.68 per bushel; ear corn silage, $.65 per cwt.; alfalfa hay, $20 per ton; and linseed meal, $100 per ton.
†Labor, overhead expenses and credit for manure not included.

Dairy Cows

...ON SOFT CORN GIVE QUALITY MILK

CHASE WILSON[3]

DAIRY COWS WILL efficiently convert soft corn into high quality milk, maintain their body weight and stay healthy while doing so. This is shown by the results of experiments conducted in two different years when soft corn was on hand as a result of early killing frosts.

The feeding value of soft corn was compared with hard corn of good quality that had a moisture content of 15 percent. The amount of moisture in the soft corn varied somewhat with different lots, but the average for the two winter seasons was 42 percent. This wet corn was stored outside where it remained in a frozen condition. To prevent further spoilage it was brought into the barn in small quantities, sufficient for three or four days' requirements. It was found necessary to thaw this frozen soft corn just before it was to be ground in the small hammer mill. A one-half inch screen was used in the mill.

Both the hard corn and soft corn were used as corn-and-cob meal and were mixed with the other feeds in the grain-concentrate ration at the time of grinding. The amount of soft corn used in the ration depended upon its moisture content. Since there was much more moisture in it than in hard corn, its feeding value per pound was less.

In these experiments the amount of soft corn used in the ration was calculated so that there would be the same amount of feed on the dry-weight basis as in the hard corn ration. The following example is typical of the grain-concentrate rations:

Item in Ration	Hard Corn Lbs.	Soft Corn Lbs.
Corn-and-cob-meal	700	1000
Wheat bran	250	250
Linseed meal	50	50
Steamed bonemeal	10	10
Salt (iodized)	10	10
Total	1020	1320

Since the soft corn ration weighed 300 pounds more than the hard corn ration, due to the high moisture content in the soft corn, it is obvious that a greater amount of it would be required for each feeding to give the same quantity of feed on a dry-weight basis. In this case, $1320 \div 1020 = 1.3$, which means that for each pound of the hard corn ration it would be necessary to feed 1.3 pounds of the soft corn ration.

In these trials the amount of grain mixture fed was 1 pound for each 3 pounds of milk produced during the experiment. For example, one of the cows was producing milk at the rate of about 45 pounds per day. Her daily ration was 15 pounds ($45 \div 3 = 15$) of the mixture containing hard corn. When this cow was put

[3]Associate Dairy Husbandman.
Others who worked on this problem are: P. L. Kelly, Dairy Husbandman, former head of the Dairy Department; D. F. Breazeale, Dairy Husbandman; Emery Bartle, Assistant Dairy Husbandman; R. J. Baker, Assistant Dairy Husbandman.

on the soft corn ration, she was given 19.5 pounds (15 x 1.3 = 19.5) daily. In addition, all of the cows were fed 1 pound of alfalfa-brome hay and 3 pounds of corn silage for each 100 pounds of body weight.

Six Holstein cows were used in the trials conducted during February, March, and the first part of April 1951. Four Holsteins, two Guernsey and two Jersey cows were used in the second trial conducted during February, March and April 1952. The cows were divided so that the different breeds were equally represented in the two groups and were selected so as to be as uniform as possible with respect to age, size and stage of lactation.

One group received the soft corn ration and the other received the hard corn ration. These rations were given to the alternate group after the end of the first feeding period. That is, the group that was fed the soft corn ration in the first 30-day period received the hard corn ration in the second 30-day period. Each feeding trial was preceded by a 10-day preliminary feeding period.

Following the completion of the final 30 days on the experiment in 1952, both groups of cows were put on a ration containing dried corn. This ration was similar to the ones used in comparing hard and soft corn except that the corn used was commercially dried. It was taken from the same pile of soft corn as that fed in the 1952 trial. Both groups of cows were put on this ration at the same time.

Table 6. Summary of 1951 and 1952 Trials

	Soft Corn	Hard Corn
Moisture in corn, %	42.4	15.4
Average milk production per day, lbs.	28.9	30.3
Lbs. feed per 100 lbs. milk*	42.5	33.3
Change in body weight per cow, lbs.	−4.0	−15.0

*1 lb. alfalfa-brome hay and 3 lbs. of corn silage were fed per 100 lbs. body weight per cow per day in addition to the grain ration.

Results

There was practically no difference in the results of feeding the soft, high-moisture corn as compared to the hard corn when fed on an equivalent dry-matter basis. A summary of the two years' work is shown in Table 6. The soft corn used averaged 42.4 percent moisture in contrast to 15.4 percent for the hard corn. The cows on hard corn produced an average of 1.4 pounds more milk per day than the ones on soft corn. However, they lost an average of 15 pounds of body weight per cow during the feeding trials while the cows fed soft corn lost an average of only 4 pounds per cow.

The results obtained in the two individual yearly trials (1951 and 1952) were very much alike. During both years the cows on hard corn produced slightly more milk than when fed soft corn. In contrast to this the cows fed soft corn had a slight advantage from the standpoint of body weight. During 1951, both groups of cows gained in weight with the greatest gain going to the ones on soft corn. In 1952 both groups lost weight during the course of the experiment. However, the smallest loss was recorded for the cows on the soft corn.

The hay that was available for

feeding in 1952 was of very poor quality. This probably is the reason for both groups of cows losing weight during this trial. Both groups also produced less milk than the year before because of the poor hay. However, there was no difference in performance in favor of either group that could be attributed to either hard or soft corn.

Table 7. Results of Feeding Commercially Dried Immature Corn, 1952

	Group I	Group II
Moisture in corn, %	15.7	15.7
Av. milk production per day, lbs.	17.9	16.5
Lbs. feed per 100 lbs. milk*	30.0	30.0
Change in body weight per cow, lbs.	+39.5	+27.5

*1 lb. alfalfa-brome hay and 3 lbs. of corn silage were fed per 100 lbs. body weight per cow per day in addition to the grain ration.

The results of feeding the dried corn are given in Table 7. In this case all eight cows were on the same ration. All cows ate and utilized this corn to good advantage with no observable difference between cows or groups. The advantage in drying high moisture corn is that it can be stored through the summer months without incurring loss from deterioration.

No digestive difficulties were observed at any time with any of the cows during the two winter seasons when soft corn was fed. The experiment was started rather late in the winter both years and the corn became quite moldy before the end of the trials. The palatability of the soft corn was very good. This was true even for the soft corn that became quite moldy with the warmer weather in the spring months.

Milk samples from each cow on the experiment were saved once each week in 1951 and were examined for flavor and odor by at least two milk judges. They were saved only at irregular intervals during the 1952 trial. In spite of the fact that some of the corn was moldy, no objectionable flavors or odors which could be attributed to feed were observed.

Review of Dairy Cattle Feeding Results

Soft corn can be fed to dairy cows with very satisfactory results. Results of two years' feeding trials are presented in Table 6. They show almost equal milk production and body weight maintenance for the cows on soft corn as compared to hard corn. No other differences could be attributed in favor of either hard or soft corn. Precautions to be observed are (1) allow the corn to remain frozen until it is to be ground and mixed into the ration, (2) prepare only a few days supply at a time and (3) calculate the amount needed in the ration, based on the dry matter it contains.

Lambs

STAY HEALTHY ON SOFT, MOLDY CORN

R. M. JORDAN[4]

A CORN CROP that is soft and immature raises many questions in the mind of the average farm flock owner or commercial lamb feeder. For example: Will sheep eat soft moldy corn and will it cause any death loss? What is the value of soft corn in relation to sound corn? Can feeder lambs be fattened on it? In what form (ear corn, or shelled) should it be fed? What season of the year should it be fed?

Four years of feeding lambs at this station, following the harvesting of soft corn crops in 1942, '44, '50, and '51, have supplied answers to these questions.

It was found that the soft moldy corn was palatable to the lambs and no death losses resulted from feeding it. The value of the soft corn depended largely on its moisture content and the time of the year it was fed, the greatest feeding value being obtained when it was fed in the winter.

The moisture content of the ear corn fed in these trials varied from about 25 percent in 1942 to about 50 percent in 1951.

In some years, the trials were purposely started late so as to end in warm weather after the corn had begun to mold and spoil. This was done to find out how well the lambs would eat moldy corn and what effect the mold would have on its feeding value.

Good quality feeder lambs were used in all trials. They were full-fed corn and alfalfa hay and had free access to a mineral mixture and water. No protein supplement was fed in the first two trials, but in the last two a small amount of soybean meal was fed. The soft corn was fed "field-run," including all moldy, rotten, and husk-covered ears.

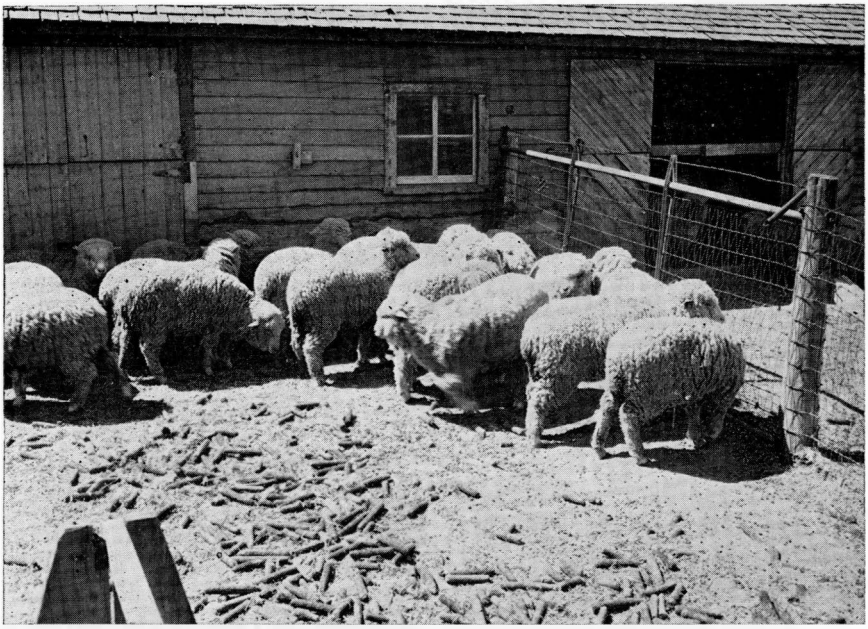
The 1942-43 and 1944-45 Trials

The results of feeding soft ear corn, alfalfa hay, and minerals to fattening lambs during the winter months of 1942-43 and 1944-45 are presented in Table 8. The soft corn fed during 1942-43 contained 25 percent moisture and that fed during 1944-45 contained 31.5 percent moisture.

The soft corn was readily eaten by the lambs and it caused no digestive disorders. The rate of gain of the lambs receiving soft corn was 0.35 pound per day as compared to 0.37 pound per lamb daily for the hard corn group. Market shrink, carcass grade and selling price were not affected by the rations fed.

In these trials, 100 pounds of hard corn was equal to 123 pounds of soft corn plus 9 pounds of alfalfa hay. On a dry-matter basis the lambs fed soft corn required 473 pounds of corn and 392 pounds of alfalfa hay for 100 pounds of gain, while those

[4]Associate Animal Husbandman. The feeding trials during 1942 to 1945 were conducted by W. H. Burkett, former Assistant Animal Husbandman.



Soft, moldy corn proved to be palatable to lambs and they made good daily gains on it.

Table 8. Soft Corn for Fattening Lambs, 1942-43 and 1944-45 (Fed 88 Days)

	Lambs Fed Alfalfa Hay and	
	Hard Ear Corn	Soft Ear Corn
Number lambs	35	37
Initial weight per lamb, lbs.	69.4	69.7
Final weight per lamb, lbs.	102.4	100.6
Gain per lamb, lbs.	33.0	30.9
Daily gain per lamb, lbs.	0.37	0.35
Average daily ration, lbs.		
Corn	2.25	2.61
Alfalfa	1.39	1.52
Feed per cwt. gain, lbs.		
Corn	608.8	746.0
Alfalfa	375.8	433.3
Market shrink, %	3.5	2.6
Selling price per 100 lbs.	$16.25	$16.25
Returns per lamb	$ 2.25	$ 3.44

Feed prices: Hard ear corn $.80 per bu. ($1.43 per cwt.); soft ear corn, $.63 per cwt.; alfalfa hay, $12.50 per ton; salt $.90 per cwt.; ground limestone, $1.00 per cwt.; bonemeal, $3.40 per cwt.

fed hard ear corn required 479 pounds of corn and 340 pounds of alfalfa hay.

1951 Trial

In many instances there is not enough livestock on a farm to consume all of the soft corn before warm spring weather commences. A pile of corn that has been stored from the preceding fall until spring (April) has moldy spoiled ears and a rank odor, indicating that it has deteriorated in quality. During the spring of 1951 (April 27–June 30) an experiment was conducted to determine the feeding value of soft corn (40 percent moisture) that had apparently deteriorated in value from the time it was harvested. The results are presented in Table 9.

These results indicate that "high-

moisture" corn deteriorates in feeding value during warm weather. The lambs receiving soft corn gained 0.1 pound less per lamb daily and required more feed per 100 pounds of gain than lambs receiving hard ear corn. These results are considerably poorer than previous tests have shown. In spite of the spoiled condition of the corn, the lambs ate up to 3 pounds per head daily. Feeding this corn to lambs offered a means of disposing of an unsaleable crop more advantageously.

1952 Trial

The moisture content of the corn crop harvested in 1951 ranged from about 20 percent to 65 percent. What is the value of corn containing 50 to 60 percent moisture as a feed? That was a frequent question during the fall of 1951.

Three groups of lambs were fed during 1952 to answer this question. The three groups were full-fed as follows: Lot I, hard shelled corn, alfalfa hay, and soybean meal; Lot II, corn containing approximately 50 percent moisture that was shelled and artificially dried to 17 percent moisture, alfalfa hay, and soybean meal; Lot III, soft shelled corn (50 percent moisture), alfalfa hay, and soybean meal.

The results of the feeding trial are presented in Table 10. A comparison of Lots I and III shows that the lambs receiving soft corn (Lot III) consumed almost 0.6 pound more corn than Lot I, daily. However, when this amount of feed is converted to a dry-matter basis, Lot I was actually receiving the heaviest feed. In spite of the high moisture content of the corn fed, there was only 0.02 pound difference in average daily gain.

The lambs receiving the artificially dried corn made exceptionally

Table 9. Soft Corn for Fattening Lambs, 1951 (Fed 64 Days)

	Lambs Fed Alfalfa Hay, Soybean Meal and		
	Shelled Corn	Hard Ear Corn	Soft Ear Corn
Number lambs	25	25	24
Average initial weight, lbs.	71.6	65.3	65.1
Average final weight, lbs.	96.3	92.0	85.3
Gain per lamb, lbs.	24.7	26.7	20.2
Average daily gain, lbs.	0.39	0.42	0.32
Average daily ration, lbs.			
Corn	1.76	2.38	2.86
Moisture-free basis	1.57	2.02	1.72
Alfalfa hay	1.60	1.59	1.66
Soybean meal	0.18	0.24	0.23
Feed per cwt. gain, lbs.			
Corn	457.8	569.5	908.3
Moisture-free basis	407.4	494.1	545.0
Alfalfa hay	414.8	380.0	528.3
Soybean meal	48.0	57.0	73.0
Selling price per 100 lbs.	$30.00	$30.00	$30.00
Return per lamb	$ 1.17	$ 1.65	$ 1.26

Feed prices used: Shelled corn $1.50 per bushel; hard ear corn $1.45 per bushel; soft ear corn $.85 per 100 pounds; alfalfa hay $25 per ton; soybean meal $4.25 per 100 pounds.

good gains and exceeded the average daily gain of the lambs receiving hard corn (0.46 vs. 0.39 pound).

In 1951 the market price of soft corn was about 25 percent of the market price of hard corn ($.45 as compared to $1.68 per bushel). Due to this price relationship and the comparable gains made, the cost of 100 pounds of gain was much lower in the lot receiving the soft corn.

While a soft corn crop may work severe hardship on the farmer who grows corn as a cash crop, the lamb feeding tests at this station show that soft corn has far more value as a feed than it has when sold as a grain on the market.

Review of Lamb Feeding Results

1. The value of soft corn as a feed for lambs depends largely on the amount of moisture it contains and the time of year it is fed. The dry matter in soft corn containing 25 to 50 percent moisture proved to be as valuable as the dry matter in hard corn. It should be kept in mind that when one is feeding soft corn, more pounds must be fed to compensate for the higher moisture content.

2. Soft moldy corn proved to be palatable to lambs and no death loss due to spoiled corn resulted in any of these trials. However, for best feeding value it should be fed during winter before molds develop.

Table 10. Comparison of Dried, Soft, Shelled Corn and Hard Shelled Corn Fed to Feeder Lambs, January 11 to March 21, 1952 (Fed 70 Days)

	Lambs Fed Alfalfa Hay, Protein Supplement, and		
	Hard Shelled Corn Lot I	Artificially Dried Shelled Corn Lot II	Soft Shelled Corn Lot III
Number of lambs	22	22	21
Average initial weight, lbs.	82.0	79.0	80.2
Average final weight, lbs.	109.0	111.0	106.3
Gain per lamb, lbs.	27.0	32.0	26.1
Daily gain per lamb, lbs.	0.39	0.46	0.37
Death loss	2	0	0
Moisture content of corn fed, %	10.0	17.0	49.8
Average daily ration, lbs.			
Shelled corn	1.39	1.36	1.98
Moisture-free basis	1.25	1.13	1.00
Soybean meal*	0.1	0.1	0.1
Alfalfa hay	1.35	1.44	1.41
Feed per cwt. gain, lbs.			
Shelled corn	361.4	297.0	529.5
Moisture-free basis	325.4	247.0	264.7
Alfalfa hay	349.5	314.5	378.6
Soybean meal	24.8	19.7	27.1
Selling price per 100 lbs.	$25.00	$25.00	$25.00
Return per lamb	$ 1.08	$ 2.31	$ 1.68
Cost of gain per 100 lbs., dollars†			
Shelled corn	10.84	6.24	4.24
Alfalfa hay	3.50	3.15	3.79
Soybean meal	1.24	.98	1.35
Total	$15.58	$10.37	$ 9.38

*It was necessary to feed this amount of protein so that Lot I could also serve as the check for several experiments.
†Feed Prices Used: Corn $1.68 per bushel; alfalfa hay $20 per ton; soybean meal $100 per ton; artificially dried corn $1.16 per bushel; immature corn $.45 per bushel.

Hogs

. . GOOD DAILY GAINS ON SOFT CORN

TURNER WRIGHT[5]

TO DETERMINE the feeding value of soft corn compared to hard corn when fed to hogs, a series of six trials were conducted from 1942 to 1952. Comparisons were made between lots of growing-fattening pigs fed hard shelled corn, soft corn dried and shelled, hard ear corn and soft ear corn. This experiment consisted of four winter trials and two summer trials. The two summer trials were run to compare the value of soft corn that had been left outside in piles over the winter, with soft corn that was fed shortly after it was harvested.

Trials I and II
Winter 1942-43 and 1944-45

In both of these trials four lots of pigs were used. The soft corn fed in these winter trials had a moisture content of 25 to 32 percent. All lots with the exception of Lot IV, were self-fed a protein supplement consisting of 2 parts tankage, 1 part soybean meal, and 1 part linseed meal, and a mineral mixture consisting of 2 parts steamed bonemeal, 2 parts ground limestone, and 1 part salt. The protein mixture fed to the pigs in Lot IV was limited each week to the amount consumed by the pigs in Lot I the preceding week. Good quality alfalfa hay was available at all times.

In the second trial the pigs made slightly faster gains and required more feed for 100 pounds of gain than those in the first trial, but in general, the same relative differences prevailed. A summary of the two years' feeding trials is presented in Table 11.

These data show that the pigs fed hard corn made slightly faster gains than those fed soft corn, and required less corn for 100 pounds gain. The requirements for protein supplement, alfalfa and mineral were practically the same. When compared on a dry-matter basis, however, there is very little difference in the amount of feed required for 100 pounds of gain. The pigs fed the soft corn showed a lower feed cost per 100 pounds gain (because of the lower price of the corn), and likewise a greater return per pig. In these two feeding trials, 100 pounds of hard ear corn was worth 130 pounds of soft ear corn, plus one-half pound of protein supplement.

At the close of the second trial the four lots of hogs were slaughtered at a commercial packing plant. The shrinkages from feed lot to market and the dressing percentages are given in Table 12.

When marketed, the hogs fed hard ear corn shrank 1.5 to 2.0 percent more than those fed soft ear corn, but dressed approximately 1 percent higher. The carcasses from the hogs in all four lots were graded good to choice.

[5]Associate Professor Emeritus.

Table 11. Soft Corn Compared with Hard Corn for Fattening Pigs Winter Trials 1942-43, 1944-45

	Lot I Hard Shelled Corn	Lot II Hard Ear Corn	Lot III Soft Ear Corn	Lot IV Soft Ear Corn (Limited Protein)
Number of pigs	20	20	20	20
Number of days fed	81.5	86.0	96.5	96.5
Initial weight per head, lbs.	125.7	123.6	124.0	124.1
Final weight per head, lbs.	276.0	280.0	282.4	286.1
Daily gain per head, lbs.	1.84	1.82	1.64	1.68
Feed for 100 lbs. gain, lbs.				
Corn	393.4	514.5	671.3	661.1
Protein supplement	58.0	52.3	54.8	61.0
Alfalfa	8.4	8.5	9.0	8.4
Mineral	1.2	1.3	1.4	1.2
Total	461.0	576.6	736.5	730.8
Total dry matter for 100 lbs. gain, lbs.	386.4	396.8	400.1	400.1
Feed cost for 100 pounds gain*	$8.42	$7.77	$6.17	$6.31

*Feed prices: Hard ear corn, $.80 per bu. ($1.43 per cwt.); hard shelled corn, $.91 per bu. ($1.62 per cwt.); soft ear corn, $.63 per cwt.; protein supplement, $3.85 per cwt.; alfalfa hay, $12.50 per ton; and mineral, $1.94 per cwt.

Table 12. Shrinkages and Dressing Percentages of Swine on Winter Feeding Trial, 1944-45

	Lot I Hard Shelled Corn	Lot II Hard Ear Corn	Lot III Soft Ear Corn	Lot IV Soft Ear Corn
Number of hogs	9	5	9	9
Average live weight per pig, lbs.	288.3	289.5	278.9	277.2
Shrink, feed lot to market, %	2.7	3.1	1.1	1.7
Average dressed weight per pig (head and leaf fat out), lbs.	220.7	211.7	201.4	199.2
Percent of live weight	76.61	73.13	72.23	71.86

Trial III. Summer 1945

To obtain information on the value of soft corn stored in outdoor piles and fed fattening pigs during spring and summer, an additional feeding trial was conducted in 1945. Four lots of pigs were fed exactly the same as during the winter trial. Both the soft and the hard corn came from the supplies used during the winter. The weights of the corn as fed were used without adjustments for seasonal deterioration. Table 13 presents the results in detail.

In the spring and summer months (as compared with the winter feeding), relatively greater amounts of both corn and protein supplement were required by the pigs fed soft corn than by those fed hard corn to produce 100 pounds of gain. The total amounts of dry matter required to produce 100 pounds of gain were greater for the pigs fed soft corn than for those fed hard corn. There was practically no difference in the shrink from feed lot to market for any of the lots. The slaughter data showed approximately 1½ percent higher dressing yield for the hogs

fed hard corn. All of the carcasses graded good. In this feeding trial, 100 pounds of hard ear corn was worth 142 pounds of soft ear corn, plus 11.5 pounds of protein supplement.

Trial IV. Winter 1946

The fourth trial was conducted in the winter of 1946. Five lots of pigs with initial weights averaging about 118 pounds were fed to final average weights of 269 to 285 pounds. The pigs were fed in the same manner as the corresponding lots in the previous trials. One additional lot was self-fed soft corn that had been dried in a commercial drier and shelled. This corn tested 12 percent moisture and weighed 46.3 pounds per bushel. The soft corn tested 33 percent moisture.

The pigs which were fed the dried shelled corn required 36.5 pounds less feed per hundredweight of gain than did those fed hard shelled corn. In this feeding test, 100 pounds of hard ear corn was worth 130 pounds of soft ear corn, plus 2½ pounds of protein feed.

Carcasses from the lots that were fed hard ear corn and soft corn, dried and shelled, graded choice; those from the pigs that were fed hard shelled corn graded good to choice. Carcasses from the two lots that were fed soft ear corn graded good, but showed greater variation in finish than those from the lots fed the dried corn or hard shelled corn.

The combined results of the three winter trials are given in Table 14.

Under the conditions prevailing it was not economical to feed the hard ear corn. Considerably more corn, reduced to a shelled corn basis, was required to produce 100 pounds of gain than was required of the hard shelled corn to produce a similar gain. This, however, was partly offset by a slightly lower protein feed requirement.

Table 13. Soft Corn Compared with Hard Corn for Fattening Pigs, Summer Feeding Trial, April 13 to July 15, 1945

	Lot I Hard Shelled Corn	Lot II Hard Ear Corn	Lot III Soft Ear Corn	Lot IV Soft Ear Corn (Limited Protein)
Number of pigs	10	10	10	10
Number of days fed	77	77	92	93
Initial weight per head, lbs.	107.8	109.5	109.4	108.6
Final weight per head, lbs.	276.7	278.5	279.1	271.6
Daily gain per head, lbs.	2.10	2.20	1.84	1.75
Feed per 100 lbs. gain, lbs.				
Corn	313.1	476.2	675.0	712.2
Protein supplement	70.5	61.0	115.6	90.4
Alfalfa hay	2.6	2.3	3.0	3.4
Mineral mixture	0.8	0.7	0.8	1.2
Total	387.00	540.2	794.4	807.2
Feed cost for 100 lbs. gain	$ 8.35	$ 8.87	$ 7.39	$ 6.71

Feed prices: Hard ear corn, $.86 per bu. ($1.23 per cwt.); hard shelled corn, $1.05 per bu. ($1.88 per cwt.); soft ear corn, $.50 per cwt.; protein supplement, $3.43 per cwt.; alfalfa hay, $15.00 per ton; and minerals, $1.94 per cwt.

Table 14. Summation of Three Winter Feeding Trials 1942-43, 1944-45 and 1946

	Lot I Hard Shelled Corn	Lot II Hard Ear Corn	Lot III Soft Ear Corn	Lot IV Soft Ear Corn (Protein Limited)
Number of pigs	30	30	30	30
Average number of days fed	81	86	89	89
Average initial weight, lbs.	123.4	122.3	122.0	122.1
Average final weight per pig, lbs.	276.5	277.6	277.9	281.2
Average daily gain per pig, lbs.	1.93	1.81	1.75	1.78
Feed consumed for 100 lbs. of gain, lbs.				
Corn	381.3	531.6	694.1	683.5
Protein supplement	56.2	50.0	52.8	56.8
Alfalfa hay	7.5	7.7	8.2	8.1
Mineral	1.1	.9	1.2	1.1
Total	446.1	590.2	756.3	749.5
Cost of 100 lbs. gain	$ 8.58	$ 9.52	$ 6.68	$ 6.80

Feed Prices (Weighted averages)—Hard shelled corn $1.69 a cwt.; hard ear corn, $1.43 a cwt.; soft ear corn, $.67 a cwt.; and protein supplement $3.70 a cwt.; alfalfa $.75 a cwt.; mineral mixture $2.00 a cwt.

In evaluating the soft corn, the hard ear corn had to be used as a basis of comparison, as the soft corn could not be shelled and stored without spoilage. The pigs fed the hard ear corn made 100 pounds of gain on 162.5 pounds less than was required of soft ear corn to make the same amount of gain. The pigs fed the soft ear corn not only required more corn but also slightly more protein feed for the production of 100 pounds of gain.

Protein Supplement Self-Fed with Soft Corn

It was thought at the beginning of the experiment that the pigs fed soft corn would eat an excessive amount of the protein feed if it were self-fed. Accordingly, the amount of protein feed given the pigs each week in Lot IV, also fed soft ear corn, was limited to the amount consumed the previous week by the pigs in Lot I, fed hard shelled corn. Table 15 shows the amount of corn consumed per pound of protein feed by the pigs in each lot.

The results do not support the assumption that pigs fed soft ear corn with a moisture content ranging from 25 to 34 percent would eat an excessive amount of the protein feed if it were self-fed. On the contrary, considering the feed consumed for 100 pounds gain, the pigs in Lot III, fed the soft ear corn, ate more of the

Table 15. Ratio of Protein Supplement to Corn Consumed

	Lot I Hard Shelled Corn	Lot II Hard Ear Corn	Lot III Soft Ear Corn	Lot IV Soft Ear Corn (Protein Limited)
Corn consumed per lb. of protein supplement, actual basis, lbs.	6.8*	10.6	13.1†	12.0

*Converted to ear corn basis (72 lbs. per bu.); 9.2 pounds ear corn to 1 pound protein.
†Converted to same moisture basis as Lot II: 11.4 pounds ear corn to 1 pound protein.

corn for each pound of the protein feed consumed than either of the two lots of pigs fed hard corn. Even when the soft ear corn fed in Lot III is reduced to the same moisture content as the hard ear corn fed the pigs in Lot II, the amount of soft ear corn consumed for 1 pound of the protein feed is greater than for the pigs in the two lots fed hard corn.

Trial V. Summer 1946

The fifth feeding trial was conducted during the late spring and early summer of 1946. This trial was a repetition of the one conducted during the winter. The soft corn used came from the same supply as was used earlier in 1946. This corn, however, instead of being left in the pile on the ground as was done for the summer feeding trial in 1945, was put in a snow fence crib with a wood floor. A moisture test made of a sample of this corn just before the feeding trial was started showed that it then contained 24 percent moisture, indicating that there had been considerable loss of moisture after it was cribbed. However, there had been some further deterioration in quality due to molds.

The dried corn used also came from the same supply as was used in the previous test. This corn tested 12 percent moisture at the beginning of this feeding period which was the same as it had tested the previous fall.

Both the hard shelled corn and hard ear corn used were of No. 2 grade, testing 15 percent moisture with a test weight of 53 pounds per bushel. The results of this second summer trial are shown in Table 16.

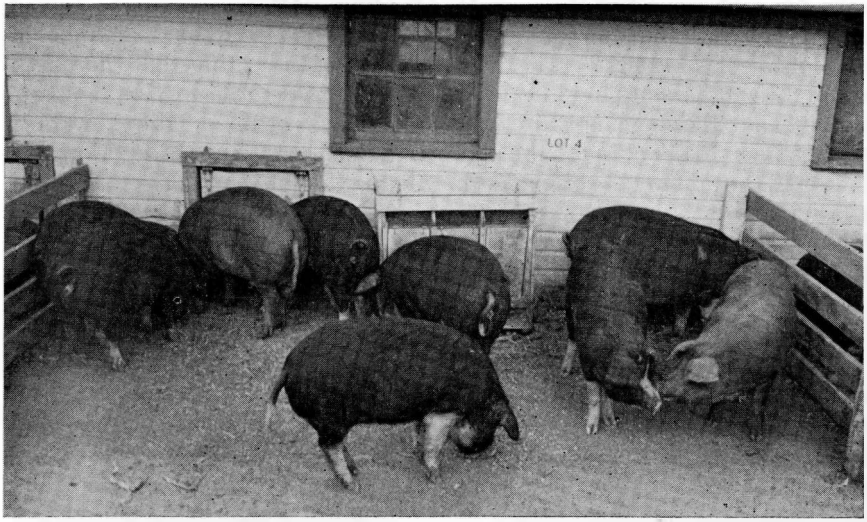
Both the hard shelled corn and hard ear corn used in this trial gave much better results than the hard shelled corn and hard ear corn used in the early spring of 1946 which

Table 16. Soft Corn Experiment, Summer, April 13 to July 9, 1946

	Lot I Hard Shelled Corn	Lot II Hard Ear Corn	Lot III Soft Ear Corn	Lot IV Soft Ear Corn (Protein Limited)	Lot V Soft Corn Dried and Shelled
Number of pigs	8	8	8	8(7)*	8
Average number of days fed	87	87	87	87	87
Average initial weight per pig, lbs.	81.6	82.1	82.1	81.7	81.8
Average final weight per pig, lbs.	265.5	260.5	240.8	241.1	260.2
Average daily gain per pig, lbs.	2.11	2.05	1.82	1.86	2.05
Feed consumed for 100 lbs. of gain, lbs.					
Corn	316.3	541.2	715.5	750.7	344.3
Protein supplement	50.6	41.1	50.8	58.6	33.9
Alfalfa hay	2.0	2.9	5.3	5.6	4.2
Mineral	0.3	0.6	0.6	0.6	0.4
Total	369.2	585.8	772.2	815.5	382.8
Cost of 100 lbs. gain†	$8.48	$9.85	$7.64	$8.17	$10.67

*One pig in Lot 4 died May 22 (over-heated) when taken to Pavilion for Livestock Feeders' Day demonstration. Wt. 172 lbs.—Gain and feed for this pig included in totals.

†Feed prices—Hard shelled corn $2.14 a cwt.; hard ear corn $1.56 a cwt.; soft ear corn $.82 a cwt.; soft corn dried and shelled $2.76 a cwt.; protein supplement $3.34 a cwt.; alfalfa hay $.75 a cwt.; and mineral mixture $2.00 a cwt.



Pigs in Lot 4, showing the finish obtained from soft corn

were of lower quality and higher moisture content. The difference in the amount of feed required to produce 100 pounds of gain was 48.2 pounds less where the shelled corn was used and 33.7 pounds less where the ear corn was used.

Soft Corn Dried and Shelled

There was considerable interest at the time these feeding trials were being conducted in drying the soft corn, shelling, and storing it for future use.

The amounts of feed required to produce 100 pounds of gain where the dried soft corn was used were practically the same in both the 1946 trials. This would seem to indicate the differences noted in the other comparisons were due to differences in quality of feed rather than to weather conditions. In the second trial in 1946, the pigs fed the soft corn, dried to 12 percent moisture and shelled, required 28 pounds more corn and 2.2 pounds more alfalfa to produce 100 pounds of gain than did those fed the hard shelled corn. However, this was practically offset by a requirement of 16.7 pounds less of protein supplement to produce the same amount of gains. A summation of the results of the two trials is given in Table 17.

Three pounds more of the dried soft corn was required to produce 100 pounds of gain than of hard shelled corn. However, 17 pounds less protein feed was required to produce the same amount of gain. The total feed requirement for the production of 100 pounds of gain was 12.6 pounds less for the pigs fed the soft corn dried and shelled than for the pigs fed the hard shelled corn.

When the costs of gains are con-

sidered and when the feed prices prevailing in 1946 are used, 100 pounds of gain cost $2.17 more for the pigs fed the dried soft corn than for the pigs fed the hard corn. Using the June 1952 feed prices as a basis for comparison, 100 pounds of gain made by the hogs fed the dried soft corn cost $1.63 less than a similar amount of gain made by the pigs fed the hard shelled corn.

Trial VI. Winter-Spring 1951-52

An additional feeding trial was conducted in the winter and early spring of 1952 using corn with a considerably higher moisture content than was used in the previous trials. This corn contained approximately 50 percent moisture. It was fed as soft ear corn, soft shelled corn and soft shelled corn dried to 17 percent moisture. Hard shelled corn grown in 1950 with a 10 percent moisture content was used for a check.

The protein supplement used consisted of 42 parts tankage, 28 parts soybean oil meal, 29 parts ground alfalfa and 1 part antibiotic-vitamin carrier. This supplement contained 40.79 percent crude protein. The mineral supplement consisted of 40 parts ground limestone, 40 parts steamed bonemeal and 20 parts iodized salt. Sixty fall pigs, weighing approximately 96 pounds each, were divided into four lots and fed to final average weights ranging from 200.5 to 213.5 pounds. The data obtained in this feeding trial are shown in Table 18.

There was considerable wastage

Table 17. Hard Shelled Corn Compared with Soft Corn, Dried and Shelled. Summary Two Feeding Trials, 1946

	Lot I Hard Shelled Corn	Lot V Soft Corn Dried and Shelled
Number of pigs	18	18
Average number of days fed	84	83
Average initial weight per pig, lbs.	102.3	102.0
Average final weight per pig, lbs.	272.1	274.1
Total gain per pig, lbs.	169.8	172.2
Average daily gain per pig, lbs.	2.02	2.1
Feed consumed for 100 lbs. gain		
Corn	338.0	341.3
Protein supplement	51.7	34.7
Alfalfa hay	4.0	5.2
Mineral	0.6	0.5
Total	394.3	381.7
Cost of 100 lbs. gain		
Feed prices, 1946	$8.46	$10.63
June 1952	12.99	11.36

Feed prices, 1946: Hard shelled corn $1.98 a cwt.; soft corn dried and shelled $2.76 a cwt.; protein supplement $3.34 a cwt.; alfalfa hay $.75 a cwt.; and mineral mixture $2.00 a cwt.

Feed prices, June 1952: Hard shelled corn $3.00 a cwt.; soft corn dried and shelled $2.76 a cwt.; protein supplement $5.40 a cwt.; alfalfa hay $1.00 a cwt.; and mineral mixture $3.00 a cwt.

Table 18. Soft Corn Compared with Hard Corn for Fattening Pigs January 30 to April 9, 1952

	Lot I Hard Shelled Corn	Lot II Soft Corn Shelled and Dried	Lot III Soft Corn Shelled	Lot IV Soft Ear Corn
Number of pigs	15	15	15	14
Average number days on feed per pig	63.5	66.3	68.1	68.5
Average initial weight per pig, lbs.	95.6	96.3	96.5	96.6
Average final weight per pig, lbs.	213.5	210.6	210.4	200.5
Average total gain per pig, lbs.	117.9	114.3	113.9	103.9
Average daily gain per pig, lbs.	1.86	1.73	1.67	1.52
Feed consumed per cwt. of gain, lbs., actual basis:				
Corn	342.7	455.1	599.0	1209.6
Protein supplement	41.2	29.8	36.1	42.3
Mineral	2.6	2.4	3.4	3.6
Total feed	386.5	487.3	638.5	1255.5
Feed consumed per cwt. of gain, lbs., moisture-free basis				
Corn	308.4	377.3	300.7	384.0
Protein supplement	40.0	28.9	35.0	41.0
Mineral	2.6	2.4	3.4	3.6
Total feed	351.0	408.6	339.1	428.6
Feed cost per cwt. gain*	$12.39	$10.96	$6.67	$7.88

*Feed prices used: Hard corn, $1.68 per bu. ($3.00 per cwt.); dried corn, $1.16 per bu. ($2.07 per cwt.); wet shelled corn, $.45 per bu. ($.80 per cwt.); wet ear corn, $.33 per bu. of 70 pounds ($.47 per cwt.); protein supplement, $4.91 per cwt.; and mineral mixture, $3.32 per cwt.

The cost of the soft corn shelled and dried was based on the cost of the wet shelled corn at $.80 a cwt. plus the drying charge which was $.24 a bu. of 56 pounds, wet shelled corn.

Test weights per bushel on 2-1-52: hard corn, 55 pounds; dried corn, 29 pounds; soft shelled corn 33 pounds; on 2-29-52: hard corn, 55 pounds; dried corn, 30 pounds; and soft shelled corn, 30 pounds.

of feed in Lot II fed the soft corn shelled and dried and in Lot IV fed the soft ear corn. The corn that had been shelled and dried was rather chaffy and the pigs rooted a considerable amount of the corn out of the feeder in an effort to get the more mature kernels. If these hogs had been fed a less bulky protein feed they probably would not have wasted so much corn, as considerably less protein feed or supplement was used by this lot for 100 pounds gain than was used by the lot fed the hard shelled corn.

A large part of the wastage of the soft ear corn was due to the pigs not wanting to stay outside in bad weather and eat the corn off the cobs. Although the ear corn was fed in small self-feeders designed for hay, these pigs would often carry the ears inside the pen even though they were partly eaten.

In this experiment all of the pigs fed the soft corn made cheaper gains than those fed the hard shelled corn. The gains made by the pigs fed the soft corn, shelled and dried, were more expensive than those fed the soft shelled corn without drying. This was due to the cost of drying the corn for that lot and the excessive amount of wastage. When the

results obtained from the lot fed the hard shelled corn and from the lot fed the soft shelled corn are compared on a dry-matter basis, it is seen that the two had approximately the same feeding value.

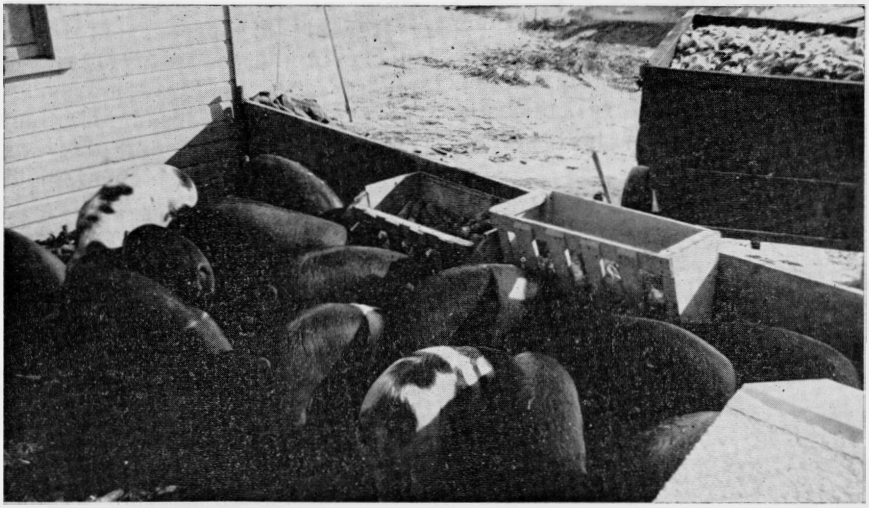
Review of the Swine Feeding Results

Results of six feeding trials with soft corn for growing-fattening pigs show that hogs are well adapted to utilize soft corn. When such corn is full fed, the protein supplement can be self-fed, since pigs on soft corn do not consume an excessive amount of supplement or mineral.

In all six trials, the pigs fed soft corn showed a lower rate of gain per day than the pigs fed hard corn. However, when the dried soft corn was fed the pigs made practically the same rate of gain as the pigs fed hard corn. Compared on a dry-matter basis, the value of soft corn is practically equal to hard corn for growing-fattening pigs. However, the pigs on soft corn required more corn and also slightly more protein feed for each 100 pounds of gain. It was found that best results were obtained by feeding the soft corn in the winter, because of deterioration in the quality of the corn in the warmer months.

The economy of the practice of drying and shelling the soft corn for later feeding and storage will depend on the costs involved and the selling price of hard corn.

These were the pigs that were fed exceptionally high moisture corn. The trials conducted from 1942 to 1952 showed that even when high moisture corn is self-fed, the protein supplement may be self-fed since pigs so fed do not consume an excessive amount of the supplement or mineral.



Poultry

. . . FED SOFT CORN, FRESHLY GROUND

WM. KOHLMEYER[6]

SOFT, MOLDY CORN has often been suspected as a source of trouble when used for poultry feeding. Evidence on this point is not clearcut. Experiments have been reported in which chicks fed up to 40 percent moldy corn in the ration showed no excessive mortality, but did not grow as rapidly as chicks fed a similar diet based upon non-moldy corn. Other cases are reported where death losses occurred after moldy corn was fed. It would seem that the feeding values of moldy corn for chickens would depend upon the kinds and amounts of molds present, the proportion of the ration made up of moldy corn, and conditions of mixing, storage, and feeding.

In seasons when most or all of the corn is harvested and stored with high moisture content, some flock owners may be forced to use it as feed. This has occurred at the State College Poultry department. Shelled corn was delivered which contained from 30 to 33 percent moisture. No difficulty was experienced when such corn, freshly ground, was used as 20 to 40 percent of a mash mixture for hens, chicks, or turkeys. The fact that the other mash ingredients carried much lower moisture levels probably accounted for the absence of noticeable spoilage during a short storage period.

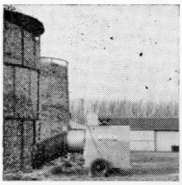
When high-moisture shelled corn was fed to laying hens, no harmful effects were observed.

However, the 30 percent moisture corn did heat in the bin as temperatures rose with the approach of spring. In an effort to prevent heating, some of the corn was spread out on the floor to a depth of 5 to 6 inches. This checked the heating damage, but mold development proceeded until much of the corn was practically black in color. Ground, high-moisture corn showed a greater tendency to heat than shelled corn.

It would be expected that the inclusion of high-moisture corn in the poultry ration would result in somewhat higher feed consumption than would occur when sound corn was fed. Conditions which favor mold development would also be expected to reduce the vitamin A value of yellow corn.

[6]Poultry Husbandman.

Open cribs used in 1945 to store and dry ear corn of 30 percent moisture content.



Drying . . . . . AND STORING THE CORN CROP

H. H. DeLong and C. M. Nagel[7]

If after early frosts, one has more soft corn than can be fed during the winter months, the most economical method of handling the surplus is to dry and store the corn for future use. Drying corn, either on the ear or shelled right from the picker sheller is becoming a common practice in South Dakota and fits in with modern methods of production, harvesting and handling.

Corn is frequently picked with the picker-husker while the moisture content is 30 to 35 percent, although damage to ears by snapping rollers is noticeable at this stage. Field losses may not be as great, however, as when the corn is allowed to get very dry. The picker-sheller works best when the corn has approximately 24 percent moisture. And in extreme seasons, such as the fall of 1951, it may be necessary to pick corn in which some ears still have 60 percent or more moisture in them.

Since shelled corn should not exceed 13 percent moisture content when it is stored and ear corn should not have more than 18 percent for winter open crib storage, drying often becomes necessary. Also, to get the best price when marketing the crop, corn should not have more than 14 percent moisture.

Drying corn below 14 percent for immediate marketing may penalize the producer by reducing the marketed weight without increasing the grade. U. S. grain grades for corn with regard to maximum moisture content, are as follows: No. 1—14 percent; No. 2—15.5 percent; No. 3 —17.5 percent; No. 4—20 percent.

Moisture content is commonly defined in terms of the original "wet weight." After drying, a sample is then defined in terms of a new "wet weight." An illustration of this is given in Fig. 4, which shows the percentage of moisture in the original sample, the moisture removed, and the moisture remaining, to give 14 percent of the new sample.

Corn with a high moisture content is discriminated against, not only because it contains less dry matter and feed value per pound of grain, but because it promotes mold growth and allows insect damage when temperatures are favorable.

Spoilage from Molds

Stored corn with a moisture content of 13 percent is considered safe from spoilage by molds. This applies to shelled corn as well as to ear corn. As the moisture increases up to 30 percent, changes will occur slowly if the corn is kept in storage over a prolonged period.

Furthermore, fungi, or molds, through their digestion and spoilage of corn can create additional moisture. Certain molds can also

[7]Agricultural Engineer and Plant Pathologist, respectively.

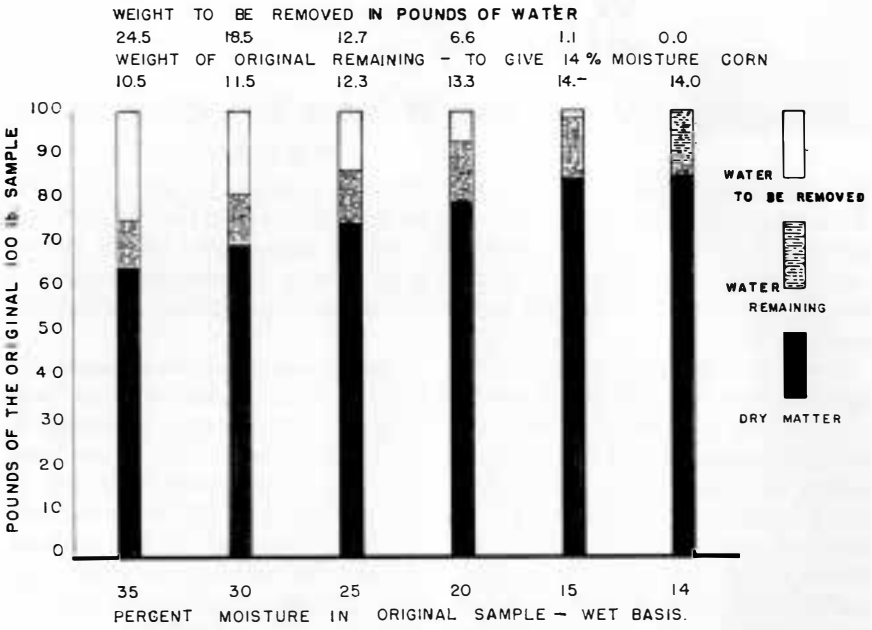


Fig. 4. This illustration shows percentage of moisture in the original sample, moisture removed and the moisture remaining to give 14 percent of the new sample.

produce heat under storage conditions. This means that just through their normal growth activities, molds can create more favorable growing conditions for themselves.

The extent of deterioration of high moisture ear corn by several species of molds is presented in Table 19. The principal fungi responsible for the spoilage were the following: *Aspergillus flavus; A. niger; A. spp.; Mucor racemosus; Penicillium spp.,* and several other species of less importance under the conditions of this experiment.

The effects of aeration as influenced by type and width of crib on mold development are indicated in Table 19. The results show that when corn of 30 percent moisture is stored in cribs varying in width the least mold damage occurred in the narrow crib.

Methods of Drying

To find the most efficient and economical way to dry a soft corn crop, different types of drying equipment and three methods of drying—open crib, forced cold air, and forced heated air—were investigated.

In the 1944-45 storage season, seven experimental corn cribs were constructed and filled during the period of March 20 to April 6, 1945. Six of the cribs were 8 feet high and 12 feet long, but varied otherwise in structure. All of the floors except one were made of wood, and the roofs,

when used, were likewise made of wood. Only one crib contained ear corn that was poorly husked.

The corn which was cribbed had been piled in a long windrow in the fall when husked, and had been left there over winter. Samples taken before the corn was moved showed a moisture content of 30 percent. At filling time, it had the following grade factors: Sample grade yellow corn; bushel weight, 47 pounds; odor, none; total mold damaged kernels, 33.6 percent.

On May 15, corn samples were removed with an ear corn probe. Data on grade, bushel weight, odor, and total mold damage are included in Table 19.

On the basis of the data presented in Table 19, the best control of ear corn spoilage, when using cribs of varying widths, was obtained in cribs 4 feet in width.

Many farmers have 8-foot cribs. It is possible and practical to alter an 8-foot crib to create conditions similar to a 4-foot crib (which is more expensive to build on a per bushel cost basis). A snow-fence type ventilator can be placed down through the center of the crib, dividing it so that it is comparable, insofar as drying out of the corn is concerned, to a 4-foot crib. Any method which will rapidly dry out the moisture will bring mold growth and spoilage of corn under control.

Drying by natural air is limited to ear corn and to seasons where the corn moisture content need be lowered only a few percent.

Drying with Forced Cold Air

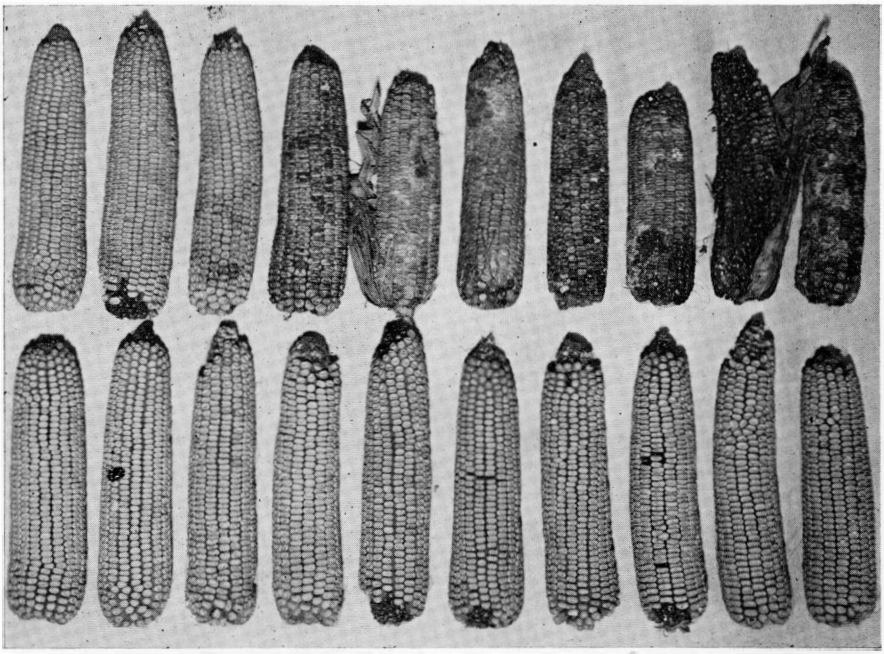
Drying corn by cold forced air also has its limitations. Air below 20° F. can hold little moisture so its power to dry grain is limited to the early fall days when the air is still warm. Fans running from 10 a.m. to 4 p.m. on the warmer days of early fall would be effective but would be slow, taking 25 to 40 days to dry the corn.

Using a cold air fan late in the year will do little, if any, drying, though it may be used to check heating and molding of grain. During

Table 19. Effect of Crib Width, Aeration, Presence or Absence of Roof and Floor on Mold Development and Spoilage of Stored Ear Corn of 30 Percent Moisture

Crib Dimensions	Grade*	Bu. Wt. (Lbs.)*	Odor*	Total Mold Damage (%)*
4′ Wide floor and roof	Sample grade	41.5	None	35.2
6′ Wide, floor and roof	" "	43.0	Musty	43.6
6′ Wide, asphalt roofing for floor and roof	" "	38.0	Musty	71.6
6′ Wide, floor, no roof	" "	38.5	Musty	72.0
6′ Wide, floor and roof (husks left on)	" "	38.0	Musty	88.0
8′ Wide, floor and roof	" "	37.0	Musty	88.0
16′ Diameter, floor, no roof (with 24″ vertical ventilator in center)	" "	36.0	Musty	93.0

*Based on official United States grain standards.



Corn samples from the 1944-45 feeding trials. Top: soft corn with 32 percent moisture. Bottom: hard corn that graded No. 3 and averaged 16.3 percent moisture.

the 1951-52 season a gasoline engine driven fan was used on a 250-bushel crib of late harvested corn which contained more than 50 percent moisture. Weather during December was unusually cold and the attempt to dry with cold air was abandoned. Later a heat exchanger and a blow torch type of heater were added. This heater caused a 20° rise in temperature, but when operated in 0° F. weather, no drying was accomplished.

Much better results were obtained with a small test drier built for indoor use where the bin was mounted on scales so that the change in weight of the drying corn could be noted at any time. The bin was 4x4x4 feet in size and held about 1200 pounds of ear corn. Room air of 50° to 55° F. and 35 to 40 percent relative humidity was first run through a heating chamber, then to the bin. The air entered the bin at 80° to 85° F. and at 15 percent relative humidity.

Six tests were run indoors to determine drying rates under controlled conditions.

The corn was dried from an average of 50 percent moisture down to 15.7 percent in 80 to 85 hours. The corn at the bottom of the bin averaged 8.2 percent moisture for the six trials and the corn on the top surface averaged 21.4 percent. Such a variation can always be expected, even on as short an air path as 4 feet.

The drying rate of these six trials

under controlled conditions and with equipment where the actual water loss could be noted is shown in Fig. 5. Drying corn in cribs with all kinds of weather changes, and varying lengths of air travel will result in many more problems.

Drying Ear Corn with Forced Heated Air

During the 1952 fall season a 1,700-bushel corn crib of the upright cylindrical shape was prepared for use with a large size farm crop drier. A large air passage shaft was built on the inside of the crib, extending three-fourths of the crib height. This central shaft was connected by a lateral passageway to the side of the crib at the outlet door for an air entrance passage.

Most of the corn in the 1952 season was mature and dry. However, one field produced corn which averaged 23.7 percent moisture. Individual ear tests ran from 15 percent to 55 percent with some ears of 30 percent moisture content in every load

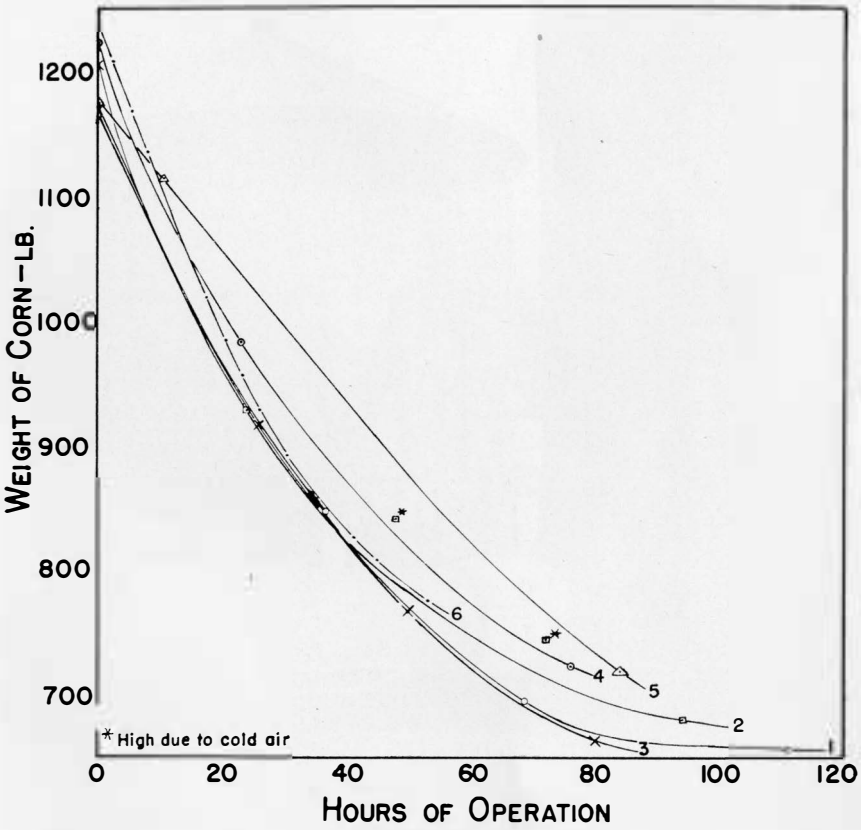
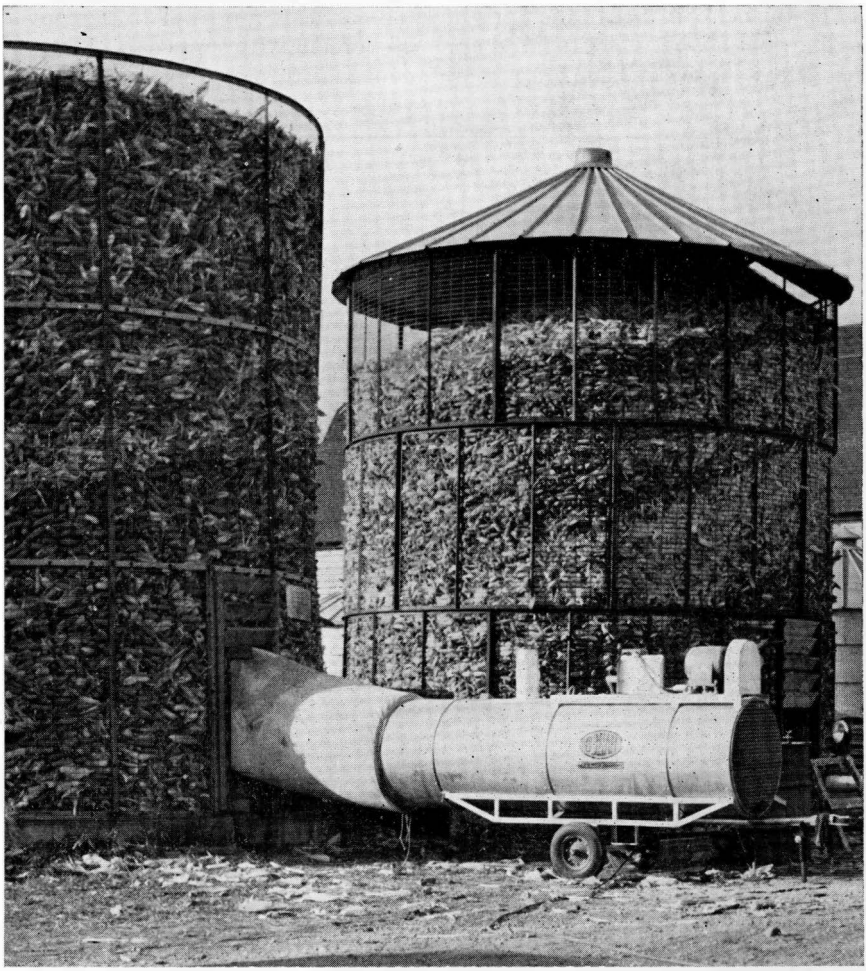


Fig. 5. Showing loss of weight during experimental corn drying periods.

tested. The crop drier used was of the direct fired type, 7½ HP motor, rated 16,500 cfm. at ½" static pressure, with dual burners that consumed 10 gallons of fuel oil per hour when set to run continuously. This drier was operated a total of 15 hours (burner ran 13½ hours) on the following dates: November 21, 24, 25, and December 4 and 5. On these days the outdoor temperatures were uniform, ranging from 25° to 42° F. The burner raised temperatures in the crib inlet to above 150° F. (This was feed corn, so a temperature of 150° was not considered too high.)

To dry the 1700 bushels of corn, 120 gallons of fuel were consumed



A 1700-bushel crib of corn being dried by heated air in an engineering experiment.

at a cost of $16.80. Power costs for the 7½ HP motor operating on 230V was estimated at $2.10, with electric power valued at 2 cents per kwh. (Fuel and power costs were, therefore, a little over 1 cent a bushel.)

At the close of the test, samples obtained from the outside layers of corn averaged 17 percent. It was not possible to get tests of corn next to the inlet air passage with the grain probe, but it has been shown in other tests that this corn should be several percent drier. The efficiency of the drying was not particularly high, but it must be remembered that much of the corn was mature and dry, with only part of the corn of high moisture content. At times, the moisture movement out of the crib was noticeable when steam would condense in the cool air just outside the crib.

A similar, but smaller, crib was prepared for use with a "heat exchanger" type of crop drier of the 3 HP size. Continued burner trouble with this drier prevented the completion of the test.

Review of Drying and Storage Results

Ear corn that contains only a little more than 18 percent moisture will dry down for safe storage in open cribs in many seasons. Narrow cribs, or those with adequate ventilators or breezeways are best. During the 1945 season, the Station found that the cribs giving the best results were those in which no part of the cribbed corn was more than 2 feet from a side wall or ventilator. These tests were run with corn of 30 percent moisture, and some damage from mold occurred. In fact, mold had developed on the corn before it was placed in the cribs.

Drying by forced cold air is limited to days in the early fall when the air is still warm. Running a cold air fan late in the year will do little, if any drying, though it may be used to check heating and molding of grain.

Heated air driers have an advantage in that they can be used at any time of the year, regardless of weather conditions. Several makes of crop driers are now on the market.

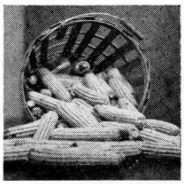
The following suggestions are in order for those using crop driers for high moisture corn or grain.

1. Be sure that the inlet passage structure is not restricted.

2. Have the air distribution duct in the crib of large size, and arranged so that air travel is a uniform distance in all parts of the crib.

3. Try to avoid getting shelled corn and husks elevated into a crib of ear corn. These make a denser section in some places and thus cause unequal air travel.

4. Moisture tests should be made frequently on corn that is being dried, so that a thorough job can be done, without drying some of the corn to a very low moisture content.



Growing

. . . . . A CORN CROP THAT MATURES

A. N. HUME and W. W. WORZELLA[8]

ACTUALLY, much of the soft corn crop could be avoided if care is taken in selection of varieties, date of planting, plants per hill, and maturity of hybrid. In order to determine some of the factors that affect maturity and yield of corn, experiments were started in 1945 at Brookings and at Highmore.

For these experiments three kinds of corn were used: An early corn, a corn with a medium growth period, and a full-season (not a late) corn. With each hybrid the corn was planted thick, and thinned to two, three and four plants per hill. Hills were 42 inches apart in each direction. Also, each set (three hybrids each, at two, three, and four plants per hill) was planted on about May 1, and again on about May 20, at Brookings and at Highmore.

Each year, then, corn was grown in 18 different ways or combinations in the eastern as well as in the central section of this state. Except for the 1951 cool season, the growing conditions at these locations were quite favorable during the seven years of this study. A satisfactory stand and a crop worth harvesting was produced each year.

The corn was harvested soon after a freezing frost (September 16 to October 19), and before it had a chance to lose much moisture, because other experiments also had to be harvested during the fall period. However, moisture samples were taken on each plot harvested and all yields corrected and adjusted to a uniform moisture basis.

The corn in these experiments was grown on good soil that was fertilized and manured. Fertility, therefore, was not a limiting factor as the soil contained more plant food than was used by the various treatments. The average yields of corn at the Station at Brookings are shown in Fig. 6. Yields are reported in bushels per acre with 15 percent moisture.

Plant May 10 to May 20 in Eastern Part of State

Note that in the eastern part of this state, corn planted about May 20 yielded more than that planted May 1. This is true not only as an average but also for each of the seven years under test. The higher yields obtained on May 20 were due to the early-and medium-season hybrids, since the full-season hybrid produced about one bushel more per acre when planted on May 1. The results indicate, therefore, that in the eastern part of this state the ground should be warm before planting corn, so that the seedlings can continue to grow and their vigor not be delayed by colder weather.

With early- or medium-season hybrids, lower yields can be expected if corn is planted too early. With

[8]Agronomist Emeritus and Agronomist, respectively.

full-season hybrids, early planting increased the yield by about one bushel over the later planting.

At Highmore, or in the central part of this state, the date of planting had little effect on the yield of corn. Results from seven years' trials show an average yield of 22.9 bushels when planted on May 1 and 23.4 bushels for the May 20 planting.

Greater Yields from 4 Plants per Hill

The number of plants per hill greatly affected the yield of the early-, medium-, or full-season hybrids in the eastern part of the state. The average yields for all hybrids planted at the two dates were 46.9 bushels for two plants, 53.9 bushels for three plants, and 57.8 bushels for four plants per hill.

In the central part of the state, the number of plants per hill had little influence on corn yields. The yields were 22.9, 23.9 and 22.7 bushels per acre for two, three and four plants per hill, respectively, at Highmore.

At the main station at Brookings, when all treatments are averaged, the early hybrids did not produce as much corn as the medium- or full-season hybrids. It must be remembered, however, that this experiment was conducted on good fertile soil and fertility was not a limiting factor as it often is on many farms. Soils low in fertility delay maturity, reduce yield and increase the moisture content of the corn.

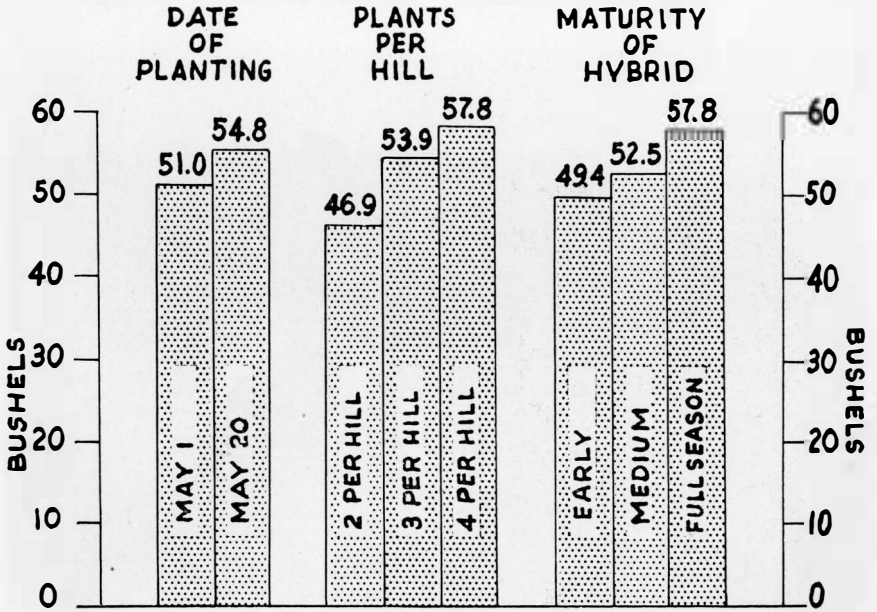


Fig. 6. Corn yields as affected by planting date, rate and maturity.

At Highmore, during this 7-year period, yield of corn was not affected by maturity of the hybrids used. The early hybrid produced 23.5 bushels, medium, 23.0 bushels and full-season hybrid 23.0 bushels per acre.

The highest yielding hybrids are desirable, but moisture content or maturity is also very important and must be considered in choosing the proper corn. Soft and immature corn results in additional bulk, spoilage, storage, drying and feeding problems, as well as harvesting during cold and snowy weather. Moisture content of corn in trials obtained at Brookings are shown in Fig. 7. As mentioned earlier, the moisture percentages reported are higher, since this test had to be harvested soon after frost and before it had a chance to lose the normal moisture content.

Moisture Content Affected by Planting Date, Rate, and Maturity

It will be noted that the corn planted May 1 possessed less moisture than that planted May 20. The same was true at Highmore, since the average moisture content of corn planted on May 1 was 28.0 percent and on May 20, 31.5 percent.

The number of plants per hill also had some effect on the moisture content. For eastern South Dakota, corn with three and four plants per hill possessed about 2 percent more moisture than that having two plants per hill. At Highmore, corn with four plants per hill contained about 3 percent more moisture than that planted thinner.

As would be expected, the earlier hybrids contained less moisture than the later hybrids. At Brookings, the early-, medium- and full-season

Most farmers would prefer to harvest their corn early like the farmer is doing above.

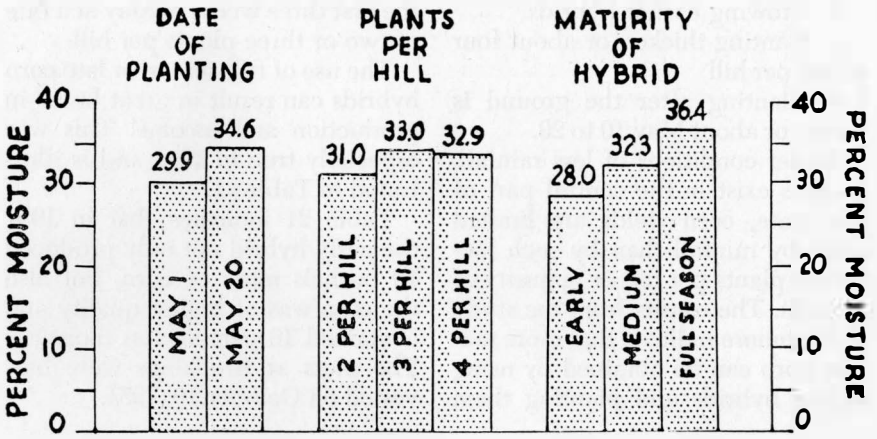


Fig. 7. Moisture content as affected by planting date, rate and maturity.

hybrids contained an average of 28.0, 32.3 and 36.4 percent moisture, respectively. At the Highmore substation, the average moisture percentages were 25.9 for early, 27.9 for medium, and 30.9 for full-season hybrids.

Averages as reported above, and which include hybrids of different maturity grown under varied conditions, show only general trends and reflect the kind of corn crops produced in this area during the past seven years. To improve on our methods and grow mature corn most years, rather than only 50 percent of the time, it is necessary to examine more closely each of the 18 different combinations in this experiment. A study of three of the various combinations of growing corn is shown in Table 20.

Grow Mature Corn

These three ways of growing corn illustrate that either mature corn was grown in eastern South Dakota every year (Method No. 3), or soft corn was produced four years out of the past seven (Method No. 17). The average yields obtained, however, were lower when sound mature corn was produced every year than when other methods were used. For eastern South Dakota the results indicate that more mature corn and high yield can be obtained in most years by adopting the practices used in Method No. 6. For the eastern part that would mean:

Table 20. Three Methods of Growing Corn, Brookings, S. D., 1945-51

Method Used	Yield (Bu.)	Moisture (%)	Remarks
No. 3, Early hybrid, 4 plants/hill, May 1	52	26	Fair yield, mature corn every year
No. 6, Early hybrid, 4 plants/hill, May 20	58	32	High yield, mature corn 6 yrs. in 7
No. 17, Full season, 3 plants/hill, May 20	58	40	High yield, soft corn 4 year in 7

1. Growing earlier hybrids
2. Planting thicker, or about four plants per hill
3. Planting after the ground is warm, or about May 10 to 20.

Under conditions of less rainfall, such as exist in the central part of this state, corn yields are limited more by rainfall than by such factors as plants per hill or maturity of hybrids. The results from the study at Highmore indicate that more mature corn can be obtained by using earlier hybrids and planting them the first three weeks in May at a rate of two or three plants per hill.

The use of full-season or late corn hybrids can result in great losses in production and income. This was especially true in 1951 and is illustrated in Table 21.

Table 21 indicates that in 1951 the early hybrid not only produced 10 bushels more of corn, but also the corn was of higher quality and contained 10 percent less moisture. The plots at Brookings were harvested on October 19, 1951.

Table 21. Unadapted Hybrids Reduce Wealth and Income, Brookings, S. D., 1951

Method Used	Yield (Bu.)	Moisture (%)	Remarks
No. 6. Early hybrid, 4 plants/hill, May 20	46	36	Fair yield of soft corn
No. 18. Full season, 4 plants/hill, May 20	36	46	Poor yield of soft corn

Soft corn stored in long uncovered piles contained considerable husk and moldy ears.

Summary

THE GREAT AMOUNT of soft corn that has been produced in South Dakota during the last decade has caused many problems such as late harvesting, storage, drying, feeding and spoilage, and it has also greatly reduced the wealth and income from some 4,000,000 acres of the state's most productive land.

Unadapted hybrid varieties are one of the main reasons for the immature corn crops. Agronomists at the Station have shown, as a result of seven years of experiments, that mature corn can be grown most of the time if the proper hybrid and proper management practices are used. Yield, as well as moisture content, is affected by date of planting, rate of plants per hill, and maturity of the variety.

In years when soft corn has to be harvested, it can either be dried with mechanical equipment or fed to advantage to livestock. If the amount of corn is greater than that which can be fed before the beginning of warm weather, the excess should be stored in narrow cribs to allow it to dry out rapidly.

Research by the Agricultural Engineering department has shown that ear corn with only a little more than 18 percent moisture content will dry down in open cribs in many seasons. Narrow cribs, or those with ventilators or breezeways, are most advantageous. Drying with forced cold air is satisfactory only during warm and dry weather, since blowing cold air through the corn will do little, if any, drying.

Forced heated air is needed for rapid drying during the cold weather. A factory-built combination of fan and burner with the proper controls is necessary to achieve good results in drying the corn.

Molds, which are responsible for great damage in stored soft corn, were best checked in narrow cribs, 4 feet in width. It was found in experiments by the Plant Pathology department that molds will develop under a wide range of storage conditions and varying degrees of moisture and temperature. Therefore, proper storage facilities are the only means to reduce hazards from mold spoilage. It is both practical and possible to alter an 8-foot crib to create conditions similar to a 4-foot crib by placing a snow-fence type ventilator down the center of the crib.

When soft corn is fed to livestock, the important point to keep in mind is that the weight of *dry matter* of the soft corn has to be considered when its feeding value is compared to that of mature corn. Therefore, more of the soft corn has to be fed to achieve the same results as with hard corn. Chemical analysis at the Station has shown that the dry matter in soft corn has a chemical composition closely resembling that of the dry matter of mature corn. In the very immature corn (over 60 percent moisture) the dry matter contains less energy than the mature corn. But this is at least partially compensated for by its higher protein, ash and vitamin B content.

Feeding trials conducted by the Animal Husbandry department with beef cattle, swine and lambs have borne out the results of the chemical analyses.

Beef cattle made good use of soft corn in the feeding trials undertaken in 1943, 1944, 1951 and 1952. Even though the corn varied considerably in moisture content in the different years, it was found that, regardless of the degree of moisture, the feeding value of soft corn was equal to that of mature corn if calculated on a dry-matter basis.

Dairy cows also used soft corn to good advantage in the two years trials were conducted by the Dairy department. The cows converted the soft corn efficiently into high quality milk, maintained their body weight and stayed healthy.

Six feeding trials with growing fattening pigs showed that pigs gain adequately on the soft corn and do not consume an excessive amount of protein supplement when on this feed.

Lambs ate more soft corn per day than hard corn, but they too utilized the dry matter in the soft corn as efficiently as the dry matter in the hard corn. In the two trials undertaken, soft moldy corn proved to be palatable to the lambs and no death loss due to spoiled corn resulted in any of these trials. However, for greatest feeding value it was found that it should be fed during the winter months before molds increase.

The Poultry department fed shelled corn with a moisture content of 30 to 33 percent to poultry. No difficulty was experienced when such corn, freshly ground, was used as 20 to 40 percent of a mash mixture for hens, chicks or turkeys. Also, no harmful effects were observed when high moisture shelled corn was fed to laying hens. The inclusion of high moisture corn in the poultry ration is expected to result in somewhat higher feed consumption, though no actual figures are available. Conditions which favor mold development would also be expected to reduce the vitamin A value of yellow corn.

For all trials conducted, soft corn had the same feeding value as hard corn, when figured on a dry-matter basis. A farmer who has soft corn usually will obtain a greater return from it by feeding it to cattle, lambs or pigs than by selling it as cash grain.

Relative Feed Values of Corn of Different Moisture Contents

Moisture	Pounds Equal to No. 2 Shelled Corn		Weight Required to Equal 1 Bushel of Ear Corn	Estimated Value as Feed in Percent of No. 2 Corn
Percent	100 Lbs.	Lbs./Bu.	Lbs.	Percent
15	100	56	70	100
20	106	60	74	94
25	113	63	79	88
30	121	68	85	82
35	131	73	92	76
40	142	79	99	71
45	155	87	108	65
50	170	95	119	59

Soft corn can be most effectively utilized as a feed if made into silage. If this practice will not fit into the livestock feeding operations, then the soft ear corn should be harvested and stored as follows:

1. In long narrow piles on the ground if it can be fed during the winter season.
2. In narrow, well-ventilated cribs if it is to be fed the following spring or summer (corn of 25 to 35 percent moisture).
3. Cribbed and artificially dried for long storage.
4. Corn with 45 percent or more moisture can be made into ear corn silage.