

ON THE CORN FRONTIER

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THIS bulletin is an attempt to summarize the known facts about corn in the North. Specifically, the discussion refers to North-western Minnesota. Some of the general observations, however, may apply to all of the northern United States and Canada. No attempt has been made to furnish data in support of the statements made.

Many stations have contributed to the conclusions stated herein, but findings of the Northwest Experiment Station, the Central experiment station, and the agricultural experiment stations of North Dakota, Montana, and Nebraska have been drawn upon most freely.¹ Experiences and methods of successful farmers in northwestern Minnesota have not been overlooked. In the section devoted to storing seed corn, particularly, the practices of these men have been incorporated with information gained from experiment stations.

ORIGIN OF CORN

Corn unquestionably originated in the far south, with its long hot days and sweltering nights. Yet it has dared the north. Its appearance has changed somewhat—corn grown within 15 miles of the Alaska boundary does not look exactly like that of Mexico, but it is corn nevertheless—*Zea mays*. Man has materially helped in the production of corn adapted to northern regions but, strangely, not until he had first almost exterminated it from northern latitudes through thoughtless methods.

EARLY HISTORY OF CORN GROWING

Early settlers in the prairie and northwestern states always doubted the possibility of growing corn. The first settlers in Illinois drove over vast prairies and located near timber, little realizing the future of those prairies for corn production. Not many years ago it was considered impossible to grow this crop in northern Iowa. Gradually, however, corn has been moving northwestward for the last half century.

In 1879 there were 438,737 acres of corn in Minnesota, while in 1926 there were 4,343,000 acres with a total production of 147,662,000 bushels. In the Red River Valley of northwestern Minnesota, the corn acreage has more than doubled in the last decade (84,500 acres in 1917 and 194,300 acres in 1926). Commercial production of corn on the prairies is found in a region extending 150 miles north of

¹ Grateful acknowledgment is made to all who have either knowingly or unwittingly contributed to this bulletin. It is hoped that their recompense may be found in a practical usefulness of the information. Special acknowledgment is made to Andrew Boss, A. C. Army, and H. K. Hayes for advice and valuable assistance in editing. Acknowledgment is also gratefully made to my colleague, E. R. Clark.

the Canadian boundary, while the crop has been grown successfully at Fort Vermillion, 650 miles north of the 49th parallel; and at Swede Creek, in the Yukon Territory, 15 miles south of Dawson City, which is almost on the Alaska boundary.

The conquest of the North has been rapid during the last half century but it has been in part a second conquest. Corn was extensively raised by the Indians even north of the Great Lakes and the St. Lawrence River. Indian legends abound in references to corn and some of their most important religious ceremonies were dedicated to this crop. In 1738 white explorers bought large quantities of corn from the Indians near what is now Bismarck, North Dakota. In 1833 a distillery was established at old Fort Union, now Mondak, on the Montana-North Dakota line. With this wide distribution of corn in the north among the Indians, why should a second conquest have been necessary?

With a few exceptions, farmers failed to recognize the value of the Indian corn. Most of those who attempted to introduce corn into the north were from Illinois, Iowa, and Wisconsin. They brought with them not only ideas of corn growing learned in their home communities, but also seed of the varieties grown in those communities. As this corn failed to ripen, they sent south for more seed. As a result of their failures they were convinced that corn could not be grown. Their influence was important—they came from a corn country and knew corn. If they couldn't succeed, who could? Without doubt their knowledge of corn was adequate for the regions in which they formerly farmed, but they had not learned an important fact, the discovery and application of which has made possible a more rapid extension of the corn frontier.

CHANGES IN GROWTH HABITS

Corn is a plastic plant, it responds to selection by both human hands and environment. At the Illinois Agricultural Experiment Station, selection was made for ears borne high on the stalk and ears borne low. Starting with one variety, the highest ears were kept separate from the low ears and planted in two plots the following year. High ears were again selected from the one plot and low ears from the other. Ears from the original stock were borne at a height of 49.6 inches. In 1925, after 23 years of selection, the height of the ear was raised in the high strain to 99.8 inches and lowered in the low strain to 9.7 inches.

Likewise, a selection for high and low oil content after 28 years has increased the percentage of oil from 4.7 in the original strain to 10.21 in the high-oil strain and decreased it to 1.43 per cent in the

low-oil strain. Using an adapted variety, the Nebraska station hastened maturity 5 days by four years of selection for earliness.

Corn may be modified by natural and artificial selection, because all commercial varieties are composed of mixtures of various hereditary qualities that result from the natural cross-pollination habit. Varieties of wheat, oats, and barley are relatively uniform in contrast to corn, because they are normally self-pollinated, i.e., seeds are produced by a union of male and female elements from the same plant. With corn, however, the male flowers are produced in the tassel and the female flowers in the ear shoot. Pollen grains from the tassels, carrying male sexual cells, fall upon the silks of the ears of other plants. A union of a sexual cell from the pollen with the egg cell at the base of the silk causes fertilization and leads to the production of a seed. Consequently, the seeds on each ear contain the potential characters of many father plants contributing the pollen, together with those of the mother plant.

If, instead of permitting the plants to cross-pollinate, the pollen from each plant is dusted on the silks of the same plant and the silks are covered with a bag, the plant is self-fertilized. After several years of "selfing" in this manner the various characters contained in the original ear may be isolated. Strains may thus be developed that differ widely in height of plant, diameter of stalk, amount of leaves, number of suckers, tendency to lodge, barrenness, color, and earliness. These wide differences in characteristics may all be contained in the kernels of one ear. By selection, various strains and varieties may be isolated.

Adapted corn has been through a process of natural or artificial selection, or both, under certain environmental conditions. By these means, characters and characteristics have been developed which make it suitable for the soil and climate of its region. Bringing southern corn to northern climates is introducing varieties unadapted to the region. Ignorance of this adaptation resulted in the failures of early settlers to grow corn in the North. But why was the Indian corn, known to be successful, disregarded? Why, after failure with more southern varieties, did not farmers grow those already here? A few did; most of them did not because of their appearance.

CHARACTERISTICS OF EARLY MATURING CORN

Certain characteristics of growth are associated with early maturity. Growth and yield are directly dependent upon the amount of leaf surface. When the pollen is shed, growth of the stalk practically stops. If a large leaf area is not developed by the time pollen is shed, the yield is limited. In early varieties, large leaf areas are developed in the form of suckers and ear-leaves. Early varieties are

comparatively short, with many suckers. The ears are borne low and contain shallow kernels that are more or less flinty.

Such types of corn did not find ready favor with farmers who were familiar with the tall-growing, large-eared, and deep kernalled varieties of the south. This prejudice has been hard to overcome. Realization of the value of early corn has come only after thoro investigation and trial.

After the early failures with corn, interest in the crop lagged. Small grains were extensively planted and corn was almost forgotten. With the continuous growing of small grains, weeds were a serious problem. A cultivated crop became necessary for weed control. Sweet clover and alfalfa were found to be thoroly adapted to the soil and climate. These crops necessitated livestock to which they could be fed. Livestock and corn are old companions—attention was again directed to corn.

INVESTIGATIONS SHOW VALUE OF NORTHERN CORN

Investigations indicated that some of the Indian corn did not fully utilize the seasons of the North. It was found that somewhat taller and later varieties could be used which would still ripen or produce good ensilage. Strains were isolated from some later varieties by selection. Furthermore, it was found that the early varieties were not as low-yielding as appearances indicated. The average yield of corn in Minnesota, in 1926, was 34.0 bushels. At the Northwest Experiment Station, Crookston, about 85 miles south of the Canadian line, a four-year average is reported (1919-22) of 49.6 bushels per acre (field weight) for Northwestern Dent.

The flinty kernel of the early varieties was found less objectionable than at first supposed. Yields of flint corn are fully as good as of early dents and feed analyses show them to be of about equal value.

GROWING CORN IN THE NORTH

In the North corn has not generally been given the attention from a cultural standpoint that it deserves. Planting has been late. Seed has often been of poor quality. Cultivation has been neglected and seed has usually been drilled in. Can corn assume a position of importance in northern agriculture? The question can be answered only by trials in which certain essentials are recognized.

Classification

Roughly, northern corn can be classified into flint, dent, and flour types.

There is a general impression that all flint corn is early, of short stature, produces many suckers, and bears hard, vitreous kernels with-

out dents. Only the flinty kernel character is common to the entire class. There is a wide variation in the other characters from the extremely early, low-growing Howe's Alberta to the late, tall-growing Longfellow. Varieties intermediate in both maturity and height are Dakota White, Gehu, Quebec, and Pearl.

The dent varieties are taller, later, and produce fewer suckers than the early flints. Their kernels are distinctly dented in the crown. As a class, they are too late even for the best silage in an average year.

Early strains of the dents are suitable for northern latitudes. In maturity, height, and kernel indentation they are intermediate between the early flints and the true dents. The kernels retain the indentation of the dents, but tend toward flintiness on tips and butts. In no case should the dimple, or indentation, become rough. Quite generally the varieties are named after the man who originated the strain or the locality from which it came as: Haney Minn. No. 13 and Crookston Northwestern Dent.

The flour corns are original Indian varieties ranging in maturity from early to late. The kernels never become flinty and, because they are more easily ground and considered to be more easily digested by stock than the dents and flints, these varieties are in demand in some localities. However, they are less important than the other classes.

Varieties and Strains

While the choice of a variety is important, as some are distinctly of southern adaptation and others of northern, at present it is more important to obtain the proper strain. There is often more difference between strains of the same variety than between varieties. The question "To what conditions has a corn become adapted?" is better than "To what variety does it belong?"

A recent issue of a local paper in northwestern Minnesota contained two advertisements of Minn. No. 13 seed corn for sale. Each lot was described as graded and of excellent germination; yet one was quoted at \$4.00 and the other at \$7.00 per bushel.

A seed dealer once held out two handfuls of yellow corn. "Could you distinguish between these lots?" he asked. They looked exactly alike even to the trained eye.

"And yet," he remarked, "there is a difference which would mean about \$30,000 in my pocket if I sold them for the same kind."

That invisible difference in the seed that meant \$30,000, or \$3.00 per bushel, was the difference resulting from source. The lot grown for many years in the northwestern part of the state could be expected to mature in the average season of this region; the other, grown in a region where there was a longer growing season, would be severely injured by an early frost. It is impossible in a bulletin of this size

to describe all varieties and strains suitable for the North. Of chief importance is the selection, first, of a variety meeting the needs of the grower, that has been thoroly acclimated by years of production under the same conditions of soil and climate.

A few of the varieties and strains that have been grown under careful trials are described in Tables I and II. The list is not complete; in fact, the writer has long suspected that on the farms of the North are strains equal or possibly superior in value to those listed. A few local strains have been obtained for testing, while many are unknown. Only through careful trial can their value be ascertained.

Table I. Description of Some Northern Varieties of Corn

Variety	Class	Color		No. of rows	Average length of ear inches
		Kernels	Cob		
Assiniboine	Early flint	Mixed red, blue, yellow, and white	White	8-12	6-7
Burleigh	" "	Same	"	8-12	6-7
Dakota White	" "	White	"	8	8-9
Gehu	" "	Lemon yellow	"	8-12	7-8½
Pearl	" "	Pearly white	"	12-14	8-9
Quebec	Mid-early flint	Orange yellow	"	10-12	8-10
Mercer	Late flint	" "	"	8-14	8-10
Smutnose	" "	Yellow with red tip	"	8	7-9
Longfellow	" "	Yellow	"	8	8-10
Manitoba Amber	Early dent	Red with yellow and white caps	"	12-14	7-9
N. W. Dent (Crookston)	" "	Red with white and yellow caps	"	12-14	7-9
Minn. No. 23	" "	Yellow with white cap	Pink	8-12	6-7
Minn. No. 13 (Hancy)	Mid-early dent	Yellow	Red	12-14	7-8
Hoppe Dent	" " "	White	White	14-16	7-9
Rustler (Luchau)	" " "	White with pink tinge at tip	"	14-16	7-9

Table II. Height, Maturity, and Yield of Northern Varieties of Corn

Variety	Average height of stalk	Average height of ears above ground	Average days to maturity	4-yr. av. per cent of ripe corn	3-yr. av. yield 14 per cent shelled corn	Average shelling per cent
	inches	inches			bu.	
Assiniboine	57	6-10	108 (4-yr.)	96.5	30.5	77 (3-yr.)
Burleigh	60	6-10	108 (")	96.5	36.8 (2-yr.)	81 (2-yr.)
Dakota White	63	12-16	109 (6-yr.)	93.8	28.7	78 (5-yr.)
Gehu	62	12-16	101 (7-yr.)	91.4	25.6	79 (4-yr.)
Pearl	62	16-20	107 (")	91.9	24.5	76 (5-yr.)
Quebec	65	18-21	113 (4-yr.)	91.0	24.7	75 (4-yr.)
Smutnose	68	22-25	117 (3-yr.)			77 (")
Longfellow	80	22-25	117 (2-yr.)			79 (2-yr.)
Manitoba Amber	68	18-24	119 (")	92.5	16.6	74 (3-yr.)
N. W. Dent (Crookston)	76	22-30	110 (7-yr.)	86.3	33.9	78 (5-yr.)
Minn. No. 23	70	21-30	111 (")	79.7	29.8	82 (")
Minn. No. 13 (Hancy)	72	18-24	116 (6-yr.)	69.3	19.2	74 (4-yr.)

Origin of Some Northern Corn Varieties

Early Flints

Assiniboine.—Original corn grown by Assiniboine Indians, of Canada.

Burleigh.—An original Indian corn grown in Burleigh County, North Dakota.

Dakota White Flint.—A white strain of Mandan Indian corn developed by Oscar H. Will of Bismarck, No. Dak., who in 1882 obtained the original "Squaw corn" from which this was developed.

Gehu.—A cross between Dakota and Mercer, made in 1887. The hybrid was further selected and developed by Oscar Will. The name refers to the biblical Jehu who "got there quick."

Pearl.—Developed by C. C. Williams, Detroit Lakes, Minn., from a mixture found in Red Lake flint about 1907.

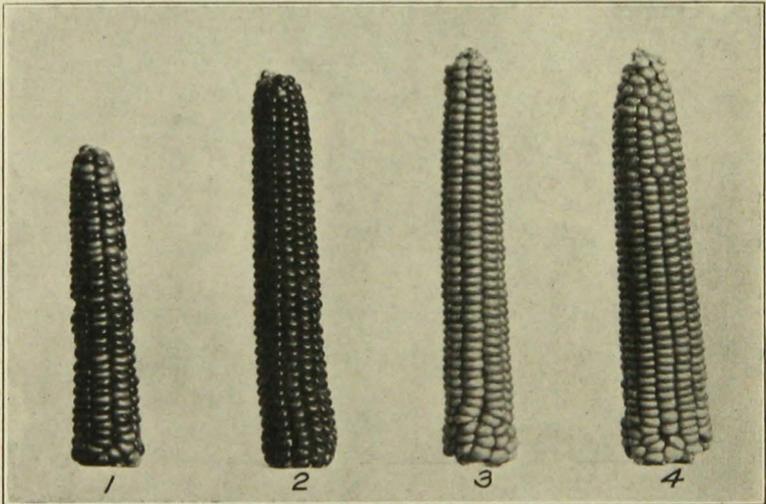


Fig. 1. Early Flints

1. Assiniboine (mixed)
2. Gehu (yellow)

3. Dakota White
4. Pearl (white)

Mid-Early Flints

Quebec.—A mid-early flint developed in Canada.

Mercer.—Originated in New England.

Early Dents

Manitoba Amber.—A double cross between Northwestern Dent and Manitoba Flint made at the Manitoba Agricultural College, Winnipeg, Canada, by Professor Southworth. Manitoba Flint resulted from an inadvertent cross between Quebec 28 and Gehu or Longfellow.

Northwestern Dent (Crookston).—Origin is unknown. The Crookston strain was developed by selection at the Northwest station from seed obtained at Fosston, Minn., in 1918.

Pioneer.—Early white dent, probably a selection from Rustler. Developed by Oscar Will from seed stock obtained from Dr. B. F. Schuster, of Wyndmere, North Dakota.

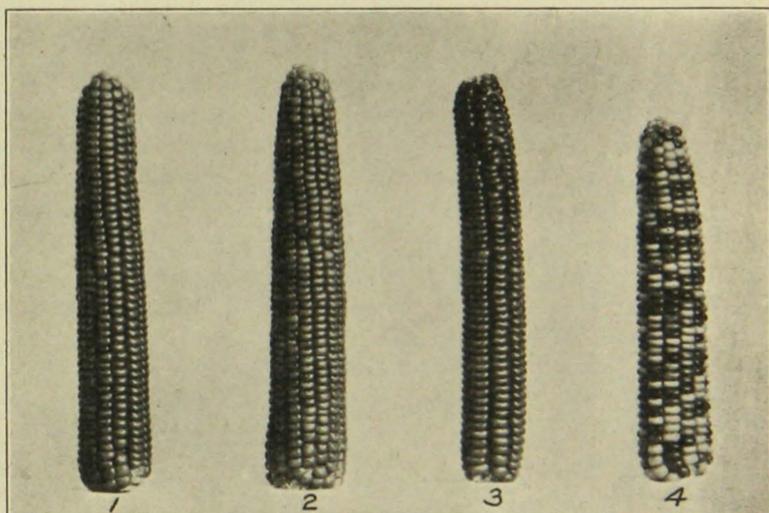


Fig. 2. Mid-early Flints

- | | |
|--------------------|-----------------------------------|
| 1. Quebec (yellow) | 3. Smutnose (yellow with red tip) |
| 2. Mercer (yellow) | 4. Rainbow (mixed) |

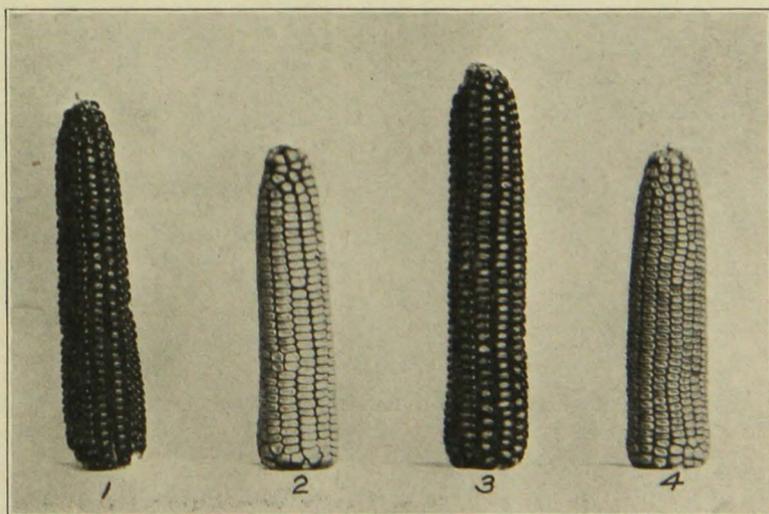


Fig. 3. Early Dents

- | | |
|-------------------------|----------------------------|
| 1. Manitoba Amber (red) | 3. Northwestern Dent (red) |
| 2. Minn. No. 23 (white) | 4. Pioneer (white) |

Minn. No. 23.—A selection by C. P. Bull, of the Minnesota Agricultural Experiment Station, from a local variety grown in Polk County, Minn. The seed was obtained in 1893.

Mid-Early Dents

Minn. No. 13 (Haney).—Developed by the Minnesota Agricultural Experiment Station from commercial seed thought to be Pride of the North stock. The Haney strain was developed by J. G. Haney at the International Harvester Company's farm, at Grand Forks, North Dakota. He obtained his seed from a strain developed by M. L. Thorpe, of Mayville, North Dakota, who had secured his seed from the Minnesota Agricultural Experiment Station.

Moccasin.—An early yellow dent developed at the North Central Experiment Station, Grand Rapids, by O. I. Bergh, from a local variety obtained in Norman County. Very similar to Haney Minn. No. 13.

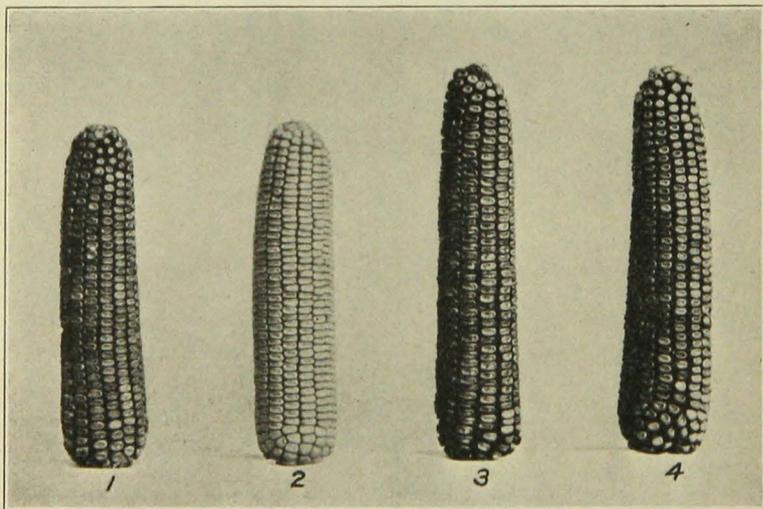


Fig. 4. Mid-early Dents

1. Haney Minn. No. 13 (yellow)
2. Rustler (white)

3. Wisconsin No. 25 (yellow)
4. Moccasin (yellow)

White Dent (Croy, Hoppe, and Luchau).—Local strains developed by John Croy, of East Grand Forks, Minn., from an unknown stock; Otto Hoppe, of Crookston, from tassel ears of a white dent; and J. B. Luchau, of Gary, from a Rustler white dent.

Wisconsin No. 25.—A cross between Minn. No. 13 and a small early yellow dent from Michigan. The cross and selection were made at the Spooner station, in Wisconsin.

Climate

Weather records are available at the Northwest station, Crookston, for thirty years. From these records, certain averages may be determined. Thus for the thirty years the average date of the last killing frost in the spring was May 19; and of the first killing frost in the fall, September 22. The average number of days between frosts was 126. For the last ten years, the average mean temperature for May, June, July, August, and September was 62.6 degrees and the average amount of rainfall in July and August was 4.9 inches for the same ten years.

Table III. Dates of Killing Frosts at Crookston, 1897-1927

Year	Latest in spring		Earliest in fall		Year	Latest in spring		Earliest in fall	
1897	May	31	Sept.	16	1912	June	7*	Sept.	24
1898	"	11	"	9	1913	"	7*	"	20
1899	"	14	"	25	1914	May	8	Oct.	26
1900	"	9	"	17	1915	June	9	Aug.	26
1901	June	7	"	18	1916	May	18	Sept.	15
1902	May	9	"	11	1917	June	1	"	2
1903	"	29	"	16	1918	May	21	"	8
1904	April	20	"	21	1919	"	1	"	25
1905	May	25	Oct.	11	1920	"	16	Oct.	3
1906	"	9	"	9	1921	"	13	"	8
1907	"	27	Sept.	25	1922	April	27	"	30
1908	"	5	"	29	1923	May	16	Sept.	13
1909	"	10	Oct.	11	1924	June	6	"	5
1910	June	2	Sept.	27	1925	May	17	Oct.	6
1911	May	12	"	24	1926	"	22	Sept.	12
					1927	"	15	"	25
					Average	May	19	Sept.	22

* Light frost only.

Temperature and Precipitation at Crookston, 1924-26, and 10-yr. Average

Month	Mean temperature				Precipitation			
	10-yr. av.	1924	1925	1926	10-yr. av.	1924	1925	1926
	deg.	deg.	deg.	deg.	in.	in.	in.	in.
January	5.3	0.6	6.0	13.4	0.30	0.34	0.09	0.25
February	8.8	15.4	11.8	18.6	0.73	0.06	0.22	0.09
March	23.0	26.6	27.6	23.5	0.31	0.32	0.31	0.05
April	41.2	40.4	48.9	43.1	1.66	5.10	2.79	0.14
May	55.6	46.8	53.4	59.8	2.83	2.81	4.60	2.16
June	63.5	47.8	62.9	60.5	2.84	1.58	6.82	3.43
July	69.1	66.4	67.4	69.0	3.11	2.64	0.86	1.28
August	67.0	65.2	70.0	66.4	1.60	1.65	1.46	1.49
September	57.7	56.0	59.8	54.6	2.05	3.54	5.66	0.65
October	43.6	51.9	34.8	42.8	1.09	2.24	0.58	3.51
November	26.7	26.5	28.0	20.4	1.14	0.14	0.25	0.72
December	10.0	1.5	12.4	5.9	0.39	0.44	0.12	0.22
Year	39.3	44.5	40.3	39.8	18.05	20.86	23.76	13.99

Unfortunately, the weather does not behave according to averages. During thirty years there has never been a year with exactly 126 days free from frost—in 16 of those years the season was shorter and in the other 14, longer. A variety that required 126 frost-free days

would have failed to mature more than half the time. An average of the 16 short seasons is somewhat more dependable, i.e., 109 days. Some have advised planting a variety that will mature in the shortest season, which, once in the thirty years, was 78 days. This seems hardly justified for two reasons; (1) because the farmer would have had some feed from his crop even in that year; and (2) because, altho he did not have a crop of ripe corn, it may be considered as much an accident as the cows breaking in and destroying the writer's crop—it having occurred only once in thirty years. On the other hand, there is no justification for selecting a variety that would need an extremely long season, as in 1922, when there were 164 frost-free days.

There is no assurance that the climate for the next thirty years will be the same as in the past, but it is a significant fact that the average frost-free season for the first ten years (1897-1906) was 127.8 days, for the next ten years (1907-16), 125.7 days, and for the last ten years (1917-26), 125.4 days.

In some climates the frost-free season would not correspond to the season between date of planting and date of the first fall frost, but in this climate the seasons correspond quite closely, as May 19 is not much later than the average planting date.

One of the best years for northern corn in the last decade was 1923. In that year the mean temperature (average of highest for the day and lowest at night) for May, June, July, August, and September was 64.3 degrees. If we except 1924, when the mean temperature was only 56.4 degrees, there has been little variation between any season and this optimum temperature.

Aside from the length of the season, which determines the amount of ripe corn, the yield seems to depend largely upon sufficient rainfall in July and August, when kernels are filling. In 1923, the good year, 6.45 inches of rain fell in these two months. In the three good years of the last decade, 1919, 1922, and 1923, the rainfall for July and August was respectively 10.52, 5.15, and 6.45 inches. In 1920, with a season of 137 days, the rainfall was 2.61 inches and yields were poor. Likewise, the poor years of 1925 and 1926 had respectively seasons of 142 and 113 days and rainfall of 2.32 and 2.77 inches.

Recommended Varieties

From the facts brought out in this study, it seems advisable to select a variety that will mature in about 109 days, if ripe corn is desired. It is also necessary to grow varieties which, from their adaptation to semi-arid conditions, will require the least water. It is wise to conserve as much soil moisture as possible by good soil preparation,

careful cultivation, elimination of weeds, and maintenance of organic matter content.

Of all common farm crops, corn requires the least moisture to produce a pound of dry matter and yet there is a marked variation between varieties and strains. Varieties adapted to northern latitudes require less water than those adapted to southern and more humid latitudes.

For silage, corn should reach the glazed stage, which is approximately a week before maturity; hence a variety or strain should be selected that will mature in about 116 days.

Average days to maturity are given for the varieties listed in Table II. The figures were obtained at the Northwest station where drainage conditions are unfavorable for corn production. The number of years for which the average is determined is given to indicate that the figures are not strictly comparable. Thus, altho from these figures Gehu appears earlier than Assiniboine, it is not always so. Except as between distinctly early and late varieties, the order of maturity varies with the season. The writer has attempted at other times to list varieties in the absolute order of their earliness, but the order applicable to one year is often upset in the next. The figures given, therefore, are accurate for the period covered but should be considered only approximate for any given season.

Moreover, differences in soil, drainage, and location with regard to shelter will cause differences in the number of days required to mature the crop on different farms.

In general, all the early flints, Crookston strain Northwestern Dent, Minn. No. 23, and Manitoba Amber may be recommended for grain production. The Haney strain of Minn. No. 13 and early strains of white dent are suitable for silage and, in the southern part of the district, for grain. For points north of Crookston, Northwestern Dent may fail to ripen, but will make good silage.

The early flints are difficult to harvest, as they cannot be cut readily with the ordinary corn binder, and they are difficult to husk. Twenty cents a bushel has been paid for husking these flints when seed is desired. Their principal use is for hogging-off. Pearl flint, Quebec flint, Northwestern Dent, Minn. No. 23, and Manitoba Amber are easily cut with a corn binder and readily husked, altho Pearl flint has a stout shank, which slows up husking.

Yields are reported in Table II. These averages represent only ripe corn figured at 56 pounds per bushel and containing 14 per cent moisture. Corn, as ordinarily husked in the northwest, contains from 50 to 60 per cent moisture. Field weights would, therefore, be much higher but would not represent actual feed values. The average yield of corn for Minnesota (1924-26), field weight, is 32 bushels.

It will be noticed from the table that Crookston Northwestern Dent is the highest yielder but the low-growing Assiniboine is a close second. Despised as a "squaw corn" it has averaged 30.5 bushels of ripe corn—real feed—in three years, two of which were undoubtedly unfavorable for this crop. In the good year of 1923, it yielded 59.2 bushels of No. 1 ripe corn (14 per cent moisture).



Fig. 5. Source of Seed May Determine Earliness

Strains of Northwestern Dent photographed Aug. 21.

Left: Crookston strain silked Aug. 9; Right: Wright County strain silked Aug. 16.

Seed and Germination

Having selected the variety and the strain, the next move is to obtain seed. Of what avail is it, when land is carefully prepared and the crop given the best culture, if seed of adapted varieties, which is also capable of vigorous growth, is not used?

In general, it will pay the northern farmer to buy his seed rather than save it. Northern seed corn must be more carefully handled than that produced farther south, and unless the farmer is equipped

with both drying facilities and good storage conditions and is also experienced, it is safer to buy of a seed dealer who is so equipped. Exception can possibly be made for the farmer who needs only a small amount of seed and can dry and store it in the house. (See Curing Seed, page 24.)

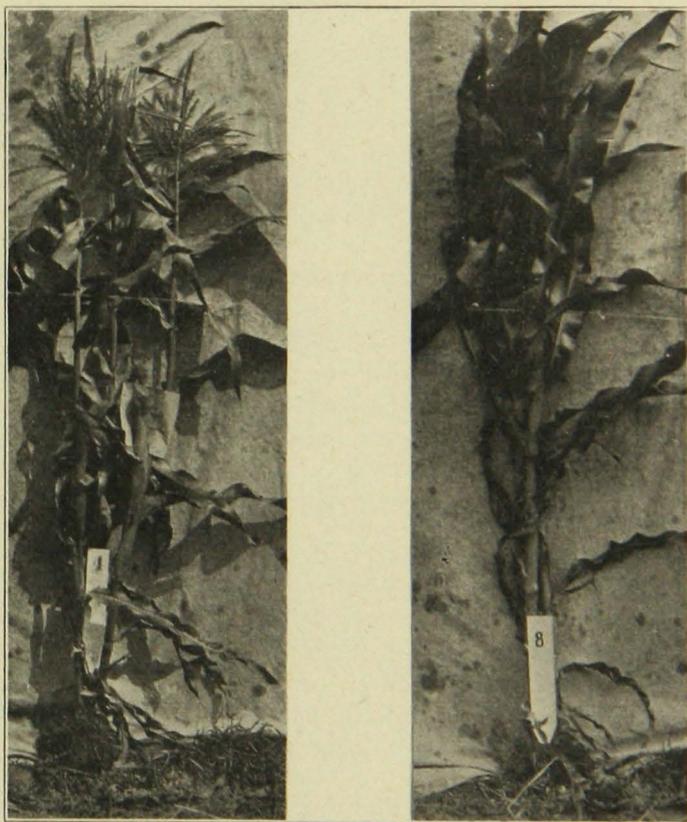


Fig. 6. Acclimated Seed Is Earliest

Strains of Minn. No. 13 photographed Aug. 21.

Left: Haney strain silked Aug. 13; Right: Chatfield strain not tasseled Aug. 21. The Haney Minn. No. 13 silked 3 days earlier than the Wright County Northwestern Dent in Fig. 5.

Of first importance is the source. The seed should come from an adapted strain. How can one tell? The seed itself will not tell the story by its appearance. Sometimes the price will indicate its value as seed of northern strains is necessarily expensive to produce. The grower must determine the source for himself. If this is impossible dependence must be placed in the seller. Only reliable seed dealers should be patronized. The experiment station and State Crop Im-

provement Association can render valuable service, for the former is usually acquainted with sources of suitable seed and the latter certifies seed as to source.

A guaranteed germination test is also important. Unless seed is very poor, one can not always tell about its germination by looking at it. The farmer can easily determine the viability of his seed. He may either test it himself or send a sample to the State Seed Laboratory for a germination test. Various types of rag-doll testers are described in Special Bulletin No. 101, which may be obtained by writing to the Agricultural Extension Division, University Farm, St. Paul.

A preliminary test will show whether ear testing is necessary. If a representative sample of the seed shows good germination and there are no evidences of poor ears, ear-testing will not be necessary. A low preliminary test or doubt as to the uniformity of the ears makes single ear testing advisable.

Graded seed is also important and is always supplied by the best seed dealers. While germination may be just as good in ungraded seed, graded seed is more satisfactory for check-row planting because it drops more uniformly from the planter.

CULTURAL METHODS

Much will depend upon the season. Nevertheless "the Lord helps those who help themselves." Mother Nature does not do her best unaided. Nor can she overcome violations of her laws through neglect or ignorance on the part of the farmer. The United States is the world's largest corn producer. Corn has been grown in this country so long that it is practically native, and many scientific facts concerning the culture of the crop are available.

Planting

In a series of tests in Ohio, ranging over 27 years, it was found that corn came up in varying lengths of time at different mean temperatures as follows: 5 days at 71 degrees F., 6 days at 67 degrees, 7 days at 66 degrees, 8 days at 61 degrees, 9 days at 60 degrees, 10 days at 55 degrees, and from 10 to 12 days at 49 degrees. The ordinary recommendation is to plant corn when the normal daily temperature rises to 55 degrees F.

In growing corn in the North there are other factors to be considered, especially on the heavier soils. One of these is frequent rains in May, which prevent planting. As an average for the last ten years at Crookston, it has rained 7 days in the 21 between May 10 and May 31. This has often delayed planting until June.

It is the general opinion among northern corn growers that seed of adapted strains is more than ordinarily resistant to unfavorable conditions of soil and climate. This opinion is supported by tests made at the Northwest station. Seed of Northwestern Dent (Crx) germinating 90 per cent was kept saturated with water at a temperature of 48 to 50 degrees for three weeks (a very severe test). Upon removal to the greenhouse after this period, 40 per cent germinated, producing strong sprouts.

Northwestern Dent (Crookston) and Dakota White Flint were planted May 1, May 20, and June 1. It snowed on May 1 and the field was so wet on May 10 that not even hand planting could be done. The yields were respectively: Northwestern Dent 31.4, 34.5, and 13.3 bushels; Dakota White Flint 40.2, 45.1, and 25.8 bushels. Further, the percentage of moisture and the number of soft ears were lowest in both varieties from the May 1 planting. Altho the May 20 plantings yielded best, there was much less loss in yield from the early planting than from the June 1 planting.

Young corn may be frosted in the spring without serious injury but early fall frosts, unless very light, stop all growth and ripening.

The northern corn grower will do better to plant too early rather than too late.

Rate of Planting

Three or four kernels in a hill is the proper rate. For the small varieties, rows may be planted from 3 feet to 3 feet 3 inches apart. With rows 3 feet 6 inches apart and three or four kernels per hill, a bushel of seed will plant about six acres.

Checking vs. Drilling

Where weeds are a factor, checked corn is preferable to drilled corn because the crop can be cultivated both ways. Yields are about the same if approximately the same number of kernels are planted per acre. On rich land with sufficient moisture, dropping kernels from 6 to 10 inches apart in the row may yield more silage than checking, but the amount of digestible feed produced per acre is about the same.

Depth of Planting

The plumule is the part of the germinating seed that later produces the stalk and the leaves. It is covered with a sheath that acts as a spike to push upward through the soil. If the seed is planted so deep that the leaves break through this sheath (coleoptile) before it has reached the surface, the plant usually dies. Corn may be planted deeper with safety when the soil is warm and dry, but from one to two inches is the proper depth in the heavy soils of the North.

For northwestern Minnesota, the lister is not advisable. It plants the seed in cold soil. As a result, germination is slow and it becomes difficult to control weeds.

Cultivating

Contrary to a general impression, the most important object in corn cultivation is to keep out weeds and not to conserve moisture by a mulch. In heavy soils that crack, cultivation retards evaporation by filling the cracks, and the aeration of heavy soil by cultivation is beneficial, but the important objective is weed control.

Shallow cultivation should be the rule. If deep cultivation is practiced, it should be when the corn is small, as shallow roots spread rapidly between the rows. The number of cultivations is governed by the growth of weeds. A practice that is almost universal in the corn belt but not common in the north is the carrying of a stick to uncover plants covered by the cultivator. Even with guards on the cultivator, some plants are needlessly left covered with dirt.

Corn cultivation in the North conflicts seriously with haying (especially of alfalfa) and early harvest. No doubt this is the reason for so many weedy corn fields. Two-row cultivators will help to solve this problem.

Corn and Weeds

Where such annual weeds as wild oats are troublesome, a cultivated crop such as corn can be used to advantage. It may be used after fallow to rid the land of weeds that have escaped previous cultivation. Its value in this practice depends upon hand work to eliminate weeds found in the hills. Without this, it is not effective.

For quack grass and sow thistle, corn is not a clean-up crop. It might be made effective but, from the experience of the writer, it is better to condemn it altogether. Even when checked in, the few cultivations given the crop are beneficial to the weeds rather than harmful. After the corn is laid by, quack grass and sow thistles grow luxuriantly and the plants in the rows or hills are encouraged to extraordinary efforts by cultivation. If the weeds have been in patches, they are dragged over the field by the cultivators, there to make "two blades grow where one grew before."

On a half-acre plot at this station corn has been planted every year for seventeen years. It has been fall-plowed and has been hoed at least twice a year for the last six years. Sow thistles are still troublesome on it.

Corn follows a crop of alfalfa, sweet clover, or red clover best, as land in these crops is usually fairly free from quack grass and sow thistles. Moreover, corn is better adapted than small grains to follow a crop that has supplied the soil with only partially decayed organic

matter and considerable amounts of nitrates. Corn also follows well after fallow, sugar beets, or potatoes for the same reasons.

TASSELING AND SILKING

The production of a kernel of corn results from the fertilization of the egg cell at the base of the silk by the male reproductive cell of the pollen grain. Each kernel on an ear must be produced in this manner. The pollen is produced in the tassel, the female element is

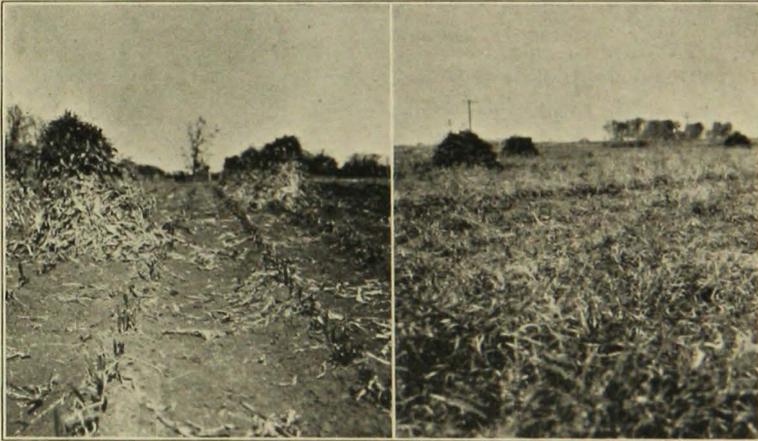


Fig. 7. Clean Cultivation—Only Too Rare in the Northwest

Fig. 8. Poor Cultivation—Only Too Common in the Northwest

borne on the cob. When a pollen grain falls upon a silk and germinates, and the pollen tube grows down the silk it carries the male sexual cell, which unites with an egg at the base of the silk. Imperfectly filled ears are often due to lack of fertilization. This may be caused by hot dry weather or hard rains at tasseling and silking time, which prevent pollination.

In almost all cases the pollen from one plant is blown by the wind to the silks of other plants. Rarely does the pollen fall upon the silks of the same plant. For this reason corn "mixes" easily when two varieties are grown in close proximity. How far pollen may be carried has not been determined, to the writer's knowledge. Obviously trees, hills, and the direction of the wind will affect the distance at which two varieties may be planted with safety. Ordinarily, a quarter of a mile is considered sufficient if the first 10 or 12 rows of the field to the windward are discarded for seed. Crossing is not always evident in the ears the first year.

Because the endosperm of the seed results from fertilization of male and female sexual cells, an immediate effect of cross-pollination

may sometimes be seen in the seed. Kernels of sweet corn resulting from pollination by field varieties immediately become starchy. These can be discarded, the sweet or wrinkled seeds are not injured. Yellow seeds in normally white varieties are evidences of cross-pollination. The yellow grains should be discarded. Purple or red seeds in white or yellow varieties are evidence of crosses with Indian corn and off-colored seeds should be discarded. If other mixtures are noted, it may be desirable to obtain new seed instead of attempting to rogue out the off types.

In Nebraska the average period during which pollen is shed is about 6 days, altho some plants continued to shed pollen for 13 days. Silk first appeared 2 days after pollen began to drop. Fertilization after the pollen grain fell upon the silk was completed in about 24 hours, and the silks became discolored in from 42 to 72 hours after pollination.

At the North Dakota Experiment Station it was found that the date when 80 per cent of the plants was silked is very significant. From that date until the kernels are glazed an average of 41 days elapsed for some varieties. This 41-day period could also be divided, as an average, into three intervals (a) to milk stage, 16 days; (b) to dough, 29 days; and (c) to glazed, 41 days. Roughly, the farmer may estimate that it will take about 40 days from silking to corn in good silage condition and another 7 days to ripe corn.

Self-Fertilization

Altho very little corn is naturally self-fertilized, inbreeding may be done under control. If bags are placed over the tassels and ear shoots before the silks emerge and if pollen is collected and dusted upon the silks of the same plant and the ear shoots are immediately covered with a bag, then the plant is self-fertilized. This practice, continued for several years, will isolate pure lines of corn. The lines become uniform for various characters—some desirable and some undesirable. If desirable lines are then recombined by using the pollen of several upon silks of another desirable line, an improved strain should result. This is the newest method of improving corn. The plan is being thoroly tried and significant results have already been attained, but the method is too costly to be used by the average farmer.

Crossing Varieties

Self-fertilization in corn tends to reduce the vigor and yield. Normally cross-pollinated corn in a field does not "run out." It might be supposed that crossing two varieties would increase vigor and yield. It might also be supposed that an early variety crossed with a late one would produce a cross (hybrid) intermediate in maturity

between the two parents. In many cases such suppositions are correct. Experiments for several years show that the cross usually yields more than the average of the parents and often more than the better parent. A cross between Squaw flint and Minn. No. 13 yielded as much ear corn as the Minn. No. 13 and ripened a week to 10 days earlier.

In order to get the benefit of these hybrids, it is necessary to produce crossed seed each year. The cross is made by planting the two varieties in alternate single- or double-row blocks throughout the field and then detasseling all of one variety before any of the silks of that variety can be seen. Detasseling is accomplished by pulling the tassels out by hand. This makes the use of this method impractical for the average farmer. Only specialists can afford to do it. Double-crossed corn is on the market in Iowa and Illinois, altho not in large amounts.

The new methods of producing corn varieties are in general practice by corn breeders, but not by farmers. As one plant breeder expresses it: "It appears probable that corn of better quality and of 20 to 30 per cent higher yielding ability can be obtained by the newer breeding methods."

HARVESTING

If man does his part by careful attention to preparation of the soil, the use of adapted seed, and proper cultivation, Mother Nature will do her part. The plant draws its food from air, water, and soil. Hydrogen, oxygen, and carbon are drawn from air and water. The soil furnishes nitrogen, phosphorus, potassium, calcium, magnesium, iron, and sulphur. Nature takes all these materials and, with sunshine and rain, makes the corn crop.

When fall comes the corn crop matures and then man must complete his part of the work. The farmer must now garner his harvest at the opportune time—he must save the season's product before it has been dissipated by winds and frost. However, he must wait until Nature has completed her work so far as his requirements are concerned. He must cut neither too early nor too late.

Silage

One important fact stands out as a result of many investigations. The amount of dry matter and the amount of nutriment in corn increase with maturity. Corn produces the largest amount of dry matter and nutriment in the glazing stage i.e., when the kernels begin to harden and appear glassy. At this stage about 15 per cent of the feed value is contained in the stalk, 30 per cent in the leaves, and 55 per cent in the ears. To save the leaves is therefore important. Usually, only the lower leaves are beginning to turn brown in the glazing stage. A frost will make earlier cutting necessary, as corn should then

be cut immediately to save leaves and avoid excessive drying. For silage, corn should contain between 65 and 75 per cent of water. Corn in the glazed stage was found to contain 67.3 per cent of water at the North Dakota Experiment Station.

Corn for silage is best cut in the glazing stage. Obviously, only such varieties as will reach this stage should be planted. As with varieties used for grain production, there are many suitable strains, some of which are known through experimental trials and some, perhaps, are growing on local farms, the performance of which is not known. In Table II a few are described. In 1926 all varieties were cut on September 13 and in 1927 on September 23, following frost. All varieties had not reached their maximum production of feed because they had not reached the glazed stage. In both years Haney Minn. No. 13 and Smutnose flint were cut too early and altho as a 2-year average their dry matter is the same as that of Northwestern Dent, they did not have the same feeding value.

The frequent use of so-called "silage corn" in the North is to be discouraged. One variety, planted by the writer, yielded 11.4 tons when green, but 9.9 tons of this was water. From such corn only 13 pounds out of 100 was feed and that was poor, owing to lack of development.

Silage is frequently put up at a loss on northwestern Minnesota farms. Where it is put up at a profit, the margin is small. Operating costs are high and yields are low. In 1926 the average cost was \$18.21 per acre on a Farm Management route near Crookston. The cost per ton depends on yield. There is no economy in handling 11.4 tons of corn to get 1.5 tons of feed when 6.9 tons of an earlier variety would have produced the same amount and of better quality.

For the northern part of the Red River Valley, early strains of Northwestern Dent are suitable. For the southern part, early strains of Minn. No. 13, Rustler, and Northwestern Dent are recommended.

Quite aside from the varieties, the economical production of silage depends upon the amount of spoilage. The principle of ensiling corn is the exclusion of air. Sufficient moisture must be contained in the plant or added so that it may be tightly packed, and the pieces must be cut small enough to fit closely. The top of the silo may be sealed with wet cut straw to avoid spoilage. In designing a silo, the diameter should be considered with reference to the size of the herd. Spoilage frequently occurs when the silo is so large in diameter that a complete layer is not removed each day. The material of which the silo is made is of much less importance with reference to spoilage than the factors just mentioned.

Fodder

What has been said of varieties for silage is in general true for fodder. Maximum feed is obtained only from varieties reaching the glazed stage of development. Ordinarily, there is more loss of feed from fodder than from silage, but the expense of handling is less. Stacking reduces this loss and makes winter feeding easier. If the corn is dry and the stacks are narrow, little spoilage will result. If wet, the layers of corn may be alternated with straw about four inches thick.

Grain

Altho the greatest use of corn in the Red River Valley is for silage, some corn for grain is needed, as evidenced by the shipments of feed corn into this district every year. In the main, early flints such as Dakota White, Gehu, and Pearl will have to be relied upon, altho in some places Northwestern Dent and Minn. No. 23 mature successfully. Where Gehu and Dakota White are grown, hogging-off will be most practical. Pearl may be cut with a binder for fodder and is more easily husked than Dakota White or Gehu. Limited trials have indicated that it is possible to snap the flints, cribbing them with the husks on. This method is considerably cheaper than husking and when the corn is kept off the ground and the crib protected from rain and snow, it has kept well in the trials made. It may not keep well in warm weather.

There is little difference between yellow and white varieties for feed if the stock has access to alfalfa, which supplies a vitamin not found in white corn.

Selecting seed.—If seed is saved, it should be selected in the field. Selection from husked ears is not so satisfactory as field selection. As corn is a cross-fertilized plant, many heritable factors of weakness and other undesirable characteristics may be combined in an ear without any visible evidence of such factors. In order to eliminate, as far as possible by selection, such undesirable factors, it is necessary to select seed ears from normal vigorous plants in full-stand hills.

1. Select seed early, while most plants are still green. Select early-maturing ears if earliness is not due to injury or disease. Ears may be ripened prematurely by disease.

2. Avoid ears with weak shanks. Ears hanging straight down have diseased shanks.

3. Select from vigorous plants in full-stand hills. Weak plants may make a vigorous growth if they are alone in the hill. They show their weakness when competing with two or three other plants in the same hill. Do not select seed from hills of less than full stand.

4. Select sound ears with kernels firmly attached, denoting maturity. Moldy or immature ears should not be considered.

5. Select ears free from mixture, mixtures are not always evident in the kernel. White cobs in red-cob varieties and vice versa denote mixtures.

6. Do not select too closely for ear type. Continued selection for one particular type tends toward reduced yields and vigor. Select as large, well-matured ears as can be found from full hills and healthy looking plants, and type of ear will largely take care of itself. For our northern varieties, relatively long ears with smooth kernel indentation are associated with early maturity and are desirable. Size of ear is to be attained through increased length rather than increased circumference. Within the same variety, ears large around with either a large number of rows or with exceptionally wide kernels are later than more slender ears. Rough wrinkled dent kernels are associated with late maturity.

Curing seed.—The curing of seed corn in commercial quantities in northwestern Minnesota is considerably more difficult and expensive than in the corn belt. There is always danger of losing a crop by early frosts and even in a normal year curing presents several problems.

As an average of the last four years, Crookston Northwestern Dent saved for seed at the Northwestern station has contained 51 per cent of moisture at picking time. In two of those years it contained over 60 per cent. Corn with that moisture content molds readily if piled, even in small quantities. Further, such corn will be killed for seed by a temperature of 24 degrees Fahrenheit. It should be stored inside with plenty of ventilation to control mold and with facilities for heating in cold weather. In fact, it is usually necessary to apply some heat to control molding. Corn piled 6 to 8 inches high on poultry-wire racks at this station has begun to mold even with heat. When the corn dries to approximately 25 per cent moisture, danger from molds is about over, but it will be injured by a temperature of 12 degrees.

The practice of cribbing seed corn outdoors in narrow wire cribs is unsafe in this region.

The commercial seed-corn dealer in the northern territory must be prepared to house all corn almost as soon as picked. There must be ample room to spread the corn thin and there must be facilities for keeping the temperature above 24 degrees Fahrenheit. This corn must be conveyed to a drier that will reduce the moisture to from 10 to 14 per cent as rapidly as possible. The dealer must face a shrinkage of approximately 50 per cent in ear corn because of moisture, and another shrinkage of 20 per cent in shelling. Culling and grading will

still further shrink it. For these reasons commercial seed production is expensive.

One plan of solving these difficulties is to use seed of northern varieties grown farther south for one year. Careful comparisons of this seed with seed corn produced at Crookston indicate that the practice is safe and practical. Another method is to grow small acreages for seed under contract to a seed-house fully equipped for curing and drying. Small amounts of corn can often be successfully cured on the ordinary farm with little additional equipment, but the same precautions must be observed. After corn has been dried to a moisture content of from 10 to 14 per cent, it will stand any amount of freezing and may be stored in a smaller place. The room, however, must be kept dry and moderately cool.

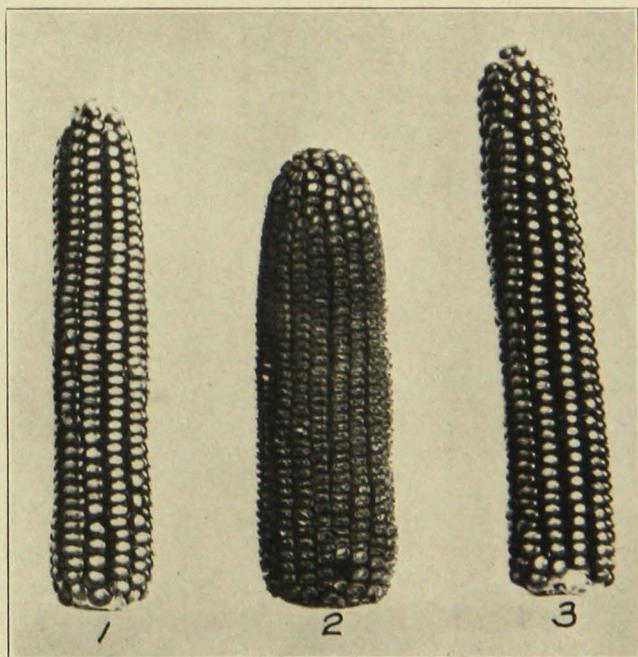


Fig. 9. Kernel Indentation

- | | |
|---------------------------------|---------------|
| 1. Desirable dimple | 3. Too flinty |
| 2. Too rough for early maturity | |

The farmer who wishes to save only a small amount of seed for his own use must observe the principles discussed but, with only a small amount, he can make use of many simple devices for keeping the ears separate to avoid molding. Heat for drying is usually easily supplied by the house stove.

JUDGING CORN AT CORN SHOWS

Those who note many fine samples of corn at a crops show sometimes wonder on what basis the judge places one first and another last. Often the first-prize sample has not looked the part of a prize-winner. Those who have attended corn shows for the last fifteen or twenty years have noted a difference in standards. Perhaps some have purchased a champion sample, planted it, and were disappointed in the result.

Changing Standards

The points once emphasized in judging corn have been found of little or no value in selecting seed for commercial use. Ten ears with well filled tips and butts, straight rows, and of definite length and circumference will not necessarily produce similar ears. Partly because these characters are the result of weather and soil conditions and partly because the seed ear is the result of cross-pollination, "like does not beget like" exactly in this crop. Furthermore, long-continued close selection tends to reduce vigor.

Certain characters in northern corn, however, indicate value. One is **Maturity**. Immature samples at a show are evidence that the corn was of too late a strain for the season. Maturity indicates (altho it does not prove) good seed vitality. An interesting fact brought out by several investigations is that corn that matures also yields best in this district. As maturity is of first importance in the growing of corn in the north, it is given greatest weight in judging. Maturity is evidenced by hard and dry ears, with kernels firm on the cob. Loose, chaffy kernels, light-weight ears, and spongy cobs are indications of immaturity.

Teri ears of ripe corn at a show, however, are not evidence in themselves that the entire crop matured. They may have been the only ripe ears selected from bushels of soft corn. They may also have been grown under very favorable conditions not representative of any large area in the district. For these reasons **type** is extremely important. The type will vary for each section of the district and it must rest in the discretion and experience of the judge to encourage later strains in some sections and discriminate against them in others. Nevertheless, certain general type features are required. Ears should be relatively long and slender. Increase in diameter is associated with late maturity, but length of ear seems unrelated to maturity. Smooth kernels are associated with earliness—rough indentations indicate lateness. Too much flintiness in kernels of dent corn should be discriminated against.

Uniformity of sample is likewise important. The sample should be uniform in size and shape of ears, and in size, shape, color, and

indentation of kernels. Altho a uniform sample may not produce like ears when planted, it shows care in selection and a definite ideal in the mind of the grower. As one rather famous winner at corn shows put it, "A man must grow good corn before he can select a good sample."

Other Important Standards

The three requirements mentioned have developed in importance as knowledge of northern corn increased. Other standards of importance in judging any corn samples are: (1) Freedom from disease and damage; (a) sample should be free from traces of mold, mice-bitten kernels, and smutted or damaged tips; (b) germs should have bright, healthy appearance; (c) shanks should be broken off clean. Shredded or pink-colored shanks are objectionable. (2) Samples should be typical of the varieties represented. (3) Kernels and cobs should show no traces of cross-pollination by other varieties.

The color in corn may occur in three parts of the kernel. The outer seed-coat or pericarp may be red or colorless. The remainder of the kernel, except the germ, is called the endosperm. The outer layer of the endosperm, or aleurone layer, may be purple, red, or colorless. The endosperm may be white or various shades of yellow.

With a colorless pericarp, the colors of aleurone layer and endosperm may show through, but a yellow or white endosperm can not show through a red pericarp.

Evidences in the kernel of mixture between varieties depends upon what part of the kernel has been affected. The cob and the pericarp are produced by the mother plant and are formed whether the silks are fertilized or not. Obviously, color in the cob and pericarp can not be affected the first year by crossing. For a red pericarp variety like Northwestern Dent there is no immediate change in the color of the pericarp as a result of cross-pollination. Extreme variation in the pericarp color is evidence of a cross with another variety. The endosperm, including the aleurone layer, is formed as a result of fertilization and therefore may be affected immediately in color by pollen from another variety. (4) Showmanship: The Corn Show is essentially a show. Just as a meal is more appetizing if attractively served, so a show has more appeal if samples are attractively exhibited. The judge will do well to consider evidences of good and poor showmanship. Ears with long, ugly shanks, mice-bitten ears, and ears with husks incompletely removed are evidence of poor showmanship. No discrimination should be made for ears from which kernels have been removed for examination. This is perfectly justified. Ears numbered by the exhibitor should be set up in the order indicated.

Probably the greatest value of a coin show is its educational aspect. The farmers who are the better producers have an opportunity to discuss their problems together. The judges can aid by teaching correct ideals.

2018