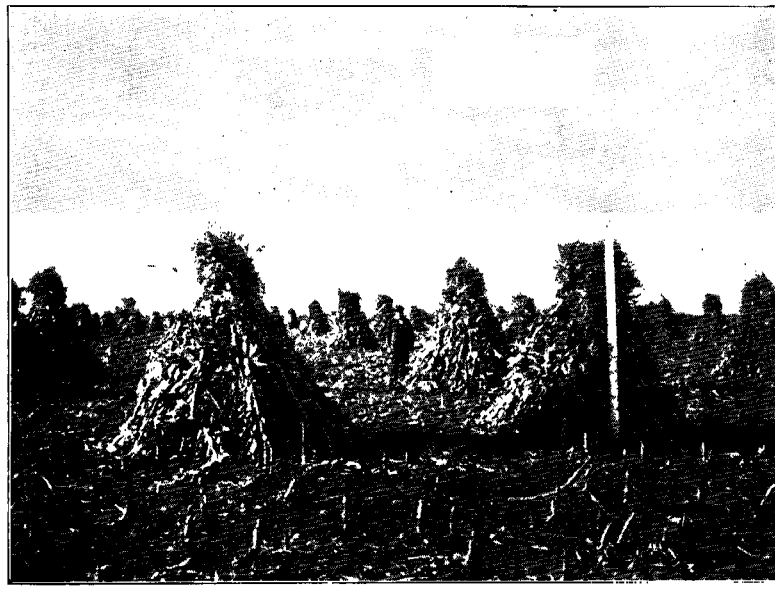
June, 1907 Bulletin 147

Kansas State Agricultural College

Agricultural Experiment Station

Indian Corn



A Field of Kansas Sunflower Corn, 1906.

BY

A. M. Ten Eyck and V. M. Shoesmith

MANHATTAN
PUBLISHED BY THE COLLEGE PRINTING DEPARTMENT

Indian Corn

By A. M. TenEyck and V. M. Shoesmith

The experiments reported in this bulletin were begun in most cases in 1903, and have been carried on now for four seasons. The report of the first year's work was published in bulletin No. 123 of this Station, and the present bulletin is a discussion of the work of the last three years, including the average yields of crops for the four years, 1903-'04-'05-'06, when the experiments were continued during this period. Although some discussion has been made of the planting and culture of the crop for each season, the descriptive data given in the tables refer only to the crop of 1905, unless otherwise stated.

This bulletin is, in a measure, a part and continuation of bulletin No. 144, on "Small Grain Crops," to which the reader is referred for a general discussion regarding the soil and weather conditions during the years mentioned, in their relation to the production of crops.

TRIALS OF VARIETIES

One hundred twelve varieties of corn have been planted in the trials of varieties during the past four years. Some of these varieties have been planted one year only, while others have been grown during each of the four seasons in comparative tests. In 1904 and 1905 the varieties of corn were planted in the same field. This land was rented from a neighboring farmer and was the ordinary upland of this locality, the soil being a rather heavy, clay loam, which had not been manured or fertilized for many years. The field sloped rather uniformly toward the east, the plots of 1904 extending with the slope, while those of 1905 crossed the plots of the previous year, extending across the slope. The variation in the productiveness of the soil at the several intervals in the slope was determined by planting check plots of one variety of corn. Each of the several adjoining plots of corn was compared with its check and the checks were compared with each other, the yield of each of the plots being raised or lowered in order to make it comparable with the average yield of the check plots. Thus the yields of the several varieties, as published in the tables, are comparable with each other.

Corn was grown also on the field in question in 1903, and no work was done in preparing the land for the next year's crop until March 10 to 15, 1904, when the field was disked twice, which put the soil into good condition for conserving the moisture. The field was disked again April 29 to May 2, and on May 2 and 3 the corn was listed in furrows about five inches deep, with rows three and one-half feet apart and kernels sixteen inches apart in the row. The weather was cold and wet for several days after planting, and this with other conditions resulted in a very poor stand of corn for

PLATE I.—Husking the varieties of corn, 1905.

most of the varieties. Several of the varieties which were among the highest producers in 1903, 1905 and 1906 made such poor stands in 1904 that the yields were relatively low. The actual yields of each variety in 1904 are published in table I, no correction being made for difference in stand, but the percentage stand of each variety is given in the table, and this data may be of value to the reader in comparing the yields of the several varieties of corn for that season.

In preparing for the 1905 planting the land was plowed November 24 to December 10, and left in this rough condition through the winter. The field was harrowed March 29, and harrowed again April 28, and the corn was planted on April 28 and 29 with the John Deere edge-drop planter, in rows three and one-half feet apart, kernels sixteen inches apart in the row. A fairly good stand was secured, and there was a promise of a large yield of corn until the latter part of August, when a period of extremely hot weather seriously injured the crop.

In 1906 the varieties of corn were planted in plots which had been seeded to winter wheat in 1905, followed with rape planted in the stubble after the wheat harvest. The rape made a fairly good stand and attained a growth of about sixteen inches in height and was plowed under for green manure near the middle of October. The land was disked soon after plowing and was harrowed with the Acme and common straight-tooth harrows in the spring before planting. The corn was planted May 2 to 4 in the same manner as in 1905. The weather and soil conditions were very favorable to the germination of the corn, which came up well and made a good stand on all the plots, but some of it was destroyed in part by cut-worms, and the vacant' places were replanted with the hoe, May 21 and 22. The later treatment given the corn was about the same as is usually practiced on the Station farm, namely, the corn was cultivated four times with the two-horse cultivators, the surface Acme cultivator being used for the first two cultivations and the six-shovel cultivator for the last two cultivations. The corn was cultivated once with the five.shovel cultivator about the last of July, the large weeds being cut with the hoe. The corn made a vigorous growth and promised a large crop until near maturity, when hot, dry weather caused many of the varieties to ripen prematurely, thus affecting the yield and quality of the corn.

In table I are given the yields and other data for thirty-four of the seventy-nine varieties reported in bulletin No. 123 and for seventeen other varieties grown for the first time in 1904 or 1905. It will be observed that forty-five of the varieties reported in bulletin No. 123 have been dropped, either because they proved to be inferior in yield or quality, or else it was not possible to again secure seed of a certain variety. This is true of the Klondike corn, which ranked high in yield in 1903. Some of the varieties which have been dropped were really good producers, but resembled other varieties which were still better producers and more pure and true to type. Such are the Bicker's Choice, Rumold, Ramsey, McAuley, Yellow, Blaine, Sedgwick, Dahlsten, Blackler, Green, Jordan, Justin, and Elton's White. The seed of all of these was secured from Kansas farmers, and the corn had some good qualities, but the varieties were more mixed in type and less productive than Hildreth, McAuley, Hammett. Kansas Sunflower, and other "native-bred" varieties which have proved to be superior in yield and equal in purity of type and quality to the best imported "pure-bred" varieties.

A much larger number of new varieties have been tested during the past three years than are reported in table I. In 1904

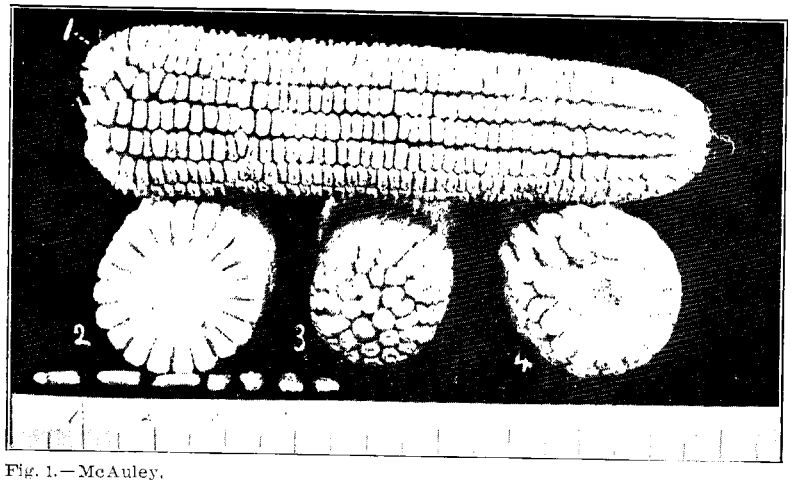


Fig. 1.—McAuley.

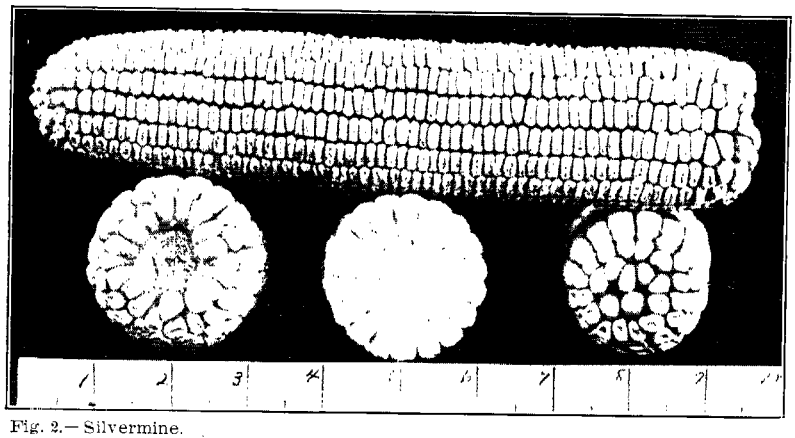


Fig. 2.—Silvermine.

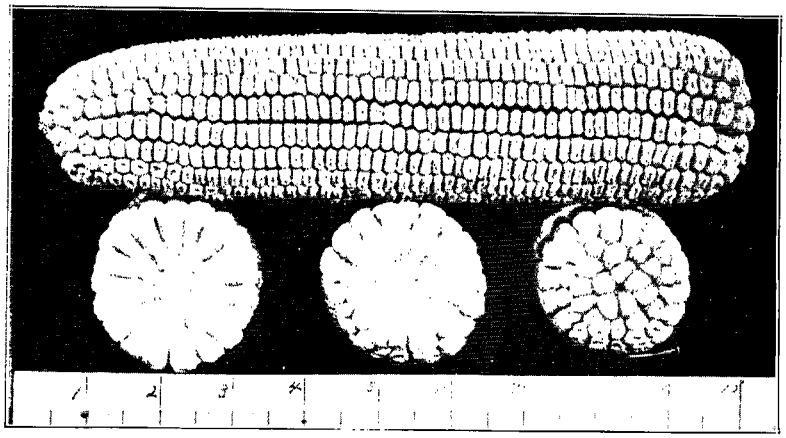


Fig. 3.—Boone County White.

PLATE II.—Typical ears.

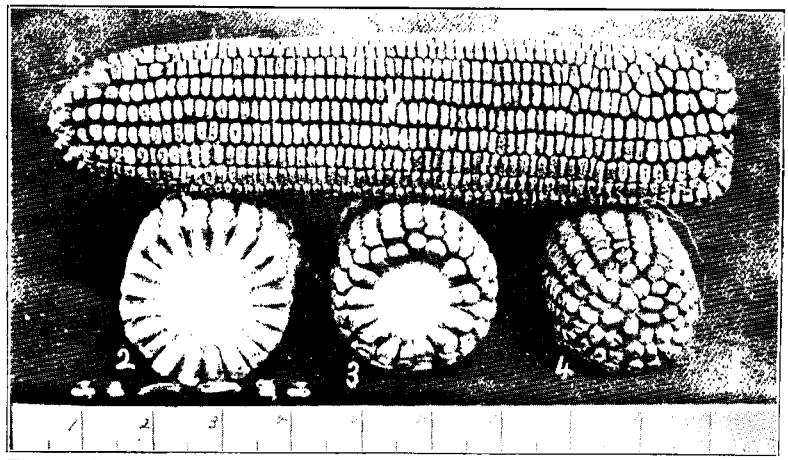


Fig. 1—Hildreth.

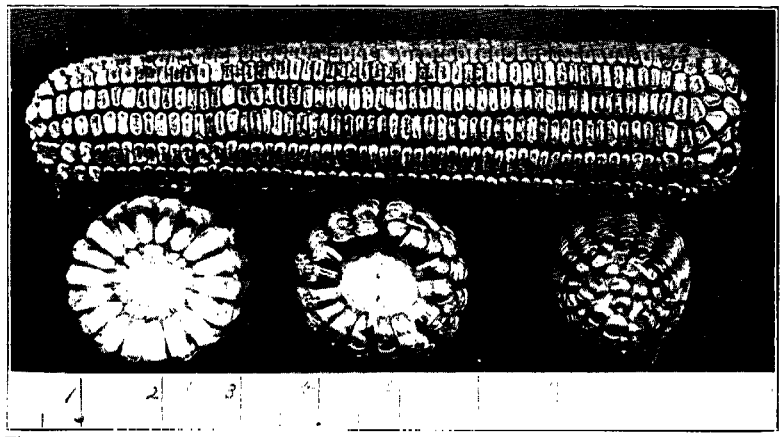


Fig. 2—Kansas Sunflower.

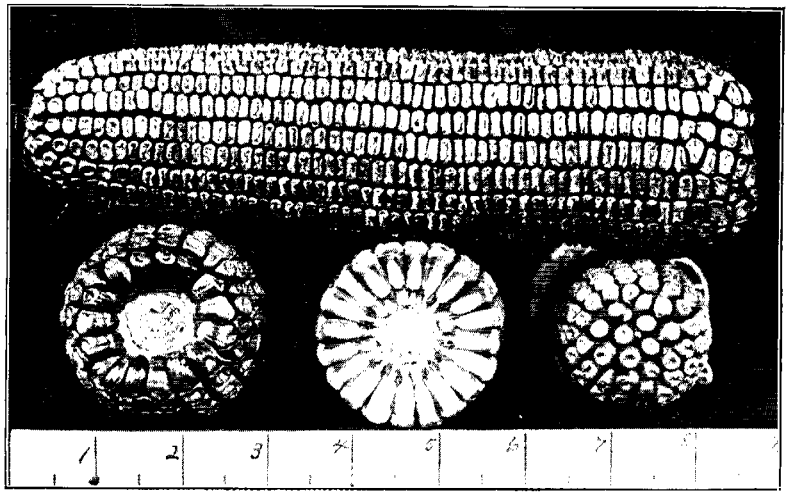


Fig. 3—Reid's Yellow Dent.

PLATE III.—Typical ears.

eighty-four different varieties or samples of corn were grown in separate plot's. In 1905 seventy-five varieties were planted, and eighty-four varieties or different samples of the same variety were tested again in 1906.

As a rule, new samples of corn have been secured from the original source each year, because when the corn is grown in small plots in the same field it becomes mixed the first year so that seed from these plots can hardly be used for planting a second year. The seed of several of the best-producing varieties has, however, been produced on the Station farm by planting these varieties in separate fields. The source of the seed-corn is noted in table I, under the head "where from," and the reader is referred to this table for complete data on each of the several varieties which were considered worthy of special report.

When the corn was husked samples of about a bushel were saved from all of the plots for the purpose of determining the grade, percentage of moisture, and percentage of shelled corn, which data are published in table I, together with the yield of air-dry shelled corn per acre. The percentage of moisture was determined by carefully weighing and drying the corn (corn and cobs separately) in an oven which was heated to a temperature of 110 centigrade. The percentage of moisture in the ear corn varied greatly with the different samples, ranging in 1904 from 11.90 to 29.02 per cent; in 1905, from 11.66 to 21.86 per cent; and in 1906, from 10.73 to 19.43 per cent. After determining the percentage of moisture the total amount of chemically-dry shelled corn per acre was calculated, and this amount was increased by fifteen per cent (the moisture allowed in the air-dry corn), to obtain the yields of air-dry shelled corn as published in table I. It will be observed that fifteen per cent is about the average amount of moisture which well-cured ear corn will contain when it is put into the crib in the fall.

In order that the yields of the different varieties of corn may be comparable it was necessary to dry the corn and report each yield with the same percentage of moisture in the airdry corn, as described above. The percentage of shelled corn on the ear, as reported in table I, was figured on the basis of the absolutely dry matter in grain and cob.

The percentage of suckers was figured on the basis that one sucker per plant equals one hundred per cent. For instance, Golden Beauty No. 1 is reported as having 160 per cent of suckers, which means that on the average there was 1.6 suckers per plant. By comparing the number of stalks per plot and the yield of ear

corn per plot, a comparison may be made as to the average weight of ears and the number of ears per stalk. The percentage of leafiness, as noted in the table, is an estimate made in the field a short time before the corn was mature.

In table II are given the more important data in regard to thirty-two varieties which produced average yields for the four seasons --1903-'04-'05-'06—of over forty-eight bushels of grain per acre, arranged in the order of their yields. Eight other good-producing varieties tested for three years and three varieties tested for two years are also included in this table. The yields for 1906 and the average yields for two, three and four years for each of the several varieties tested may be compared in this table.

Of the forty-three varieties reported in table II, twenty-four are "native," or have been grown in this State for several years, and, of the nineteen varieties which were secured from other states, six were received from the Nebraska Experiment Station, located at Lincoln, Neb., where the soil and climate conditions are not greatly different from those at Manhattan. These results indicate that Kansas-grown corn is better adapted for growing in this State than seed-corn secured from other states, even though the imported corn was pure bred and a high producing variety. Further work should be done in testing and improving our "native" varieties, and it is also desirable that some of the best varieties from other states should be more thoroughly adapted to Kansas conditions.

The number of days required to mature corn in 1905 varied from 121 to 143, with an average period of 129 clays. The varieties were not recorded as "mature" until nearly all the ears were past the "glazed" or "hard-dough" stage, the crop being practicallly safe from frost several days earlier. Of the thirty-five varieties which have been tested during the four years, the sixteen which matured in 126 days or less made an average yield of 61.43 bushels per acre, while the nineteen varieties which required 127 or more days for maturing made an average yield of 64.94 bushels per acre, inclicating that during such seasons as the past four the later-maturing varieties are slightly better producers than the medium or medium early maturing sorts.

TABLE II. - Best Producing Varieties of Corn for One, Two, Three and Four Years.

Bulletin No.	NAME OF VARIETY.	Type.	Seed from.	Days to mature...	Moisture in ear corn as husked, per cent.	Total score, per cent.	Dry shelled corn on ear, per cent.....	Yield per acre, air-dry shelled corn, 1906, bu...	Average yield per acre, air-dry shelled corn. 1905-'06, bu.	1904-'05-'06, bu.	1903-'04-'05-'06, bu.
11	Hildreth	Yellow dent	Kans	136	19.57	81.1	84.25	82.28	65.97	58.01	65.21
5	Kansas Sunflower	Yellow dent	Kans	132	16.58	80.7	83.72	86.20	66.65	60.31	62.97
58	Forsythe Favorite	White dent	Kansas	127	17.02	79.6	82.03	73.64	63.28	57.95	61.60
20	Golden Row	*Yellow dent*	Nebraska	121	14.13	74.5	83.46	84.64	69.28	60.73	60.95
55	Hammett	White dent	Kansas	137	14.35	76.1	84.08	65.28	57.48	51.55	60.68
3	Leaming	Yellow dent	Kansas	123	13.11	73.4	81.54	87.96	67.32	61.02	59.36
50	U. S. P. B. Selection No. 77.	White dent	Ohio	129	12.20	76.5	83.17	81.20	63.83	58.59	59.31
25	Hogue Yellow Dent	Yellow dent	Nebraska	125	14.68	76.5	80.67	75.81	60.18	54.65	59.14
34	Golden Cap	Yellow dent	Nebraska	123	11.42	74.0	80.22	84.64	62.76	56.63	58.70
48	*Sanders' Improved*	White dent	Georgia	129	24.27	83.8	88.54	74.01	57.45	51.08	58.05
67	Brazilian Flour	White	Kansas	136	15.40	80.0	83.60	62.73	52.11	46.39	55.90
82	Farmers' Reliance	Yellow dent	Kansas	122	13.41	83.8	82.61	73.11	59.08	56.39	55.63
86	Legal Tender	Yellow dent	Kansas	127	13.96	78.0	83.33	88.91	64.09	55.39	55.31*
46	Boone County White	White dent	Indiana	126	12.52	83.8	82.67	81.70	62.51	55.80	55.16
51	Cocke Prolific	White dent	Tennessee	132	14.21	75.3	86.51	60.29	52.61	48.29	55.15
16	*Mammoth Golden Yellow*	Yellow dent	Nebraska	124	14.49	74.5	74.50	80.50	64.88	56.07	54.72
42	Leaming	Yellow dent	Ohio	121	12.81	72.0	82.20	74.96	56.72	52.43	54.55
62	Mammoth White Dent	White dent	Kansas	136	17.58	84.6	80.30	71.53	55.77	46.29	54.00
60	Nebraska White Prize	White dent	Nebraska	124	13.94	81.1	81.31	76.24	59.55	54.69	53.57
61	White Kansas King	White dent	Kansas	130	16.63	82.7	85.85	70.79	53.38	49.06	53.21
47	Boone County White	White dent	Tennessee	127	14.22	79.6	83.21	73.15	58.33	53.72	52.82
28	Reid Yellow Dent	Yellow dent	Kansas	125	13.47	82.3	82.64	63.83	52.74	51.42	52.81
66	Red Cob Ensilage	White dent	Iowa	124	14.21	79.2	82.59	59.16	50.63	46.81	52.73
59	Boone County White	White dent	Kansas	126	14.62	80.0	81.46	60.73	51.25	51.69	52.47
56	Stevens	White dent	Kansas	132	15.74	77.7	80.91	63.54	54.49	50.83	52.24
40	Reid Yellow Dent	Yellow dent	Illinois	125	14.74	82.3	83.19	75.91	60.15	43.29	51.65
22	Iowa Goldmine	Yellow dent	Iowa	124	12.04	73.4	82.20	70.83	53.15	51.93	51.05
17	Early Mastodon	White-cap Y. D.	Iowa	125	13.29	74.6	84.01	76.78	58.91	49.93	50.63
71	Griffing	Calico dent	Kansas	131	13.70	82.7	84.72	45.60	47.28	45.31	50.32
41	Riley's Favorite	Yellow dent	Indiana	124	13.28	79.2	84.09	72.60	56.13	49.25	49.26
29	Pride of the North	Yellow dent	Kansas	121	12.00	69.4	80.69	54.16	48.56	45.02	49.16
31	King of the Earliest	Yellow dent	Kansas	119	13.25	76.1	83.90	63.66	47.16	44.36	48.47
80	White Injun	White dent	Kansas	112	17.97	81.7	82.93	73.78	66.74	61.25	.....
95	McAuley	White dent	Kansas	131	15.84	81.1	81.35	75.15	63.58	59.61	.....
93	White Salamander	White dent	Iowa	124	21.86	80.0	82.21	80.01	64.02	58.14	.....
90	Red Cob White Dent	White dent	Kansas	126	13.63	80.7	82.25	69.19	62.39	57.81	.....
92	Silvermine	White dent	Kansas	126	15.77	79.6	81.68	79.01	63.20	55.16	.....
83	Early Yellow Rose	Yellow dent	Iowa	124	13.38	76.9	82.79	75.86	60.85	54.77	.....
81	Red Injun	Red dent	Kansas	112	14.67	80.6	85.73	73.69	61.04	54.55	.....
96	Mammoth White Pearl	White dent	Nebraska	128	17.44	80.0	83.86	71.53	54.88	52.05	.....
84	Dyche	Yellow dent	Kansas	132	12.24	76.8	82.09	91.56	67.07	.....	.....
91	Warner	White dent	Kansas	124	15.29	80.7	80.67	61.59	63.62	.....	.....
94	White Elephant	White dent	Kansas	128	15.48	76.1	80.51	59.95	62.13	.....	.....

*This average includes yields from two samples of Legal Tender corn, viz. No. 88 for 1905-'06 and No. 77 (see Station Bulletin No. 123) for 1903-'04.

The yields and other data for a few of the more promising varieties which were grown in the comparative trial for the first time in 1906 are given in table III.

TABLE III.—High yielding varieties of corn, grown only in 1906.

Bulletin No.	NAME OF VARIETY.	Type.	Where from.	Height of stalks, ft.	Days to mature.	Yield per acre.	
						Stover, lbs.	Grain, bu.
97	Roseland White.	White dent	T.B. Hubbard, Kimball, Kan.	10.0	129	7356	74.10
98	Kellog's Pride of Saline	Yellow dent....	Hays Branch Expt. Station.	10.0	126	7221	74.89
99	Colorado White Dent...	White dent	Hays Branch Expt. Station.	10.3	125	4704	78.32
100	Harrison.....	Yellow dent....	G. C. Harrison, Jewell, Kan.	10.0	129	6124	76.14
101	Meinhardt.....	Yellow dent....	J.L. Meinhardt, Paxico, Kan.	11.0	128	6315	91.41
102	Conable.....	White dent	W. J. Conable, Axtell, Kan.	9.0	126	4794	80.40
103	Lamb.....	White dent	E. W. Lamb, Clyde, Kan....	10.0	126	4125	88.67
104	Chase.....	White dent	F. W. Chase, Pawnee, Neb.	8.6	128	2448	79.13
105	Hiawatha Yellow Dent.	Yellow dent....	J. D. Ziller, Hiawatha, Kan.	10.0	127	6473	90.26
106	Hubbard's Golden Beauty.....	Yellow dent....	T.B. Hubbard, Kimball, Kan.	11.0	133	6773	79.96

The varieties giving largest yields for one, two, three and four seasons are given in tables IV, V, VI, and VII.

TABLE IV.—Ten highest yielding varieties, 1906.

BULLETIN No.	Name of variety.	Type.	Yield per acre, bu.
84.....	Dyche.....	Yellow dent.....	91.56
101.....	Meinhardt.....	Yellow dent.....	91.41
105.....	Hiawatha Yellow Dent.....	Yellow dent.....	90.26
86.....	Legal Tender.....	Yellow dent.....	88.91
103.....	Lamb.....	White dent.....	88.67
3.....	Leaming.....	Yellow dent.....	87.96
5.....	Kansas Sunflower.....	Yellow dent.....	86.20
20.....	Golden Row.....	Yellow dent.....	84.64
34.....	Golden Cap.....	Yellow dent.....	84.64
11.....	Hildreth.....	Yellow dent.....	82.28

TABLE V.—Ten highest yielding varieties, 1905 and 1906.

BULLETIN No.	Name of variety.	Type.	Avg. yield per acre, bu.
20.....	Golden Row.....	Yellow dent.....	69.28
3.....	Leaming.....	Yellow dent.....	67.82
84.....	Dyche.....	Yellow dent.....	67.07
80.....	White Injun.....	White dent.....	66.74
5.....	Kansas Sunflower.....	Yellow dent.....	66.65
11.....	Hildreth.....	Yellow dent.....	65.97
16.....	Mammoth Golden Yellow.....	Yellow dent.....	64.88
86.....	Legal Tender.....	Yellow dent.....	64.09
93.....	White Salamander.....	White dent.....	64.02
91.....	Warner.....	White dent.....	63.62

TABLE VI.—Ten highest yielding varieties, 1904, 1905, and 1906.

BULLETIN NO.	Name of variety.	Type.	Avg. yield per acre, bu.
80	White Injun	White dent	61.25
3	Learning	Yellow dent	61.02
20	Golden Row	Yellow dent	60.73
5	Kansas Sunflower	Yellow dent	60.31
95	McAuley	White dent	59.64
50	U. S. P. B. Sel. No. 77	White dent	58.59
93	White Salamander	White dent	58.44
11	Hildreth	Yellow dent	58.01
58	Forsythe Favorite	White dent	57.95
90	Red Cob White Dent	White dent	57.81

TABLE VII.—Ten highest yielding varieties, 1903, 1904, 1905, and 1906.

BULLETIN NO.	Name of variety.	Type.	Avg. yield per acre, bu.
11*	Hildreth	Yellow dent	65.21
5*	Kansas Sunflower	Yellow dent	62.97
58	Forsythe Favorite	White dent	61.60
20*	Golden Row	Yellow dent	60.95
55	Hammett	White dent	60.68
3*	Learning	Yellow dent	59.36
50	U. S. P. B. Sel. No. 77	White dent	59.31
25	Hogue Yellow Dent	Yellow dent	59.14
34	Golden Cap	Yellow dent	58.70
48	Sander's Improved	White dent	58.05

*These varieties are included among the ten highest yielders for each of the four seasons.

The White Injun, which holds the highest three-year record, is a red-cobbed, white dent corn, which is a selection from the Red Injun No. 81, a cross-bred corn which was originally selected for breeding by this department on account of its deep kernels and well-filled butts and tips. Neither of these varieties are, as yet, very pure in type.

The Red Cob White Dent is probably a selection of the St. Charles White, an old standard variety. This corn has been grown for several years by Mr. J. M. Justin, Manhattan, Kan. It is hardy, medium in its growth and maturity, has a fairly uniform type, and may be recommended for general planting.

The McAuley, which takes high rank as a producer, is a corn which was received by this department from W. S. McAuley, Americus, Kan., and planted in the breeding plot in 1903, but was not planted in the variety test until 1904. This is a white dent corn which has a fairly uniform type, resembling Boone County White. It is medium late in maturing, a vigorous grower, and is well suited to bottom-land or fertile upland, and reports from coöperative experiments indicate that it has a hardiness which enables it to do fairly well in parts of the State where the moisture and soil conditions are not the best.

The Golden Row is a medium large, yellow corn, received from

Nebraska, but not tested in this State, so far as known, except upon the Station farm. It is medium in maturity and is probably best adapted to upland conditions in northern and northeastern Kansas.

The Hogue's Yellow Dent, received from the Nebraska Experiment Station is a medium early, yellow corn with bright light yellow caps. It is an excellent corn in Nebraska and appears to be well suited to northern Kansas conditions.

PLATE IV.—A field of Hildreth corn, 1906.

Other of the best-producing varieties which were given special mention in Station Bulletin No. 123 are: Hildreth, Kansas Sunflower, Hammett, Mammoth White Dent, Griffing Calico, Forsythe Favorite, Cocke Prolific, Leaming, and Legal Tender.

PREPARATION OF SEED-BED

An experiment in preparing the seed-bed in different ways for planting corn was begun in 1903 Choosing a piece of corn-stubble land, the field was laid off in equal areas of about one half acre, and the following treatment was given in the early part of April: One plot was double-disked, another plot was double-disked and harrowed, a third was listed in furrows three and one-half feet apart, and a fourth plot was plowed and harrowed after plowing, while a fifth plot was left as a check and received no treatment.

Early in May this field was planted to corn with a lister. In plot 3, which was listed in the spring, the ridges were split at planting time, when the corn was planted in the new listed furrows.

This experiment was repeated in 1904, and again in 1905, while several additional treatments were introduced, viz., one plot was plowed deep (six to eight inches), and another shallow (three to four inches), and both planted with the surface planter. Another plot was plowed and planted with the lister, while one plot was listed early and the corn planted in the same furrows at planting time, and in the other listed plot the ridges were split at planting time as in previous experiments. The preparation treatment was always given early in the spring, as soon as the soil was in condition to cultivate.

The continuous effect of the several treatments are not shown by this experiment, since the trials have been made each year in a different field, but always in a field which had growrn corn the previous season.

The results of the trial for the several years are given in table VIII.

The trials of 1903, 1904, and 1905, with Kansas Sunflower and McAuley corn, were conducted on old land which had been farmed many years without manure or other fertilizer. The 1906 trial with the Hildreth corn was on alfalfa land, the second crop after breaking.

As an average for the four seasons, the method of listing early in the spring and splitting the ridges at planting time has given an increased yield of 5.02 bushels of corn per acre when compared with the land which received no early cultivation. There is no appreciable difference in the average yields from other early treatments, although the disked-harrowed ground has given a slightly larger average yield than the check plots.

The average yields of stover have varied in about the same proportion as the average yields of corn, with the exception that the untreated land ranked second in yield of stover and third in yield of corn.

By comparing the yields of corn for each of the several seasons it will be observed that the plot which was listed early and the ridges split at planting time gave the largest yield in 1903 only, but has ranked high in yield each year. In 1904 the untreated plot gave the largest yield of any of the plots in the series, while the disked plot ranked second. The plot which was listed early and planted in the same furrows produced the most corn in 1905, while the disked-harrowed plot ranked second. In 1906 the plots

TABLE VIII. Preparation of seed-bed for corn and listing *versus* surface planting.

EARLY TREATMENT.	Method of planting.	Yield per acre. 1903. Kansas Sunflower.		1904. Kansas Sunflower.		1905. McAuley.		1906. Hildreth.		Average, 1903-'04-'05-'06.	
		Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.
Disked twice	Listed	3628	68.61	3003	55.12	2580	34.74	5331	70.29	3636	17.19
Disked twice, harrowed	Listed	3142	65.18	2528	50.27	2920	41.48	5201	75.34	3641	58.06
Listed	Listed in same furrows	.....	.....	.....	.....	2700	41.00	6128	80.10	.....	.....
Listed	Listed, breaking ridges	3099	74.28	2856	52.37	3344	40.40	9109†	82.29	4602	62.34
Untreated	Listed	3468	64.14	3277	58.35	3160	38.17	5556	68.61	3845	57.32
Plowed, harrowed	Listed	2302	61.26	2919	54.96	.....	.....	5701	84.23	.....	.....
Plowed shallow, harrowed	Surface planted	.....	.....	.....	.....	3180	42.40	5172	71.90	.....	.....
Plowed deep, harrowed	Surface planted	3918*	73.71*	4394	70.95	3360	41.66	5168	81.69	4285	67.01
Averages	Listed	3128	66.63	2917	54.21	2911	39.76	6340	76.30	3832	59.23
	Surface planted	3918	73.71	4394	70.95	3120	42.03	5170	76.80	4301	65.88

*Test was in another field, but yield made comparable by listed check.
†Corn greener when cut, and perhaps not so well cured when hauled as fodder of other plots.

giving the highest yields were as follows: First, plowed-harrowed; second, listed early, breaking ridges: third, listed early and planted in same furrows.

It appears, therefore, that with the different treatments the results may vary with different seasons. On the whole, the early cultivation with the disk and harrow has not increased the yield enough to pay for the extra labor. It should be remembered, however, that these trials have been carried on during seasons of plentiful moisture supply early in the spring, except in 1906, when there was a lack of moisture for several weeks previous to and after planting the corn. It will be observed, also, that in 1906 each of the early cultivation treatments apparently caused an increase in yield when compared with the untreated check plot, ranging from 2 to 7 bushels, for early disking, to 12 and 14 bushels, for early listing, to 16 bushels more corn per acre for early plowing. Thus, early cultivation has given beneficial results when there was need of conservation of soil moisture, but the early disking has had less effect than the early listing or plowing.

On the whole, early listing seems to be the most practicable early treatment when the purpose is to plant the corn with the lister. Early plowing is less desirable than early listing, since plowed ground does not list well. It is a question which is better after early listing: to split the ridges at planting time or plant in the same furrows. It has been urged in favor of the last method that the soil warms up earlier, producing more favorable conditions for sprouting the corn in the bottom of the early listed furrows than is secured by splitting the ridges at planting time. Perhaps, also, there is a tendency to accumulate moisture in the bottom of the listed furrows which, together with the warmer soil, favors a rapid germination and strong, early growth of the corn. This was observed to be the fact in 1905 and 1906 when these comparative tests were made, that the corn planted in the early listed furrows started as quickly as surface-planted corn and was several inches higher on June 1 than the listed corn planted in new furrows. If the ground has become packed with heavy rains, or if the corn is planted late and the land requires cultivation, better split the ridges when the corn is planted.

The early listing certainly puts the ground in excellent condition to catch and store the rain and to conserve the moisture already in the soil, and the listing may be done any time during the fall, winter, or early spring. The practice has been to plant the corn in listed furrows, crossing the rows of the previous planting.

LISTING VERSUS SURFACE PLANTING

Comparing the methods of planting, as an average for the four seasons the surface-planted corn has yielded 6.65 bushels more corn and 469 pounds more stover per acre than the listed corn. This result is largely due to the greater yields from the surface planting in 1903 and 1904—two very wet seasons. The listing method of planting is best adapted for light, warm soil, dry seasons or dry climate. Also, listed corn may usually be more cheaply planted and cultivated than surface-planted corn, and is preferred in western and central Kansas; and when large areas are cared for with a small amount of labor, listing may be preferred in eastern Kansas, but surface-planted corn, in a well-prepared seed-bed, may give the larger yields, especially if the season is wet.

Corn planted in cold, wet soil in the bottom of listed furrows is placed at a disadvantage and often makes a slow, backward growth during the early part) of the season, but it has the advantage of surface-planted corn in the latter part of the season, especially if dry, hot weather prevails, since the roots of listed corn lie deeper in the soil,* and are protected with a thicker soil mulch than the roots of surface-planted corn, which are often exposed above the surface of the ground and can only be covered by hilling the corn, which removes the soil from between the rows, leaving the deeper roots exposed and the ground furrowed and open, favoring evaporation of soil moisture. Listed corn is more easily cultivated and kept free from weeds than surface-planted corn, and also has the advantages which result from level culture, since the plan is to gradually fill the furrows during the season, leaving the ground level at the last cultivation.

SURFACE PLANTING WITH FURROW OPENER

By the use of the furrow opener attachment to the surface planter some of the advantages of listing corn may be secured with less of the disadvantages. One of these attachments, the Dempster disk-furrow opener, has been tested during the past two years in comparison with surface-planting corn. In 1905 this trial was made in three different fields, with three different varieties of corn, with the resulting yields:

*The reader is referred to Station Bulletin No. 127 for further study and discussion of the root growth of listed corn.

HOW PLANTED.	Yield of corn per acre.			
	Hildreth, bushels.	Silvermine, bushels.	Mc Auley, bushels.	Average, bushels.
Dempster disk-furrow opener.....	52.30	48.92	58.50	53.24
Surface planted.....	46.41	45.68	63.73	51.94
Listed.....	43.90*	43.21	57.88	48.33

*Not planted in this field, but yields calculated by surface planted check in another field; preparation of seed-bed trial, see page 235.

† Average of all cultivation plots, see page 247.

All the ground, except that planted with the lister, was plowed in preparing the seed-beds for the above plantings.

As an average for the three trials the corn planted with the Delnpster att'achment yielded 4.91 bushels more grain per acre than the listed corn and 1.9 bushels more grain than the surface-planted corn. The yields of stover were not determined except for the Silvermine corn, and were similar for all plots.

Through an accident the correct yields were not secured from this trial in 1906. However, the notes taken during the season indicated that the disk-furrow planting would again produce the largest crop. It was noted each season that the corn planted with the disk-furrow openers sprouted quicker and made a more vigorous early growth than the surface-planted corn, and this ranker growth was observed throughout the season. There is an advantage, also, in cultivating the disk-furrow planted corn, similar to that secured by listing, in that the weeds in the row are more easily covered and destroyed by the early cultivation than is the case with surface-planted corn. Also, there may be a similar advantage, as obtained by listing, in that the corn roots lie relatively deeper in the soil and are covered with a greater depth of mellov soil at the last cultivation when the corn is laid-by. It is well to remember, however, that when the furrow openers are used it is necessary to plow the land and prepare a good seed-bed the same as for surface planting, and also that it requires four horses to operate the corn-planter with the furrow opener attachment.

Experiments carried on at this Station in 1892-'96, as reported in Bulletin No. 64, gave results favoring listing as compared with surface planting as follows:

Listing, average yield, 29.47 bushels per acre.

Surface planting, average yield, 87.49 bushels per acre.

CONSERVATION OF SOIL MOISTURE BY EARLY CULTIVATION

Some study of the moisture content' of the soil of the several plots has been made each year in connection with these experiments. In 1903 soil samples were taken April 1, before the

preparation treatment was begun: and again May 9, soon after the corn was planted. No appreciable saving of moisture was observed from any of the early cultivation treatments except the plowing, which showed a gain of 2½ per cent of water in the first foot of soil and 0.87 per cent in the first six feet, compared with the check plot. All of the treated plots made slight gains in the surface foot of soil.

A more complete soil moisture test was made in 1904, then samples were taken March 14, May 2, June 29, August 2, and September 28 Little difference was observed in the moisture content of the several plots from the later samplings. Comparing the first two sets of samples, it appears that the treated plots, compared with the check plot, gained in moisture as follows:

Early Treatment.	Gain in moisture, per cent.
Disked	.42
Disked—harrowed	1.14
Listed—ridges split at planting	3.82
Plowed—harrowed	1.56
Plowed—harrowed, surface planted	1.98

These gains in moisture occurred usually in the first and second feet of soil. However, the early listed ground showed a large gain of moisture also in the third foot of soil. The early plowing and early listing apparently saved more water than the disking. No moisture samples were taken from the plots in the spring of 1905, and the later samplings showed no regular or marked variations in the moisture content of the soil of the several plots.

In 1906 a full set of samples was taken April 16, but no samples were taken again until June 28. At that date the treated plots, compared with the check plot, contained more or less moisture in the first six feet of soil as follows:

Early Treatment.	Gain or loss in moisture as compared with check plot, per cent.
Disked	+2.43
Disked—harrowed	—3.61
Listed—planted in same furrows	—1.40
Listed—breaking ridges at planting	+0.61
Plowed—harrowed	—2.79
Plowed shallow, surface planted	—2.79
Plowed deep, surface planted	—0.65

All of the treated plots except the plowed ground showed decided gains in moisture. The gains were irregularly distributed, the disked plots showing more moisture in the surface soil, while

the listed plots had gained somewhat in the moisture of the deeper subsoil. The shallow plowed ground lost more moisture than the check plot, while the deep plowing gained very slightly. This apparent loss of moisture from the plowed ground might be accounted for on the plots in which the corn was surface planted by reason of the ranker growth of corn on these plots at the date the last set of samples was taken.

Although there are some irregularities, yet the results of all the moisture determinations prove that early cultivation does conserve soil moisture, and the larger yields, especially in the season of 1905, may, in part at least, be attributed to the effect of the greater supply of moisture resulting from the early cultivation.

CONSERVATION OF SOIL MOISTURE BY LISTING CORN

In 1903 the listing versus surface-planting trial was carried on in a separate field from the seed-bed preparation experiments, and soil moisture determinations were made at several dates — May 4, June 4, July 1, July 16, and July 29. During the first part of the season there was little difference in the moisture content of the two fields. On July 1, just before the last cultivation, the surface-planted ground contained 0.49 per cent more moisture than the other plot. On July 16 the average difference was 0.48 per cent in favor of the listed ground, and the last determination, July 29, showed a total average difference of 2.12 per cent in favor of the listed ground. These moisture determinations were made to a depth of six feet. The moisture samples showed a fairly uniform saving of about two per cent of moisture in each foot of soil.

In 1904 the samples were taken March 14, May 2, and June 29, and showed about the same relative gain or loss of moisture in each plot, but on August 2 the listed ground had gained 2.69 per cent more water than the surface-planted ground. This saving of moisture in the listed plot occurred largely in the first three feet of soil. Samples taken September 28 showed that although both plots had lost some moisture, the surface-planted ground had lost 2.92 per cent more than the listed ground, the loss being about equally distributed throughout the six feet of soil.

In 1905 only two sets of samples were taken: namely, on May 15 and July 8. The surface-planted ground showed 0.94 per cent greater loss in moisture at the second sampling than the listed ground, the (difference in moisture being largely in the first three feet of soil.

In 1906 the moisture samples taken June 28, compared with others taken April 16, showed that the surface-planted plots had

lost on the average 2.08 per cent more water than the listed (check) plots, this loss taking place as in former years, largely in the first three feet of soil. No samples were taken later than June 28.

These soil-moisture studies seem to show that without exception listing favors the conservation of soil moisture in the latter part of the season. This may be, in part, due to the larger growth of the surface-planted corn, but is also due in part, perhaps, to the fact that the listed corn was laid by with level culture, while the surface-planted corn was hilled slightly, exposing a greater surface to evaporation. Also, it is possible that the listed corn was cultivated uniformly deeper at the last cultivation than the surface-planted corn, thus the ground was protected by a uniformly deeper soil mulch.

DATE TO PLANT CORN-LISTING VERSUS SURFACE PLANTING

This experiment has been conducted during the past two seasons. In 1905 the Hildreth corn was planted on fall-plowed alfalfa sod, and the Silvermine corn on old land which had been cropped with corn and wheat for many years, but which had been manured in the fall of 1903. In 1906 the Legal Tender corn was planted on fall-plowed clover sod. The preparation of the seed-bed each season consisted of such surface culture as was necessary to keep the soil in good physical condition and free from weeds. One-tenth acre plots were planted with the planter and with the lister on each of the dates given in tables IX and X (except that the lister was not used in the April 9, 1906, planting).

An error was made in harvesting the Silvermine corn in 1905, so that the correct yields from the listed and surface-planted plots could not be secured but the yields for each of the dates of planting were determined and have been published in table X. The yields by the two methods of planting were correctly determined for the Hildreth corn in 1905 and the Legal Tender corn in 1906, and the results are given in table IX.

In the lister-versus-planter trials, the largest average yields of corn from both the surface-planted and listed plots were secured by planting May 11. In the 1906 trial the plantings made on May 11 gave the largest yields and those of May 18, the next largest, while the average yields from the plantings of April 20 and May 26 were nearly the same ranking next to the yields from the plantings of May 18. As an average for the two seasons, the June plantings gave the lowest yields, and the early April plantings the next lowest. However, the single test on June 2, 1906, resulted in a relatively high yield, both of corn and stover.

The average yield of stover for the two seasons was largest from the plantings of May 26, but the largest yields of stover in 1906, both by listing and surface planting, were secured from the plantings of May 18, and the second largest yields were secured from the plantings of June 2.

TABLE IX.—Date to plant corn—listing *versus* surface planting.

DATE PLANTED.	Implement used.	Yield per acre. 1905. Hildreth.		Yield per acre. 1906. Legal Tender.		Average yield per acre. 1905 and 1906.		Combined average yield per acre. 1905 and 1906.	
		Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.	Stover, lbs.+	Grain, bu.+	Stover, bs.	Grain, bu.
April 9....	Planter....	3731	51.51	2398*	37.98*	3061*	44.75*	3144	45.55
	Lister.....	3302	47.17	.....	.....	.....	.....		
April 20....	Planter....	4095	58.03	2190	64.89	3142	61.46	3139	59.23
	Lister.....	4029	54.81	2241	59.16	3135	56.99		
April 30....	Planter....	4986	55.75	2605	52.53	3795	54.14	3725	53.66
	Lister.....	4986	55.84	2322	50.51	3654	53.18		
May 11....	Planter....	5119	57.00	3621	85.14	4370	71.07	4191	64.68
	Lister.....	4788	50.18	3237	66.38	4012	58.28		
May 18....	Planter....	.....	.....	4173	77.35	.....	.....	.....	.....
	Lister.....	.....	.....	3577	64.31	.....	.....		
May 26....	Planter....	6886	58.77	3962	67.75	5399	63.26	4991	58.65
	Lister.....	6109	52.47	3055	55.62	4582	54.05		
June 2....	Planter....	.....	.....	3514	57.56	.....	.....	.....	.....
	Lister.....	.....	.....	4145	64.12	.....	.....		
June 8....	Planter....	7067	24.79	2420	35.00	4718	29.86	4795	28.57
	Lister.....	7067	24.79	2025	44.95	4846	34.84		
Averages..	Planter....	5306	50.97	3212	62.89	4290	55.96	4269	56.61
	Lister.....	5047	47.54	3029	57.86	3945	52.19	4007	52.53

*Not included in the averages at bottom of table.
+Moisture in stover, 25 per cent. Moisture in corn, 15 per cent.

By comparing the yields for the several dates, from the different methods of planting it will be observed that the surface plantings gave the largest yield of corn in every trial in both seasons, except the plantings of April 30, 1905, and June 2 and 8, 1906. The averages for each year favor surface planting by about three and one-half bushels more corn per acre in 1905 and over five bushels more corn per acre in 1906. Larger yields of stover, with three exceptions, were secured from surface planting than from listing, the difference between the yields of stover being, in most cases, similar in proportion to the difference between the yields of grain for the same plots."

*See page 239 for reports of other experiments on different methods of planting corn.

TABLE X.—Date to plant corn: a summary of results for two seasons, 1905 and 1906.

DATE PLANTED.	Yield per acre, 1905.				Yield per acre, 1906.		Average yield per acre for the two years' trials.	
	Silvermine.		Hildreth.		Legal Tender.			
	Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.	Stover, lbs.*	Grain, bu.*	Stover, lbs.	Grain, bu.
April 9	2014	36.30	3517	49.34	2398	37.98	2643	41.21
April 20	3362	42.44	4062	56.42	2216	62.03	3180	53.63
April 30	2783	46.35	4986	55.80	2462	51.52	3410	51.22
May 11	3479	37.42	4954	53.59	3429	75.76	3987	55.59
May 26	4026	46.91	6473	55.62	3509	66.69	4669	56.41
June 8	4144	32.95	7067	24.79	2523	39.98	4578	32.57

*Moisture in stover, 25 per cent. Moisture in corn, 15 per cent.

As a result of the three trials the largest average yield of corn was produced by planting May 26, and the next largest yield was secured from planting May 11. The largest average yield of stover has also been produced by planting May 26, and the second largest yield by planting June 8, while the yield from the planting made on May 11 ranks third. A larger growth of stalks may be produced by planting rather late in the season, and this is a point worthy of attention if the corn is grown for the production of fodder as well as ears.

The test of 1906 indicates that the late-planted corn was not so dry when husked as the early-planted corn. In 1905 no corrections were made for the different amounts of moisture in the corn and stover. The 1906 yields were corrected for moisture as noted in tables IX and X. Samples were taken in 1906, when the corn was husked (November 5) and when the stover was hauled (November 6). The percentage of moisture in the ear corn varied from 12.03 per cent for the April 20 planting to 21.11 per cent for the June 8 planting. The samples of June 2 and May 26 plantings contained 18.93 per cent and 15.82 per cent of moisture, respectively, the average moisture in all samples being 14.55 per cent. The moisture in the stover averaged 32.65 per cent, and the only sample which varied greatly from the average was taken from the June 8 planting, which showed 47.58 per cent of water in the stover when it was stacked.

In 1905 the Silvermine corn was husked and the stover and corn hauled and weighed October 5, while the Hildreth corn was not husked until November 16 to 18. The Silvermine and Legal Tender are medium early maturing varieties, while the Hildreth is a late-maturing corn. Corn matured earlier in 1905 than in 1906, and the difference in the weight of the corn and stover from the different plantings may not have been so great, in 1905 as in 1906.

On the whole, the results of these trials favor rather late planting both for the production of ears and stover. As to how late corn may be planted depends upon the locality, season soil and variety of corn. A medium early-maturing corn may be perhaps as late as the first of June and still have plenty of time to mature if conditions are favorable but a period of dry weather is perhaps more apt to injure the crop from late plnnting than from early planting, and it is believed that late-planted corn is more apt to be injured, at the time of pollenating, by hot winds and unfavorable weather conditions.

This experiment indicates that corn should not be planted as early with the lister as with the planter. The soil in the bottom of the listed furrow is colder and contains more moisture than the surface of level soil, and does not usually become sufficiently warm and dry to make a good seed-bed for corn before about the first of May.

THE CULTIVATION OF SURFACE-PLANTED CORN

In 1903 the cultivation experiments with corn were conducted on spring-plowed land. previously in Kafir-corn and not manured. In 1904 the trial was made on fall-plowed land, which had been treated to a good coat of manure previous to plowing. Two plots were used in 1905, one being the field used in the experiment in 1904 (planted with Silvermine), and the other fall-plowed alfalfa sod (planted with Hildreth). The trial was again made on fall plowed alfalfa sod in 1906. A good seed-bed was prepared each spring before planting by the use of the Acme and smoothing harrows. The planting was done each year during the last week in April or the first week in May, with the ordinary two-horse planter. The Reid's Yellow Dent, Hildreth and Silvermine varieties have been used in the experiment as noted in table XI. The practice has been to lay the corn by with a final cultivation about the first of July, the corn receiving regularly four cultivations each season.

In these experiments one plot has been cultivated shallow throughout the season, and another deep throughout the season, while on two of the plots the depth of cultivation was changed in the middle of the season, the first two cultivations on one plot being shallow and the last two deep, while on the other plot this plan of cultivation was reversed. The shallow cultivation has been performed with the Tower surface cultivator while the Deere six-shovel cultivator was used for the deep cultivation. The plan has been to cultivate only medium deep, and not so deep as to injure the roots of the corn. The depth of the shallow cultivation aver-

TABLE XI.—Cultivation experiments with corn—yield per acre.

METHOD OF CULTIVATION.	1903.		1904.		1905.				1906.		Average for 4 years, 1903, 1904, 1905, and 1906.	
	Reid's Yellow Dent.		Reid's Yellow Dent.		Hildreth.		Silvermine.		Sivermine.			
	Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.	Stover, lbs.	Grain, bu.
Shallow	2659	51.65	3097	57.51	3962	47.77	4015	43.45	4262	56.19	3427	51.31
Shallow early; deep late	2679	52.96	3067	57.25	3171	48.75	3121	50.61	3738	51.07	3215	52.13
Deep	2629	50.87	3216	53.98	3669	49.28	3072	52.44	3480	50.55	3213	51.42
Deep early; shallow late	2638	53.66	3067	49.62	4181	50.52	3441	41.26	3693	52.09	3404	50.03
Disk cultivator					2824	49.58	3225	42.17	3808	58.88		
Weeder and cultivator					3497	39.93	3048	41.15				

Planted 2½ inches deep. Planted in listed furrows, 8 inches deep.

Fig. 1.—Forty-eight days after planting.

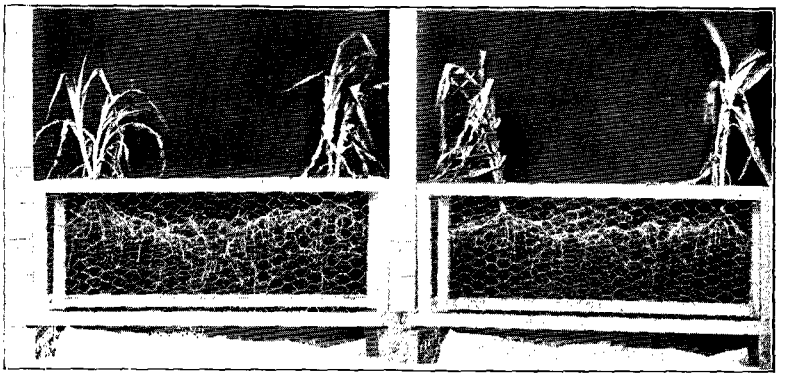


Fig. 2—Forty-seven days after planting.

PLATE V.—A study of corn roots.

Description of root samples.—These illustrations are photo-engravings of actual samples. The samples shown in Fig. 1, plate V, present a study of the root development secured from planting corn near the surface and in deep listed furrows. The frames and netting were placed in the ground and covered with soil and the corn planted. Later the frames were dug up and the dirt washed out, showing the development of the roots as shown in the figure.

Fig. 2, plate V, and Figs. 1 and 2, plate VI, are samples taken from the field and show the growth and distribution of corn roots between two hills of corn on adjacent rows. In each figure the listed corn is compared with the surface-planted corn, the samples being taken at about the same date, from adjacent plots in the field. The sample on the right-hand side in each figure is the listed corn, while the sample on the left-hand side is the surface-planted corn. It may be clearly seen from these figures that the root system of the listed corn lies somewhat deeper in the soil than the root system of the surface-planted corn. The root crowns being further below the surface allow for deeper and closer cultivation of the listed corn than of the surface-planted corn, without injury to the roots. See Station Bulletin No. 127 for detailed descriptions of roots of corn and other plants.

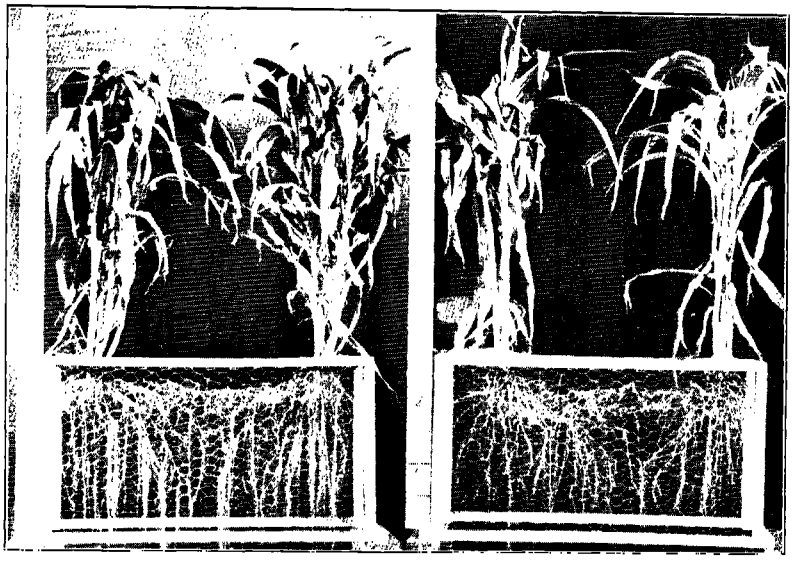


Fig. 1. Sixty-five days after planting.

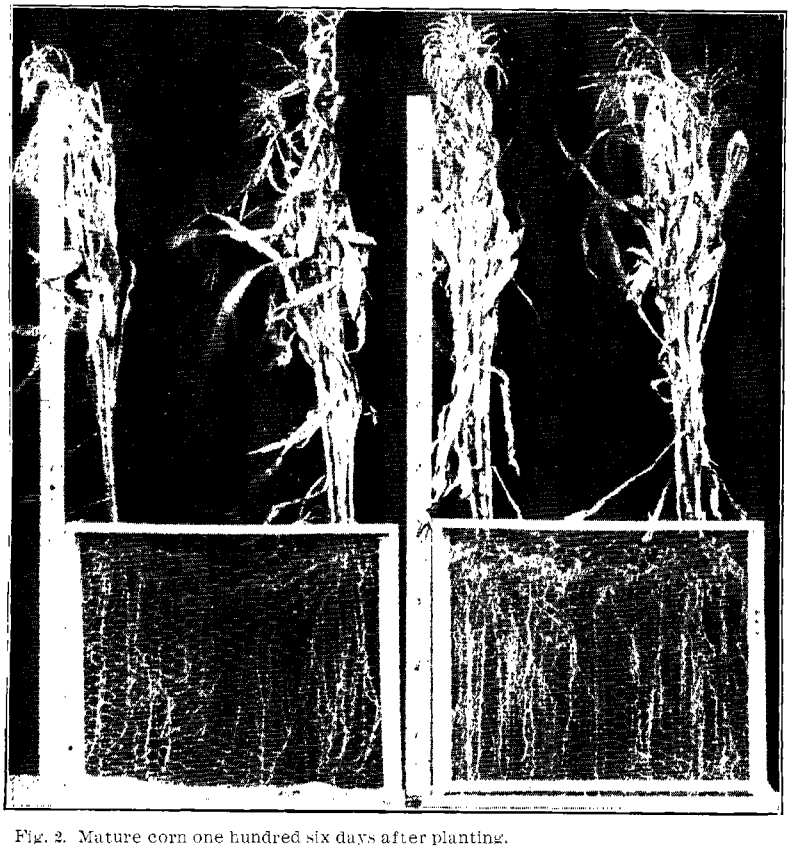


Fig. 2. Mature corn one hundred six days after planting.

PLATE VI.—A study of corn roots.

aged about one and one-half inches, while the deep cultivation was three and one-half to four inches deep.

The disk cultivator was used during the last two seasons in comparison with the other cultivators, and in 1905 one plot in each field was cultivated with the weeder several times and with the cultivator the balance of the season (two cultivations).

As a rule all of the corn was harrowed each season soon after planting, and it has been tlle practice to hoe the corn at least once each season and cut all large weeds. The results of the several trials are given in table XI.

The yields by the several methods of cultivation have varied somewhat, for the different seasons. The shallow cultivation gave the largest yield of corn in 1904 and 1906, the deep cultivation in 1905, and the deep early-shallow late cultivation in 1903. The shallow early-deep late cultivation has given uniformly high yields each season, and tlle average yield for the four seasons is slightly in favor of this method, the deep cultivation ranking second, the shallow cultivation third, and the deep early-shallow late cultivation fourth.

The seasons of 1903 and 1904 were excessively wet, and there was no lack of moisture at any time during the growing season. In 1905 a period of hot, dry weather in August checked the growth of the corn and injured the crop to some extent, and in 1906 there was a long period of dry weather in the spring, and again in August and September. No regular effect of the method of cultivation on the crop is shown in the yields secured from the several plots in the several seasons. In 1905, one of the drier seasons, the deep and shallow early-deep late cultivations gave the larger yields, while in 1906 the plots cultivated shallow and deep early-shallow late produced the larger yields. The results were in part' reversed each year also, in the wetter seasons. The small differencein the average yields and the irregular variations in the annual yields indicate that the exact method of cultivating is not of so great importance as the conditions of soil and season.

The yields of stover have not shown as much irregularity as the yields of corn, and the average yield is decidedly in favor of "laying the corn by" with a shallow cultivation. It was observed each season that the shallow-cultivated corn matured several days later than the deep-cultivated corn. These results indicate that the deep cultivation, when the corn is laid by, may check the growth to some extent, causing a less growth of stalks, earlier maturity, and a tendency to produce relatively more grain. This may be due to the slight root pruning by the deeper cultivation.

The yields from the plots cultivated with the disk-harrow compare favorably with the yields of other plots, but the trials in 1905 with the weeder and cultivator gave uniformly low yields. The weeder is all right for the earliest cultivation, when the soil is mellow-and the weeds are small, but it will not take the place of a good cultivator later in the season, when the ground becomes hard and the weeds large.

No comparative trials of different methods of cultivating listed corn have been undertaken at this Station.

CULTIVATION VERSUS SOIL-MOISTURE CONSERVATION

Some study of the soil moisture content of the soil was made each season in connection with the corn cultivation experiments. Soil samples have been taken in the spring, at the middle of the cultivation period, after the close of the cultivation period, and irregularly at other dates. No regularly marked variation in the moisture content of the soil on the several plots has been discovered by these studies. The mid-cultivation samplings show about the same soil moisture content for both the shallow and deep cultivated plots. Even after the close of the cultivation period, when the greatest effect on the conservation of the soil moisture by the several methods of cultivation should appear, no appreciable difference in the moisture content of the soil of the several plots has been found, the loss of moisture from each of the several plots, as an average for the four trials, being more nearly alike than might be expected from duplicate samples from the same plot. As already suggested concerning yields, conservation of soil moisture does not seem to depend so much upon the method of cultivation employed as upon the fact that corn receives sufficient cultivation at the right time.

LATE CULTIVATION

It is the usual practice at this Station to cultivate corn late in the season, after it is laid by, should the soil mulch be destroyed by heavy rains. A single comparative trial was made in 1904 to test the effect of late cultivation, following heavy rains which left the soil very compact, as soon as the ground was dry enough to cultivate well. The corn was cultivated (July 20) with the five-tooth single-horse cultivator. A check plot of six rows was left about the middle of the field, which was not cultivated. The yields from twelve rows of the late cultivated corn, six rows each side of the check, was compared with the yield from the check or uncultivated plot as follows:

CULTIVATION.	Yield per acre.	
	Stover, lbs.	Grain, bu.
Late cultivated	2085	15.36
Check, not cultivated	2084	44.61

The season of 1904 was rather wet, and in this single trial the extra cultivation seemed to have little effect on the yield of grain, but apparently caused an increased growth of stalks. It was observed that the late cultivated corn matured a little later than the corn which was not cultivated.

Notes taken September 5 state that the soil of the check plot was cracked open worse and was apparently drier than the soil of the late cultivated plots, and the corn receiving the extra cultivation had made a stronger growth and was apparently better corn than that on the check plot.

Soil moisture determinations to the depth of six feet, made August 3 and August 23, showed very little difference in the moisture content of the soil on the several plots.

GENERAL SUGGESTIONS

In experiments reported from other states the results have usually favored shallow cultivation of corn as opposed to deep cultivation. As a rule, however, the deep cultivation in such experiments was extremely deep, usually five to six inches. Medium deep cultivation, three to four inches, and not too close to the hill, should not injure the corn roots, and in some seasons, especially in a dry climate, the deeper cultivation may give better results than shallow cultivation.

In summing up the results of cultivation experiments carried on at this Station in 1893-'97 Prof. C. C. Georgeson says* "Our experience also seems to indicate that it is not best to pin one's faith strictly to the shallow cultivation . . . A judicious mixture of deep and shallow cultivation gives better results than to continue either throughout the entire season."

Cultivation experiments with corn at the North Dakota Experiment Station and also at the Illinois Experiment Station gave yields favoring the shallow cultivation early in the season, followed by deeper cultivation at the close of the season, when the corn was laid by. At the Illinois Experiment Station, however, the largest yield was secured by continuous shallow cultivation; thus

*See Station Bulletin No. 64.
†See North Dakota bulletin No. 51.
‡See 13th Biennial Report of the Kansas State Board of Agriculture, page 789.

the corn was not laid by, but the cultivation was continued late in the season.

Too deep cultivation not only injures the corn by destroying the roots, but during the period of cultivation it prevents the roots from feeding in the most fertile part of the soil. On the other hand, the practice of shallow cultivation may be carried too far. A relatively thick mulch of mellow soil will conserve more moisture than a thin mulch, as shown by Prof. F. H. King, in his experiments at the Wisconsin Experiment Station.*

Many farmers prefer to cultivate corn deep the first time, on the principle that, the corn roots are not injured by deep, early cultivation, and that deep cultivation warms the soil and causes the roots to strike downward. Corn may be cultivated deep and close to the hill when the plants are small without injury to the roots, but the deeper cultivation may not warm the soil so deeply or so rapidly as the shallower cultivation. Mellow soil is not so good a conductor of heat as firm soil, and less heat may enter the ground through a thick mulch of mellow soil than through a thin mulch, while the thinner mulch may be practically as effective for retaining the heat in the soil as the thicker mulch. Also, a deep soil mulch may not be necessary for conserving soil moisture in the early spring, when the air is moist and the weather relatively cool. Thus the cultivation early in the season may be rather shallow and the depth of the cultivation increased as the season advances. Late in the season, during the hot, dry weather of July and August, a deeper soil mulch may be required to conserve the moisture in the soil.

A study of the root growth of corn † has shown that the main lateral roots lie about four inches below the surface of the soil between the rows. The roots gradually approach the surface near the root stalk or crown, which requires that level-planted corn should not be cultivated close to the hill the last time. The roots of listed corn lie uniformly deeper in the soil than the roots of surface-planted corn, and the root crowns being several inches below the surface allow for deeper cultivation close to the hills without injury to the corn roots. No comparative experiments have been made at this Station in testing different methods of cultivating listed corn.

The primary object in cultivating corn is to increase the yield and improve the quality of the crop. Other objects are to prevent weeds from seeding, so that land may not become foul, and to

*See "King's Physics of Agriculture," page 186.
†See Plates V and VI.

maintain the tilth and fertility of the soil with reference to the growing of future crops.

The average farmer in cultivating corn has usually mainly one object in mind namely to kill the weeds, and this is in fact a very important purpose of cultivation. But the soil needs cultivation for other important reasons. Early in the spring, when the ground is compact and full of moisture, cultivation warms the soil by decreasing the evaporation which absorbs heat and the mulch of mellow-soil acts also as a blanket to prevent the rapid radiation of heat from the soil. The loosening of the surface soil to form a soil mulch conserves the moisture in the soil and offers also the most favorable surface to catch and store the rains. By reason of the stirring and the mellow surface the soil is aerated the foul gases arising from decaying organic matter are removed and life-giving oxygen is supplied to the soil bacteria and to the growing plant roots. And more than this, the fertility of the soil is developed by cultivation. The store of plant food in the soil is largely in an unavailable condition; before the potash, phosphoric acid, and nitrogen become soluble and thus available to the plant the soil must pass through a stage of disintegration and chemical change, which can take place only under favorable conditions, in the presence of moisture, heat, and air, factors which are largely controlled by cultivation, soil and climatic conditions being similar.

There are perhaps no exact rules or methods for cultivating corn, but a farmer observing the crop and soil conditions and understanding the principles of soil cultivation may vary the manner and practice of cultivation somewhat to suit the conditions and accomplish the objects desired. It is a safe rule to follow, and usually pays well, to prepare a good seed-bed and give the land thorough cultivation previous to planting.

After planting, corn, whether listed or surface planted, should be harrowed once or twice before it comes up, weather conditions permitting, and some practice harrowing with good results until the corn is several inches high, but with the surface-planted corn the harrowing may tear out some corn: and with listed corn a few plants are apt to be covered by harrowing, especially if the ground is trashy or lumpy. Corn may usually be harrowed safely just as it is coming up, but when the shoot is fairly out of the ground it is not best to harrow again until the corn is two or three inches high, and then preferably with a light harrow or weeder. Harrowing when the corn is very small, especially with a heavy harrow, is apt to cover or destroy considerable corn, and this may occur with listed corn as well as with surface-planted corn.

Corn which has received the treatment outlined above may be four or five inches high when it receives its first cultivation with the corn cultivator, yet it must not be left too long and the weeds must not be allowed to get so large that they cannot be covered. The time to clean corn is at the first cultivation. Most of the weeds in the row or hill which escape the first cultivation cannot be destroyed or covered at succeeding cultivations.

FERTILIZERS FOR CORN

The fertilizer experiments with corn have been carried on two years, 1905 and 1906. The trials have been made on ordinary upland soil of the Station farm. The land was in an average state of fertility but had not been recently fertilized. The corn was planted with the lister each year and the fertilizers were applied by hand in the listed furrows, except that the barn-yard manure and sodium nitrate (only one plot in 1906) were spread broad-cast before planting. The fertilizers were applied in 1905 about the first of June, when the corn stood eight or ten inches high. In 1906 the fertilizers were not applied until June 21. The applications have been made rather too late to get the full benefit of the fertilizer. The usual method of applying chemical fertilizers in the row is accomplished at planting time, with attachments to the planter or lister. The Boone County White corn was used in this experiment in 1905 and the McAuley White Dent in 1906. The amounts of fertilizers applied and the resulting yields of corn from the several plots are given in table XII.

The 1905 experiment may be considered a fair trial, and in this test all the commercial fertilizers had apparently some beneficial effect in increasing the yields of corn, the largest yield being secured from the plots fertilized with potassium sulphate and sodium nitrate. No combination of fertilizers was used in this year's test and no comparative trial was made with barn-yard manure.

In 1906 the corn was injured somewhat by cut-worms, resulting in a poor and rather irregular stand, and the results of this experiment cannot be considered a fair conclusion. It will be observed, however, that the sodium nitrate and barn-yard manure apparently had a much greater effect in increasing the yield of corn than any of the other fertilizers. The application of the sodium nitrate broadcast before planting gave better results than the application of these fertilizers in the furrow after planting. However, as observed above, the application in the row was perhaps made too late to get the full benefit of the fertilizers. The comparison of the results of the trials for the two seasons favors

fertilizing with sodium nitrate as compared with potassium sulphate, superphosphate, and sulphate of iron. The sulphate of iron may not act as a direct fertilizer, but the claim is made for it that it acts in the nature of a stimulant to the soil in the production of crops.

The yields of stover are not given in table XII. In 1905 there was little difference between the several plots in the production of stover, the average yield being 1.56 tons per acre. The plot fertilized with manure gave much the largest yield of stover in 1906, 2.11 tons per acre as opposed to 1.02 tons from the unfertilized ground. All other plots yielded less stover than the unfertilized or check plot.

TABLE XII.—Fertilizers for corn.

NAME OF FERTILIZER.	1905.		1906.		Average 1905 and 1906.	
	Fertilizer, amount per acre, lbs.	Corn, yield per acre, bu.	Fertilizer, amount per acre, lbs.	Corn, yield per acre, bu.	Fertilizer, amount per acre, lbs.	Corn, yield per acre, bu.
Superphosphate	250	58.54	150	29.07	200	43.81
Dried blood	.....	.....	75	31.74	.....	.....
Sodium nitrate (broadcast)	.....	.....	50	40.00	.....	.....
Sodium nitrate (in rows)	100	62.23	50	36.44	75	49.34
(Unfertilized)	.....	55.01	.....	33.21	.....	44.11
Special Corn Fertilizer*	.....	.....	125	28.44	.....	.....
Potassium sulphate	200	63.54	75	30.10	137½	46.82
Sulphate of iron	25	57.30	75	30.60	50	43.95
Sodium nitrate	.....	.....	50			
Potassium sulphate	.....	.....	75	32.28	.....	.....
Superphosphate	.....	.....	150			
Barn-yard manure	.....	.....	26,000	56.63	.....	.....

*Swift & Co.

ROTATION EXPERIMENT WITH CORN

In this experiment forty-eight one-fourth-acre plots (with eleven-foot alleys between them), situated in the same field, were laid off in two series of twenty-four plots each. In 1903, the first season of the experiment, fourteen of the plots in series I were planted to the following crops: Wheat, wheat followed by cow-peas as a catch crop, oats, barley, emmer, flax, millet, sorghum, Kafir-corn, corn, corn followed by cow-peas as a catch crop, corn followed by rye as a catch crop, soy-beans, and potatoes, while the remaining ten plots were used as duplicates of the above plots, with the exception of those followed by catch crops. In 1903, the second series of plots was planted to corn. In 1904, series I was planted to corn, and series II to the crops mentioned above. In 1905, the plots were planted the same as in 1903, and so on, so that each year corn has been grown after the various crops and the various crops have been grown after corn, the object of the test

being to study the effect of each of these crops upon the growing of corn.

In plots 1 and 25 cow-peas have been seeded as a catch crop as soon as possible after the wheat has been harvested, the seed-bed having been prepared by the use of the disk harrow. A fairly good stand has usually been secured and the cow-peas have generally made a growth of about sixteen inches in height before frost, and have been plowed under later in the fall, usually while the vines were still green. The cow-peas have been seeded in plots 15 and 39 with a one-horse drill between the rows of corn immediately after the last cultivation. A fair stand and a growth of twelve to sixteen inches has been secured each season. In plots 14 and 38 the rye was seeded in 1903 when the corn was laid by, but it was found that this was too early to start the rye well, and in 1904-'05-'06 the seeding was not done until about September 1.

The corn was planted with a lister in 1903, 1904, and 1905, and with a planter, in fall plowing, in 1906. The seed-bed for the other spring crops was prepared mainly with the disk harrow in 1903 and 1904, and by fall plowing in 1905 and 1906. Table XIII gives the annual yield of the various crops for the four-year periods during which this experiment has been conducted. Table XIV gives a summary of table XIII and shows the average yields for three years of the various crops preceding corn and the average yield for three years of corn following the various crops.

In order to get a comparison between the total products of the various plots an estimated value has been given each crop and the value of crops produced in the average two-year rotation computed. In studying table XIV it will be noticed that the largest average crop of corn, 69.98 bushels per acre has been grown after potatoes. Successful potato culture in this climate requires early planting in a fertile soil and well-prepared seed-bed. This experiment, however, is being conducted in an upland field, which has not been manured or fertilized, and which has been cropped for many years, and under these conditions small crops of potatoes have resulted, followed by relatively large yields of corn. Figuring the potatoes at 50 cents per bushel and the corn at 30 cents, the gross value of the crop produced in two years by this twoyear rotation would be $43.47.

The second largest average yield of corn, 67.50 bushels per acre, was produced after soy-beans, and offers a good illustration of the value of legume crops for increasing the available nitrogen in the soil, preparatory to growing large crops of corn or other

TABLE XIII.—Rotation of crops with corn.

No. of Plot.	1903.		1904.		1905.		1906.	
	Crop.	Yield per acre.	Crop.	Yield per acre.	Crop.	Yield per acre.	Crop.	Yield per acre.
1	Wheat*	3.87 bu.	Corn	44.89 bu.	Wheat*	22.53 bu.	Corn	56.81 bu.
2 and 24	Wheat	3.84 bu.	Corn	32.40 bu.	Wheat	18.67 bu.	Corn	57.57 bu.
3 and 23	Oats	31.84 bu.	Corn	45.74 bu.	Oats	35.44 bu.	Corn	56.74 bu.
4 and 22	Barley	19.21 bu.	Corn	45.72 bu.	Barley	18.79 bu.	Corn	57.07 bu.
5 and 21	Emmer	25.07 bu.	Corn	50.20 bu.	Emmer	29.87 bu.	Corn	56.42 bu.
6 and 20	Flax	6.62 bu.	Corn	48.00 bu.	Flax	6.36 bu.	Corn	57.74 bu.
7 and 19	Millet	2.16 tons.	Corn	43.12 bu.	Millet	1.11 tons	Corn	61.53 bu.
8 and 18	Sorghum	7.17 tons.	Corn	33.03 bu.	Sorghum	8.87 tons.	Corn	46.87 bu.
9 and 17	Kafir-corn	10.07 tons.	Corn	37.57 bu.	Kafir-corn	8.71 tons.	Corn	52.57 bu.
10 and 16	Corn	23.36 bu.	Corn	48.21 bu.	Corn	37.80 bu.	Corn	62.44 bu.
15	Corn*	23.13 bu.	Corn*	17.32 bu.	Corn*	45.98 bu.	Corn*	46.73 bu.
14	Corn†	26.66 bu.	Corn†	50.89 bu.	Corn†	39.15 bu.	Corn†	71.60 bu.
11 and 13	Soy-beans	14.08 bu.	Corn	58.72 bu.	Soy-beans	16.97 bu.	Corn	75.53 bu.
12	Potatoes	67.50 bu.	Corn	66.63 bu.	Potatoes	29.33 bu.	Corn	71.02 bu.
25	Corn	50.00 bu.	Wheat*	17.59 bu.	Corn	63.55 bu.	Wheat*	16.58 bu.
26 and 48	Corn	50.00 bu.	Wheat	17.20 bu.	Corn	44.89 bu.	Wheat	14.74 bu.
27 and 47	Corn	50.00 bu.	Oats	28.13 bu.	Corn	52.00 bu.	Oats	27.00 bu.
28 and 46	Corn	50.00 bu.	Barley	20.67 bu.	Corn	53.90 bu.	Barley	12.15 bu.
29 and 45	Corn	50.00 bu.	Emmer	30.67 bu.	Corn	52.34 bu.	Emmer	22.13 bu.
30 and 44	Corn	50.00 bu.	Flax	7.34 bu.	Corn	53.63 bu.	Flax	9.64 bu.
31 and 43	Corn	50.00 bu.	Millet	2.62 tons.	Corn	67.00 bu.	Millet	3.91 tons.
32 and 42	Corn	50.00 bu.	Sorghum	6.35 tons.	Corn	42.56 bu.	Sorghum	8.41 tons.
33 and 41	Corn	50.00 bu.	Kafir-corn	6.72 tons.	Corn	41.97 bu.	Kafir-corn	56.21 bu.
34 and 40	Corn	50 00 bu.	Corn	56.57 bu.	Corn	53.00 bu.	Corn	64.17 bu.
39	Corn	50.00 bu.	Corn*	67.28 bu.	Corn*	57.72 bu.	Corn*	59.89 bu.
38	Corn	50.00 bu.	Corn†	62.62 bu.	Corn†	56.73 bu.	Corn†	17.33 bu.
36 and 37	Corn	50.00 bu.	Soy-beans	11.70 bu.	Corn	68.26 bu.	Soy-beans	13.90 bu.
35	Corn	50.00 bu.	Potatoes	38.05 bu.	Corn	72.30 bu.	Potatoes	40.29 bu.

*Followed by cow-peas as a catch crop.
†Followed by rye as a catch crop.

TABLE XIV.—Showing yields of corn after various crops.

CROPS IN THE ROTATION.	Average yield per acre 1903-'04-'05 of various crops preceding corn.	Estimated value (per bu. or ton) of crops in preceding column.	Average yield of corn per acre, 1904-'05-'06, after various crops, bu.	Value of crops produced in the various 2-year rotations.
Corn and wheat*.....	Wheat..... 14.66 bu.	$0.68	55.08	$27.49
Corn and wheat.....	Wheat..... 13.24 bu.	.68	46.32	22.90
Corn and oats	Oats ..... 31.80 bu.	.33	51.49	25.94
Corn and barley.....	Barley..... 19.56 bu.	.40	52.23	23.49
Corn and emmer.....	Emmer..... 28.54 bu.	.35	52.99	25.89
Corn and flax.....	Flax..... 6.77 bu.	.90	53.12	22.03
Corn and millet.....	Millet..... 1.96 tons.	3.50	57.22	24.03
Corn and sorghum....	Sorghum..... 7.56 tons.	2.50	40.82	31.15
Corn and Kafir-corn..	Kafir-corn..... 8.50 tons.	2.50	44.04	34.46
Corn and corn.....	Corn..... 39.24 bu.	.30	54.55	28.14
Corn and corn*.....	Corn..... 45.46 bu.	.30	50.59	28.82
Corn and corn*.....	Corn..... 42.81 bu.	.30	60.74	31.07
Corn and soy-beans ..	Soy-beans..... 14.25 bu.	.65	67.50	29.51
Corn and potatoes....	Potatoes..... 44.96 bu.	.50	69.98	43.47

*Followed by cow-peas as a catch crop.
†Followed by rye as a catch crop.

heavy nitrogen feeding crops. However, the total value of the crops produced by the rotation was less than the value of the crops produced by other rotations, and this is due to the fact that the soy-bean produces small yields and is not in itself a profitable crop to grow. It appears from the above table that corn may follow corn to good advantage at least for a few years, but this practice should not be continued for a long period, unless the fertility of the soil be maintained by applying manure and fertilizers or by green manuring.

The lowest yields of corn have been produced after Kafir-corn and sorghum, but on account of the large yields of the sorghum and Kafir-corn crops the value of the total production from these rotations has been relatively high. The area planted to sorghum and Kafir-corn must, however, be somewhat restricted on the ordinary farm, as these crops, especially the sorghum, must be largely utilized upon the farm by feeding to stock. Again, Kafir-corn and sorghum are relatively greater fertility exhausting crops than corn, and within a few years this rotation may perhaps give greatly diminished returns.

The plots which have grown corn continuously in which rye was sown each fall have ranked third in average yield and fourth in value *of* the crops produced. A catch crop of rye in corn helps to eradicate weeds, utilizes available plant food left in the soil in the fall which otherwise might be washed out or drained away, provides a protection to the soil through the fall and winter, thus preventing the soil from blowing, catching the rain, and stopping the drifting snow. When corn follows rye in this way it is nec-

essary to plow or double list, and this should be done rather early in the spring, unless it is preferable to plow late in the fall. If rye is plowed under late in spring, the seed-bed is apt to be left loose and dry, and if corn is listed in rye, the rye becomes a troublesome weed which is difficult to destroy and which may injure the growth of the corn.

The sowing of the rye in the corn has seemed to give better results than the catch crop of cow-peas in the corn. This may be due to the fact that the rye has been sown late in the season,

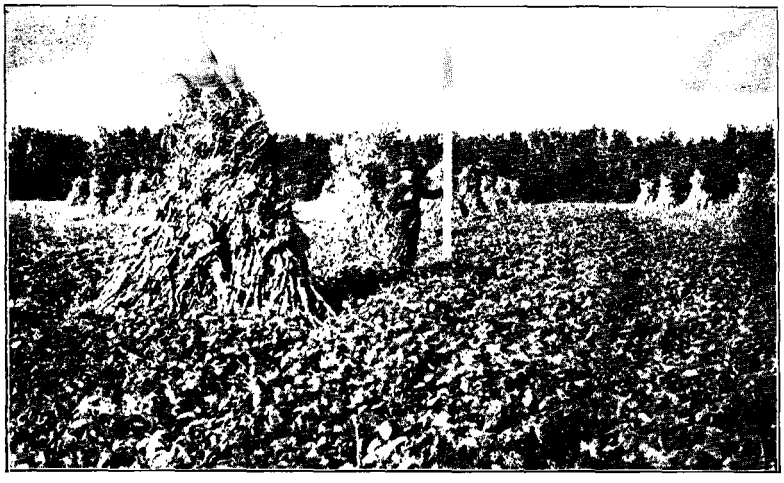


PLATE VII.—Cow-peas in corn, October 10, 1905.

after the corn had practically finished its growth, while the cow-peas were sown in the summer and had to compete with the corn for moisture and plant-food, which has usually resulted not only in a thin stand and a dwarf growth of cow-peas, but the corn has also been checked in growth enough to give some decrease in yield. Since the cow-pea is a southern plant and requires warm weather to grow, it cannot be successfully planted in corn much later than practiced in this rotation.

There is no question but that cow-peas are a valuable fertilizer when they are used as an intermediate crop between small grain and corn. This is indicated by the marked increase in yield of corn after wheat and cow-peas, as compared with corn after wheat, the average yields being 55.08 and 46.32 bushels per acre, respectively, or 8.76 bushels per acre each year in favor of the cow-peas-catch-crop rotation.

It seems advisable in a rotation of crops when cow-peas are

FIG. 1.—Planting a catch crop, June 21, 1905: the drill following the binder.

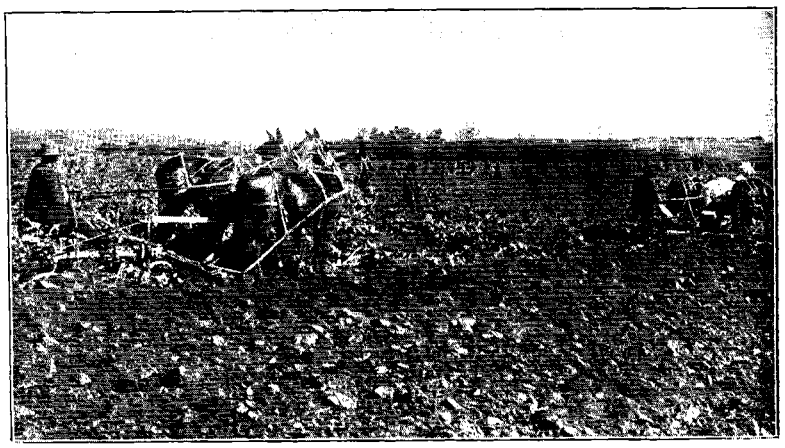


Fig. 2.—Plowing under a catch crop of rape, October 9, 1906.

PLATE VIII.—Preparing land for corn.

used to plant them after small grains rather than in the corn. Planted after the small-grain crop is harvested, the catch crop can do no harm, and if properly handled may give much benefit by adding humus and nitrogen to the soil, preventing waste of plant-food by oxidation and drainage, improving the physical condition of the soil, and increasing the yield of the succeeding crops of corn.

The rotation with millet has given a relatively large average yield of corn, 57.32 bushels per acre, but the value of the two crops is relatively low, due to the fact that the millet hay sells at a low price. However, millet is a better crop than small grain to use in rotation with either corn or wheat, when the fodder may be used to advantage for feeding to stock on the farm. In the wheat rotations, the largest average yield of wheat has been produced after millet.*

The yield of corn after the several small grains has been relatively low, although the spring grains appear to be somewhat better adapted for rotating with corn than the winter wheat. A rotation of corn with small grains cannot maintain the soil fertility, since all of the crops are really great exhausters of soil fertility.

None of the rotation systems discussed in this bulletin are ideal; the purpose has been, as stated, to learn the yearly and final effect of the several crops on the production of corn, when these crops precede the planting of corn each year, in alternate rotation, on separate fields. A practical and scientific rotation of crops is intended not only to produce large yields of the several crops, but also to maintain the fertility of the soil. Such a rotation would include grasses and the perennial legumes as well as the use of annual legumes and catch crops.

The value of the crops as given in table XIV are not designed to show the relative profits secured in carrying out the different rotation plans. On account of the cheaper cost of production, some of the crops which are relatively low in value may be the more profitable for the farmer to raise.

SHRINKAGE OF CORN IN THE CRIB

Experiments were begun in 1903 to determine the shrinkage of corn after it was cribbed in the fall. Three small board cribs of sufficient capacity to hold about four thousand pounds each of ear corn have been filled each year at husking time as follows: Crib No. 1, white dent corn, crib No. 2, yellow dent, corn; and crib No.

*See Station Bulletin No. 144.

3, mixed corn, namely, small amounts of corn of different, varieties.

The cribs were lined with fine wire netting to keep out the mice. A fourth crib was not filled with corn, but was weighed each time that the filled cribs were weighed as a check to determine the gain or loss in weight of the empty cribs. The gain or loss in weight of the check crib was added to or subtracted from the weights of each of the other cribs in securing the net weights of corn at each weighing. The average weight of the empty crib was about 410 pounds, but the cribs have usually gained in weight

PLATE IX.—Experimental cribs (the cribs rest on a platform under an open shed).

during the winter and spring, varying sometimes as much as ten per cent from the normal or lowest weight.

The corn has been husked each fall when it was dry and in good condition to crib. The plan has been to fill all the cribs as nearly at the same date as possible, the first weights being taken as soon as all the cribs were filled. The exact dates at which the weights were taken each year is noted in tables XV, XVI, and XVII, which also include the net weight of the corn at each weighing, the percentage loss in weight secured by comparing each net weight with the original net weight of the corn in each crib, and the average net weight and the average percentage loss in weight of the corn in all the cribs at each of the several dates when comparative weights were taken. It was the plan to weigh the cribs about the first of each month, but this plan has not always been fully carried out.

The varieties used in these trials were as follows: Forsythe

Favorite (white dent): McAuley (white dent), Kansas Sunflower (yellow dent), and Hildreth (yellow dent), all late or medium late maturing varieties. requiring from 130 to 135 days to mature, and the Reid Yellow Dent, a medium early variety, maturing in about 115 days. The mixed corn included a few bushels of many kinds of corn, both early and late maturing varieties, and this crib was intended to represent an average sample of field corn of all varieties commonly grown in this State.

The corn was husked and put into the cribs the last part of November and the first week in December, in 1903, and the first crib weights were taken December 5. From samples taken at husking time, the moisture in the ear corn as cribbed was determined as follows: White corn, 24.94 per cent of moisture; yellow corn, 19.73 per cent' of moisture. No moisture determinations were made of the mixed corn. Referring to table XV it will be observed that the corn lost 2.33 per cent in weight on the average during the first month. There was little decrease in weight during the balance of the winter. During the spring months the corn decreased gradually in weight, the total average loss on May 6 for all cribs being 6.14 per cent. Except the yellow corn, which showed a great loss in weight (5.66 per cent) in the last month of the trial, the weight of the corn remained about the same throughout the summer. The June weights actually showed a slight increase over those taken in May. The final weights. taken August 17 when the cribs were emptied, showed a shrinkage of 7.92 per cent as an average for the eight and a half months. The white and

TABLE XV.—Shrinkage of corn, 1903-'04.

DATE.	Crib No. 1, white corn, Forsythe Favorite.		Crib No. 2 yellow corn, Kansas Sunflower.		Crib No. 3, mixed corn, all varieties.		Average for the three cribs.	
	Actual weight of ear corn, lbs.	Loss, compared with first weight, per cent.	Actual weight of ear corn, lbs.	Loss, compared with first weight, per cent.	Actual weight of ear corn, lbs.	Loss, compared with first weight, per cent.	Actual weight of ear corn, lbs.	Loss, compared with first weight, per cent.
December 5, 1903	3555	.....	3900	.....	3768	.....	3741	.....
January 6, 1904	3436	3.34	3814	2.21	3714	1.43	3655	2.33
February 6, 1904	3438*	3.29	3805	2.44	3720*	1.27	3654	2.33
March 5, 1904	3421	3.76	3796	2.67	3634	3.56	3617	3.33
April 6, 1904	3304	7.06	3766	3.44	3607	4.27	3559	4.92
May 6, 1904	3215	9.56	3736	4.21	3593	4.64	3515	6.14
June 7, 1904	3225*	9.28	3776*	3.18	3593	4.64	3531*	5.70
July 4, 1904	3200	9.99	3736	4.21	3589	4.75	3508	6.32
August 17, 1904	3253*	8.49	3515	9.87	3565	5.39	3444	7.92

*Gained in weight.

yellow dent corn lost on the average 3.79 per cent more in weight than the mixed corn. At the close of the experiment several mice were found in the crib of yellow corn, and this may account, in part, for the greater decrease in the weight of this crib during the last six weeks of the trial.

In 1904 the corn ripened earlier than in 1903, and was husked in October, the first comparative crib weights being taken October 26.

The white corn contained 18.95 per cent of moisture and the yellow corn 21.32 per cent of moisture as determined by samples taken when the corn was put into the crib; thus the corn was drier when cribbed in 1904 than in 1903. No weights were taken in November and December in the 1904 trial. On January 31 the average loss in weight of the corn in all cribs was 5.17 per cent, the yellow corn showing the greatest decrease in weight. Again, as in the previous trial, there was little loss in the weight of the corn during the winter, but all the cribs showed a great shrinkage in weight during the spring and early summer months. The lowest weights for the year, with one exception (the yellow corn), were recorded on June 20, the average shrinkage at that date being 11.32 per cent. The final weights taken October 7, nearly twelve months after the corn was husked, showed an average shrinkage of 12.21 per cent. As in the 1903 trial, the mixed corn again lost less in weight than the yellow corn and white corn, the ratio of shrinkage being 6.72 to 14.88 per cent. On July 20 and August 24 there was an actual gain in the average weight of the

TABLE XVI.—Shrinkage of corn, 1904-'05.

DATE.	Crib No. 1, white corn, Forsythe Favorite.		Crib No. 2, yellow corn, Hildreth.		Crib No. 3, mixed corn, all varieties.		Average for the three cribs.	
	Weight of ear corn, pounds.	Loss, compared with first weight, per cent.	Weight of ear corn, pounds.	Loss, compared with first weight, per cent.	Weight of ear corn, pounds.	Loss, compared with first weight, per cent.	Weight of ear corn, pounds.	Loss, compared with first weight, per cent.
October 26, 1904	4150	.....	4190	.....	4015	.....	4118	.....
January 31, 1905	3953	4.75	3879	7.42	3881	3.34	3904	5.17
March 6, 1905	3976*	4.19	3869	7.66	3807	5.18	3884	5.67
April 8, 1905	3884	6.41	3734	10.88	3897*	2.93	3838	6.74
May 10, 1905	3769	9.18	3670	12.41	3742	6.80	3727	9.46
June 20, 1905	3679	11.11	3549	15.30	3712	7.55	3647	11.32
July 20, 1905	3705*	10.72	3629*	13.39	3698	7.90	3677*	10.67
August 24, 1905	3745*	9.75	3609	13.87	3722*	7.30	3692*	10.31
October 7, 1905	3550	14.48	3550	15.27	3745*	6.72	3615	12.21

*Gained in weight.

cribs, and the mixed corn continued to gain during the last period, from August 24 to October 7, when the final weights were taken.

In the 1905 trial the first comparative weights of the experimental cribs were taken November 16. Five weeks later (December 23) the cribs had lost only about one-half of one per cent in weight on the average, and the crib of white corn had actually gained in weight during this period. No weights were taken in January and March. On February 6 the average shrinkage was 2.56 per cent, and on April 19, 3.86 per cent. All the cribs gained in weight during May, as shown by the June 5 weighings, after which there was a gradual decrease in the weight of the corn until October 16, when the final weights were taken, which showed an average shrinkage for all the cribs of 5.82 per cent in eleven months. The yellow corn showed the greatest loss in weight, 8.48 per cent; the mixed corn shrunk 6.42 per cent, while the white corn lost only 2.44 per cent in weight during the whole period.

Five samples of the white corn, taken at husking time, contained, on the average, 15.2 per cent of moisture. A single sample of the Reid Yellow Dent, which was husked a little earlier than the McAuley, contained 189 per cent, of moisture when husked.

TABLE XVII.—Shrinkage of corn, 1905-'06.

DATE.	Crib No. 1, white corn, McAuley.		Crib No. 2, yellow corn, Reid's Yellow Dent.		Crib No. 3, mixed corn, all varieties.		Average for the three cribs.	
	Weight of ear corn, pounds.	Loss, compared with first weight, per cent.	Weight of ear corn, pounds.	Loss, compared with first weight, per cent.	Weight of ear corn, pounds.	Loss, compared with first weight, per cent.	Weight of ear corn, pounds.	Loss, compared with first weight, per cent.
November 16, 1905	3650	.....	3810	.....	3580	.....	3680	.....
December 23, 1905	3673*	.63*	3753	1.50	3557	.64	3661	.50
February 6, 1906	3635	.41	3700	2.89	3455	3.49	3597	2.26
April 19, 1906	3565	2.33	3590	5.77	3460	3.35	3538	3.86
June 5, 1906	3595*	1.50	3587	5.85	3460*	3.35	3547*	3.57
August 31, 1906	3580	1.92	3560	6.56	3443	3.82	3528	4.10
October 16, 1906	3560	2.47	3487	8.48	3350	6.42	3466	5.82

* Gained in weight.

A summary of the results of the several trials is given in table XVIII. This table shows the percentage shrinkage in weight of each kind of corn for the several periods of four, six, eight, ten and twelve months after cribbing, but these periods are only approximate and not exact. It appears from this summary that the yellow corn has given the greatest average shrinkage, not only

for the whole twelve months, but also for each of the shorter periods. The next greatest shrinkage occurred in the white corn, while the mixed corn has lost less weight during the year, and has shown less shrinkage for each of the shorter periods, except the first four months, than the white corn or yellow corn.

TABLE XVIII.—Summary of corn shrinkage trials.

DATE OF WEIGHT.	Period after cribbing, months.	Loss in weight.			
		White corn, per cent.	Yellow corn, per cent.	Mixed corn, per cent.	Average, per cent.
February	4	2.82	3.86	3.09	3.26
April	6	5.27	6.70	3.52	5.16
June	8	7.26	8.45	4.69	6.80
August	10	6.72	10.10	5.50	7.44
October	12	8.48	11.21	6.18	8.62

The final average for all the trials indicates that when corn is put into the crib fairly dry and in good condition the shrinkage during the winter months is not great, being a trifle over five per cent as an average for the first six months after the corn was cribbed. This loss would not be sufficient, usually, to equal the difference in the weights which are required for a bushel of ear corn as sold in the fall and as it may be sold in the winter or early spring. Late in the winter and in the spring seventy pounds of good, dry ear corn is considered a bushel, while in the fall the farmer is required to give seventy-five to eighty pounds for a bushel. Also, the loss on the original weight in eight or ten months is not so great as the decrease in the actual value of the corn when the fact is considered that at husking time the price of corn is often more than ten per cent less than the price in the spring or early summer. The total shrinkage of weight in a year of these nine cribs of corn has been only 8.62 per cent.

It should be observed, however, that in these experiments great precaution has been taken to prevent loss of corn by other than natural means. Mice did get into one crib, as stated above, and it is possible that there was some loss by the grain weevil, although the presence of these insects was not noticeable. Beside the loss of moisture and loss in weight of corn which may be due to natural agencies, corn held in the crib on the average farm is more or less subject to damage and loss in other ways. Mice and rats are the means of the destruction of a large amount of grain during the year, on the average farm. Poor shelter and careless methods of storing, by which the corn may be damaged by rain and snow, are also other means of loss in the weight and value of the stored crop.

As to whether the farmer should hold his corn or sell it early in the winter may depend upon several factors, as the price of corn, size of the general crop, condition at husking time, and the accommodation which the farmer mag have for saving his crop. If the crop is normal and the price of corn is unusually low at husking time, and the farmer has a good crop, the usual recommendation would be to hold the corn. Judging from these experiments, corn may be kept safely without great loss in weight until March or April, and if there is a question as to the success of the new crop it may be advisable to hold old corn even later than the date named. However, in Kansas, and in states further south, old corn is very apt to become infected with the grain weevil or grain moth and great loss occasioned in this wag, provided the corn is held too late in the summer. In the Northern States, where these pests do not prevail, corn may be safely held for late sum mer and early fall sale.

This experiment is being repeated again with the purpose of discovering, if possible, what occasions the decrease in weight. It would appear that the shrinkage in corn is not due entirely to the loss of moisture, but that there is an actual loss of dry matter. The amount of moisture in the corn has not usually been determined at the close of the experiment when the cribs were emptied, but samples of the white corn, Forsythe Favorite, cribbed in 1904, were taken October 25, 1905, soon after the cribs were emptied, and the moisture determined as follows:

Grain, 11.87 per cent of moisture
Cobs, 12.85 per cent of moisture
Ear corn, 12.05 per cent of moisture.

Another sample of ear corn taken from the seed-corn room upon the same date contained 11.42 per cent of moisture.

The shrinkage in the weight of the white corn in 1904-'05, due to loss of moisture, could not have been more than 6.9 per cent, since the new corn contained only 18.95 per cent of moisture when it was put into the crib. However, the white corn actually lost 14.48 per cent in weight in the trial referred to, and it will be observed that in almost every case the shrinkage in the weight of the corn was greater than may be accounted for by the loss of moisture.

An important point which will be studied in future trials is to determine in which part of the ear the shrinkage is greatest, namely, whether the corn or the cob loses most in moisture. A sample of Hildreth corn put into the experimental cribs last fall

(1906) * contained 19.75 per cent of moisture in the ear corn. Separate determinations showed that the grain contained only 17.72 per cent of moisture, while the cobs contained 29.36 per cent of moisture. The sample contained 82.6 per cent of shelled corn and 17.4 per cent of cobs. From the data given above it appears that the cobs and grain become about equally dry in old corn. If the minimum moisture in the dry corn reaches 12 per cent, this would give a shrinkage of 5.72 per cent in the grain and 17.36 per cent in the cobs, or an average shrinkage of 7.75 pounds for each hundred pounds of ears, and 3.02 pounds of this shrinkage, or 39 per cent of the total shrinkage, would actually occur from the drying out of the cobs.

This subject is well worthy of further investigation, as is also the point as to which dries first, the grain or the cob, and it would be important to note the relative loss of weight in the grain and cobs at certain intervals after the corn is husked.

TO MEASURE CORN IN THE CRIB

It is usual to calculate a bushel of ear corn in the crib as 2½ cubic feet in volume. In Prof. C. S. Plumb's book on "Indian Corn Culture," he gives this rule for measuring corn in the crib: "Multiply the length, breadth and height of the crib together in feet to obtain the cubic feet of space it contains. Multiply this product by 4, strike off the right-hand figure, and the result will be the number of shelled bushels." It will be observed that this rule really figures 2½ cubic feet of the ear corn as equal to a bushel. It is only approximately correct to calculate the number of bushels of corn in the crib in this way. If the corn is dry and sound, it will usually pay the seller to weigh the corn rather than to sell it by measure. If the corn is shelled, fifty-six pounds is a legal bushel, but with ear corn the weights figured for a bushel vary according to the dryness of the corn. It is usual to allow seventy pounds of ears for a bushel of shelled corn if the corn is dry and sound, but when husked and hauled from the field corn often contains a high percentage of moisture, and the weight required for a bushel often varies, at husking time and during the fall and early winter, from seventy-five to eighty or ninety pounds. Doubtless, also, if new corn is sold in the crib by measure it would be fair to allow five to ten per cent greater volume for the measured bushel, say $2\frac{5}{8}$ to $2\frac{3}{4}$ cubic feet.

*This experiment has not been completed and is not reported in this bulletin.

BREEDING AND SEED SELECTION

The work by the Agronomy Department in the breeding of corn has not been undertaken especially for the purpose of experiment, but with the object of improving some of the best producing and most promising varieties tested at this Station, the ultimate object being to distribute well-bred seed of these varieties to Kansas farmers and thus improve the quality and increase the yield of the corn crop of this State.

The fault with even the better varieties of corn grown in Kansas to-day is, that the corn is usually badly mixed in type and not pure bred. This is especially true of our "native" varieties.* However, because they have been grown a longer time in the State, these "native" varieties are often better producers and more hardy and better adapted to our soil and climate than even the best and purest imported varieties. The purest bred corn secured from other states, when grown under new conditions of soil and climate, varies greatly in the type and quality of the corn produced, and must be carefully bred and selected again when planted in Kansas in order to secure a hardy and productive type of corn which is adapted for growing in the new environment.

Among the one hundred twenty different varieties of corn tested at this Station during the last four years, a dozen varieties may be selected which are decidedly better than the average, and which have given larger yields and produced a better quality of grain than the other one hundred eight varieties. Variety tests should be more or less local in order to determine which are the best varieties to grow in a certain locality, yet the general tests made at Manhattan indicate what varieties may be best adapted for growing in other sections of the State. There is no question but that there is a great difference in varieties of corn in their adaptation to different soil and climate, and it should be the purpose of the State Experiment Station, with the assistance of the Sub-stations and the farmers, to determine which are the best-producing varieties for the different sections of the State.

A great deal of this work of testing varieties has been done in several states, but with very little results. The writer found on studying this question, that, while some states had tested a large number of varieties of several standard crops through a long period of years, sometimes as much as ten years, and finally made a report showing that certain varieties were the best producers, to-day such varieties were not recorded as being grown in those

*During the last three years a few careful growers have greatly improved the corn which they are growing and are now offering well-bred seed-corn for sale in the ear. (See Second Annual Report of the Kansas Corn Breeders' Association).

states. The trials had been made, but the seed was thrown away. Such work has very little value. Just to know that a certain variety is better than another does not help the farmer unless he can get the seed of that variety and plant and grow it. It has been the plan of the writer not only to test varieties at the Kansas Experiment Station, but as soon as it is shown that certain varieties are better than others the seed is planted in increase-plots and increased in quantity, improved by breeding and selection, in quality, type and productiveness, and distributed to the farmers of the State at a nominal price.

There is no question but that when certain varieties are proven to be good producers and are carefully selected and bred for purer type and greater productiveness, such corn is better than the average corn which the farmers of the State are growing. In the last two years the Agronomy Department of this Station has sold and distributed some eight hundred bushels of well-bred seed-corn. The distribution of this well bred corn in Kansas has already given good results, and many compliments have been received from farmers who have purchased the seed regarding the greater productiveness of the corn sent out from this Station.

Meanwhile the department is attempting to still further improve some of these better producing varieties by breeding and selection. It is not the purpose in this bulletin to go into detail regarding corn breeding. The writer hopes to treat this subject more fully in a later publication. It may be advisable, however, to give here some report of the work in this line which has been accomplished and which is now in progress. The corn breeding work now being carried on by the Agronomy Department was begun in the spring of 1903, when the writer published Press Bulletin No. 120, "Better Bred Corn for Kansas," in which the farmers who had good corn were requested to send samples of the same to this department for planting in a comparative trial of varieties, for the purpose of securing the promising varieties to be used as foundation stock for breeding and improvement.* Seed of the purest bred and best-producing varieties recommended in other states was also secured and planted in this comparative trial. Several excellent varieties of "native" Kansas corn were thus discovered, a few of the imported varieties proved to be good producers, and several of these best-producing varieties have been still further improved by breeding, either at this Station or by farmers and thousands of bushels of well-bred seed-corn have

*This work in corn breeding is independent of the experiments carried on by the Botanical and Chemical Departments of this Station with reference to increasing the protein content of corn, some results of which were published in bulletin 107 of this Station.

already been distributed throughout the State by the Experiment Station and by farmers who have become interested in corn breeding.

There is little question but that the planting of this well-bred corn, together with the teachings of the Agricultural College on this subject to its students, and through the farmers' institutes, Experiment Station bulletins, and agricultural press, assisted also by progressive farmers and the Kansas Corn Breeders' Association, has already had a marked effect in increasing the yield and improving the quality of the corn crop of the State. In a year which was not especially favorable for corn, and when partial crop failures were reported in localities all over the State, Secretary Coburn reported the average yield of corn in the State in 1906 as 28.5 bushels per acre, or seven bushels above the average yield for the last ten years.

EAR-ROW METHOD OF BREEDING CORN

The method of breeding a certain variety of corn practiced at this Station is to select the choicer ears from the general field at the beginning; later the breeding ears are largely selected from the highest yielding rows in the previous season's ear-test. The kernels of each breeding ear are planted on separate rows, care being taken to mate the ears, viz., ears which are of like type, which should cross well, from the highest producing rows, are planted side by side. The rule is to detassel every other row, while the tassels are allowed to develop on the alternate rows, the plants of which become the male parents of the seed ears which are selected from the detasseled or "mother" rows. The ear-test rows which appear inferior are also detasseled, and all inferior plants in the seed-breeding field are also detasseled. The breeding ears for future planting have, as a rule, been selected from the highest producing detasseled rows, but occasionally also seed ears have been selected from the highest producing tasseled rows. The present plan is to detassel one-half of each row at opposite ends of the breeding field. This makes it possible to save seed ears from each row which could not have been self-fertilized, but which must have been largely cross-bred with the plants on the adjacent tasseled rows. For a clearer explanation on this point, see plate X.

Only viable seed is planted in the breeding plot, viz., several of the kernels from each prospective breeding ear are subjected to a germination test, and only those ears whose kernels show a perfect germination are accepted for planting. The breeding ears are planted in uniform soil, on the same date if possible, and given

similar treatment and cultivation throughout the season. Notes are taken during the season on the growth, date of tasseling, and date of maturity of the corn in each row. A comparative description of the corn in each row is also included in these notes. The original breeding ears are carefully described and numbered previous to planting. All these notes are carefully recorded in

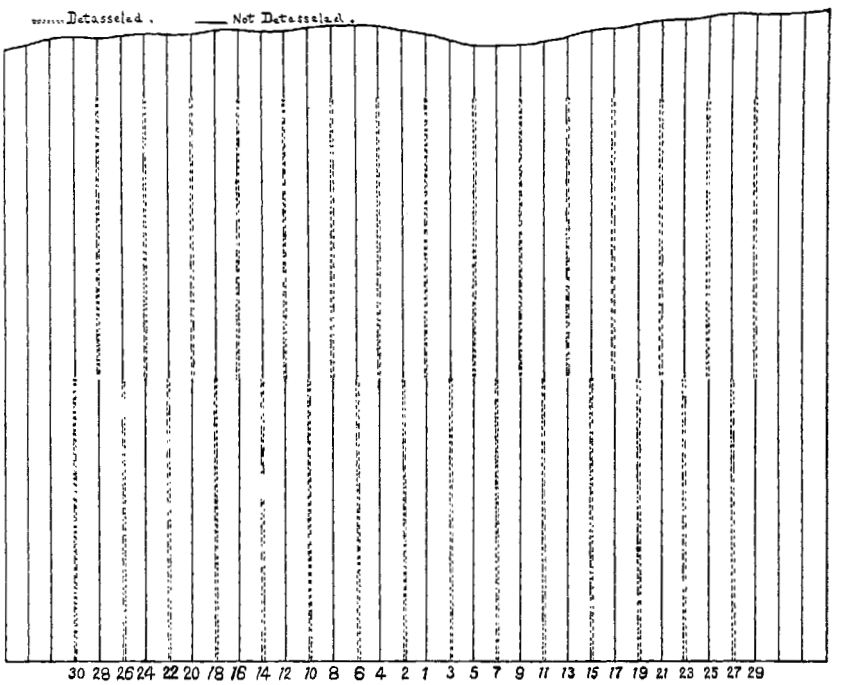


PLATE X.--Plan of ear-row breeding plot.

The ears are numbered in the order of their grade or rank as breeders, and the more desirable ears are planted near the middle of the ear-test plot. The highest bred seed, next to the breeding ears, is planted each side of the ear-test plot and is also used to plant the ends of the ear-test rows.

breeding-record books. The corn from each row is harvested and weighed separately, and the choice ears are hung up in separately marked lots and saved for seed The choice seed ears are selected before husking, as soon as the corn is fully mature, care being taken to select only the "good" ears from desirable plants.* The most desirable ears from the highest producing rows are selected as ear-row breeding stock for the coming season, and the balance of the seed ears from the highest producing rows is used as a part of the seed for general planting.

*For a more complete discussion on the method of selecting seed ears, see page 285.

By a later development of this corn breeding work, one-fourth of each breeding ear is not planted the first season, but is reserved for future use. When it has been shown by the ear test which are the best-producing ears, the reserved fourths of these breeding ears may be planted the following year, singly or in groups, thus making these ears the foundation stock for a purer type of a higher-producing strain than may perhaps be secured by planting the seed from the highest-producing ear-test rows which has been crossed with the corn on the adjacent rows.

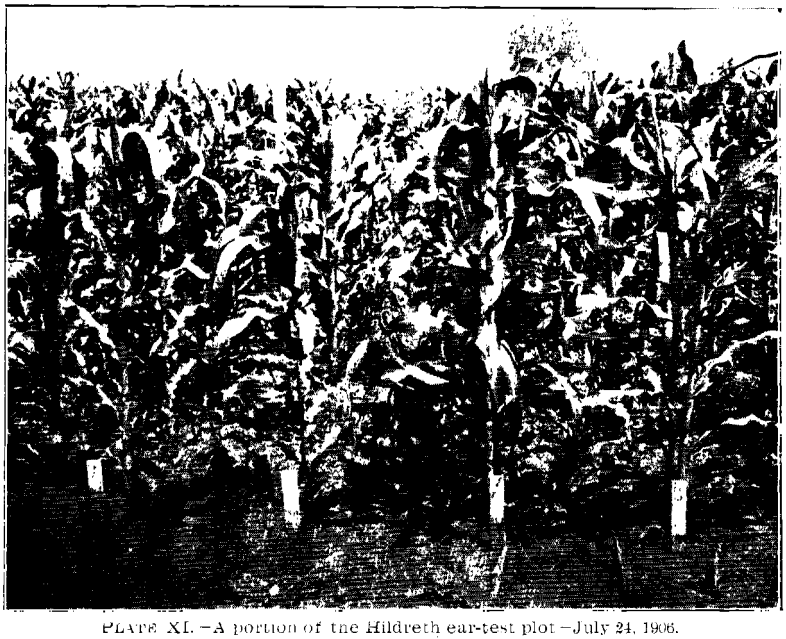


PLATE XI.—A portion of the Hildreth ear-test plot—July 24, 1906.

Another plan proposed and already partly begun which, when carefully carried out should put corn breeding in the same class as stock breeding and insure the continued improvement of corn, is to secure choice ears of the breed or variety from other breeders or other sources and plant this corn in a preliminary ear-test plot the first year, in order to prove the new ears as to purity, desirable type, and productiveness. Then the choice ears from the more desirable new ears will be planted the next season in the regular ear test and intelligently crossed with the line-bred ears. Such a plan may offset any injurious effect of in-breeding or close line-breeding, and infuse new blood, thus tending to invigorate the corn as well as to improve it still further in hardiness, type, quality, and productiveness.

At present the Agronomy Department is growing and breeding nine different varieties of corn on separate fields, as follows : Reid Yellow Dent, Silvermine, Boone County White, Legal Tender, Hogue Yellow Dent, Hildreth, McAuley, Kansas Sunflower. and White Injun. Some eighty acres were used for growing and breeding corn for seed production in 1906 and 120 acres will be devoted to this purpose in 1907. Four hundred forty ears were planted in separate rows in the several breeding plots in 1906, and 373 breeding ears were planted this spring (1907).

BREEDING REID YELLOW DENT CORN

A good sample of Reid Yellow Dent corn was secured from the Illinois Experiment Station and planted at this Station in 1902. A few bushels of seed-corn were saved from this crop and in the spring of 1903 thirteen of the more desirable ears of this lot of seed-corn were selected and planted in an ear-row breeding plot, which marks the beginning of the corn-breeding work by the Agronomy Department of this Station. (The Reid Yellow Dent and Kansas Sunflower were the only varieties bred in this way in 1903.) In 1904 the work with the Reid Yellow Dent corn was continued with eighteen ears selected from the high-producing ear-test rows of the previous season. In 1905 thirty-nine ears, all from the high-producing rows of the previous year's breeding, were planted in the breeding plot and in 1906 the number was increased to sixty-four selected ears, forty-nine of which were from the original selection, while fifteen were from a new but well-bred strain of Reid corn secured from the Nebraska Experiment Station.

To the novice in this work, the remarkable feature of the ear test is the fact that choice individual seed ears of the same variety of corn should show such a great variation in productiveness, when grown under almost exactly the same conditions of soil and culture. In 1903 the yields from the several ear-test rows ranged from 10.3 to 84.6 bushels per acre. In 1904 the relative difference was not so great, but the yields varied from 40.6 to 76.5 bushels per acre. In 1905 the yield was generally low, due largely to the conditions of soil and season: the range in yield being 32.8 to 52.5 bushels per acre. In 1906 a good general crop was harvested, but the yields of the ear-test rows showed a great variation, ranging from 20.6 to 96 bushels per acre.

Some very interesting results of these ear-test trials are presented in plate XII, in which the average yield of the four highest-producing ear-test rows is compared each year with the average yield of the four lowest-producing ear-test rows while the average yield of the ear-test plot is compared with the yield of the balance

of the field. The Reid corn has been grown in three different fields during the four seasons, thus the soil conditions have varied from year to year. The area planted each year has varied from eight to twenty acres.

The results of these breeding trials indicate that it is possible for a farmer to increase his corn crop several bushels per acre each year, simply by making a very careful selection of seed ears, while if he practices systematic breeding, as described above, the

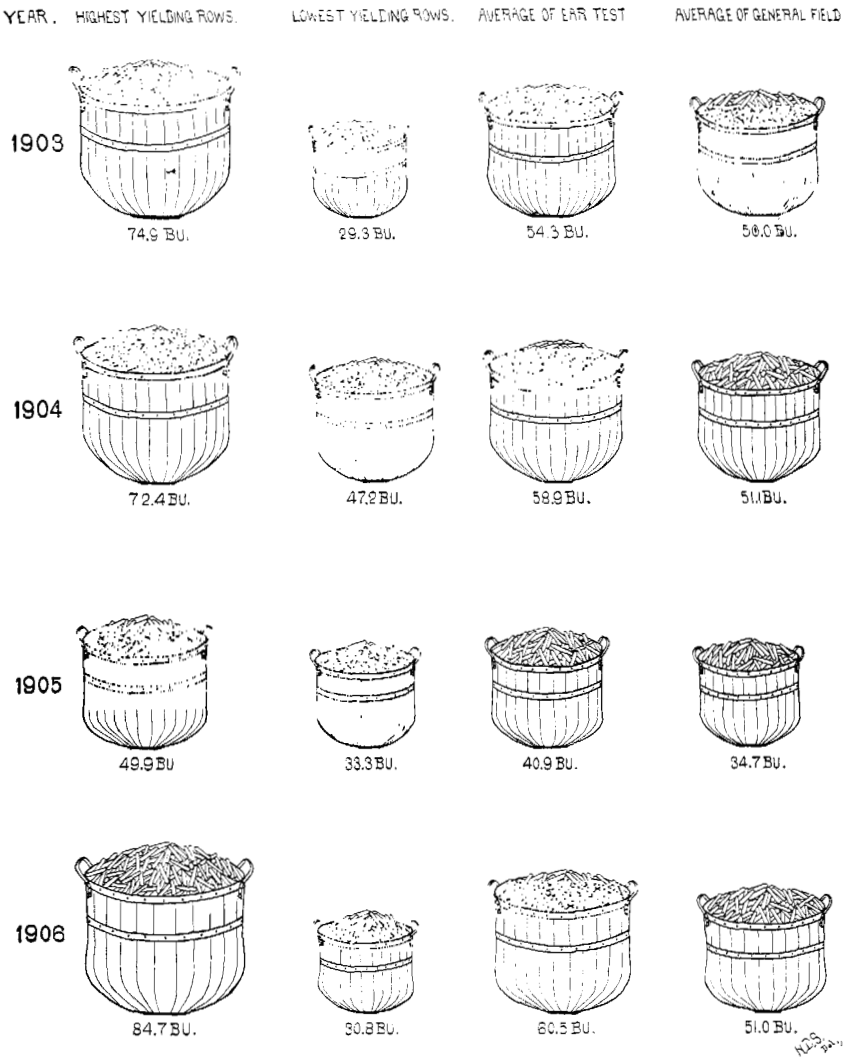


PLATE XII.—Illustrating results of breeding Reid's Yellow Dent corn—yield per acre is represented by area of baskets, not by volume.

yield may be still further increased. As an average for the four years the general field yield of Reid Yellow Dent was 46.7 bushels per acre, while the ear-test plots have yielded, on the average, 53.8 bushels per acre, which is 7.1 bushels more corn per acre each year in favor of seed selection and breeding. It should be observed in connection with these figures that the general field was planted each year with first-grade seed, being usually the choicer ears selected from the general field the year previous and including, in the last two trials, some of the high-yielding rows seed.

BREEDING HILDRETH CORN.

A bushel of Hildreth corn was secured from Mr. C. E. Hildreth, Altamont, Kan., in the spring of 1903. Several plots of this corn were planted in the variety trial that season, and a few of the better ears were selected and planted in a separate field, but no ear test was conducted. In 1904 a second selection of this corn was secured from Mr. Hildreth, and the better ears of this lot, together with selected ears from the previous year's planting, were again planted in a separate field for seed production. The first ear test with Hildreth corn was undertaken in 1905. Thirty-one choice ears from the 1904 planting were selected and planted in the breeding plot in 1905. Some of the data of this first Hildreth ear test is given in table XIX, in order that the reader may observe the actual range in yields produced by different ears of corn, and also to present some idea of the method which is employed in recording the results of this ear-breeding work. Such a table is prepared each year for each breeding plot, and the reader will understand that a large amount of very careful work must be done in preparing such records for nine different ear tests in one season. In the Hildreth ear test in 1905, as given in table XIX, the yields of the several ear-test rows varied from 35.9 to 81.7 bushels per acre. The average yield for the breeding plot was 52.4 bushels per acre, while the average yield for the general field (about ten acres) was 48.7 bushels per acre.

In studying the ear-test corn after harvesting, the usual plan has been to place the corn from each breeding plot on a large floor in piles, each pile being the product of a single ear or row. This plan allows the breeder to make a careful comparison of the product of the several breeding ears, especially with reference to type and quality. Each pile of corn, the product of a single ear, is carefully separated into "good" and "poor" ears, the latter being the nubbins, poorly filled ears, mouldy ears, etc., while the former includes all the sound, marketable corn, without regard to

TABLE XIX.—1905 record of Hildreth ear test.

No. of Ear.	Selection from 1904 crop.	Yield per acre, bushels.	Good corn, per cent.	Grade, per cent.	Rank in yield.	Rank for planting.	Number of ears selected for planting in 1906.
30	Record No. 113	50.4	74	85	16	.....	.....
28*	" " 113	77.1	73	89	2	2	5
26	" " 113	71.4	.....	85	3	.....	.....
24*	" " 113	60.2	75	90	5	3	6
22	" " 113	49.4	77	85	20	.....	.....
20*	" " 113	53.3	87	85	9	4	8
18*	" " 113	52.2	88	87	11	7	4
16	" " 113	41.2	79	82	26	.....	.....
14*	" " 113	61.2	79	87	4	5	4
12*	" " 113	35.6	84	85	31	.....	.....
10	" " 113	54.4	90	80	8	.....	.....
8*	" " 113	46.5	85	87	18	10	1
6	" " 113	50.1	84	78	15	.....	.....
4*	" " 113	49.2	83	83	22	11	2
2	" " 113	57.5	73	80	6	.....	1
1*	" " 113	30.9	81	85	27	.....	.....
3	" " 113	49.3	83	87	21	.....	1
5*	" " 450	50.3	85	80	17	9	2
7	" " 113	51.8	91	80	12	.....	.....
9*	" " 113	51.1	79	82	14	8	4
11	" " 113	45.8	88	83	24	.....	.....
13*	" " 113	52.6	82	80	10	6	2
15	" " 113	38.4	86	85	29	.....	.....
17*	" " 113	81.7	80	83	1	1	8
19	" " 113	46.2	75	85	23	.....	.....
21*	" " 118	36.1	68	80	30	.....	.....
23*	" " 113	39.9	74	83	28	.....	.....
25	" " 113	57.0	75	83	7	.....	1
27*	" " 113	49.4	79	80	19	.....	2
29*	" " 450	44.2	62	83	25	.....	1
31	" " 113	51.4	71	80	13	.....	.....

*Rows were detasseled.

type or purity of breed. In the trial referred to, the percentage of good corn varied from 62 to 91 per cent, while the score or grade ranged from 78 to 90 per cent. Greater differences in this respect have been observed in other ear tests and with other varieties of corn.

Two Hildreth ear tests were planted in 1906, one included fifty-two ears, consisting of the choice ears selected from high-yeilding rows of the previous year's ear test, while the other included twenty-two ears which were selected from outside sources. The average yield of the Hildreth ear-test plot No. 1 was 68.8 bushels per acre, while the general field (about eight acres) yielded 66.7 bushels per acre. The grade of the corn from the several breeding rows varied from 40 to 78 per cent and the percentage of good corn ranged from 52 to 90 per cent: while the yields varied from 36.7 to 94.1 bushels per acre.

Hildreth ear-test plot No. 2 gave yields for the different rows varying from 49.3 to 95.2 bushels per acre. The product of these two ear-test rows is shown in plate XIII. The corn from ear No. 3, the lowest producing ear, scored 73 points and contained 66 per cent of marketable ears, while the corn from ear No. 13, the high-

est producing ear, scored 80 points and contained 76 per cent of good ears. The average yield of the twenty-two rows in ear test No. 2 was 74.2 bushels per acre.

Experiments were made with two varieties of corn last season (1906) in order to compare the yields from seed selected from the 1905 high-yielding ear-test rows with the first-grade seed. namely, choice ears selected from the general field. The varieties of corn used were the Silvermine and Hildreth. Adjacent plots of each selection of seed were planted in each field. The results of the

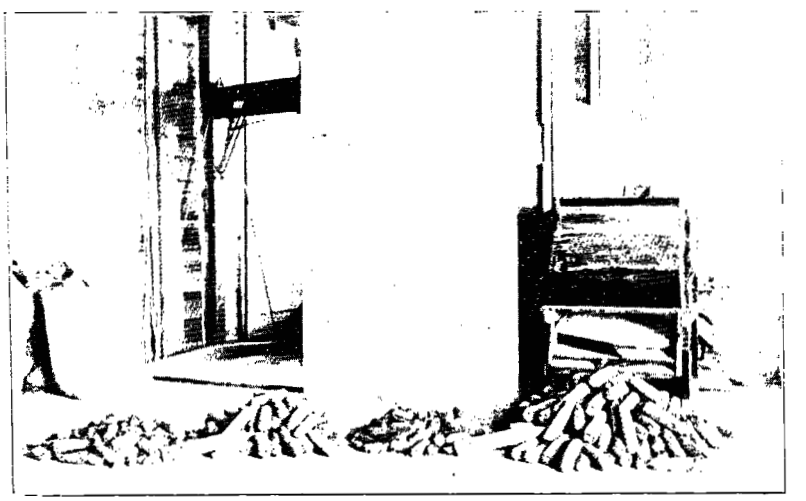


PLATE XIII.—Product of highest and lowest yielding ear-test rows—Hildreth breeding plot No. 2, 1906.

trial with the Hildreth corn are given as follows: The general-field seed yielded 66.23 bushels per acre and the high-yielding rows seed, 73.09 bushels per acre, or 6.86 bushels per acre in favor of the high-yielding rows seed. The difference in the type and quality of the corn was even greater. Over forty per cent more first-grade seed ears were selected from the high-yielding rows plot than from the plot planted with the first-grade seed.

BREEDING SILVERMINE CORN*

Several samples of Silvermine corn were planted in adjacent plots in a separate field in 1903. One of these samples came from Funk Bros., another from the Iowa Seed Company, and a third sample. bulletin No. 92 was secured from the Barteldes Seed

*The breeding stock of this variety has been sold to Mr. Ernest W. Young, Lawrence, Kan., a breeder of Silvermine corn. In order to reduce the greatly increasing work of the Agronomy Department, it is proposed to dispose of several of the corn-breeding stocks in this way, if reliable breeders are found who will continue the careful breeding of a certain variety.

Company. The Barteldes sample proved to be a better producer than the others, and ten selected ears of this strain were planted in an ear-row breeding plot in 1904. The resulting yields in this ear test varied from 33.2 to 69.8 bushels per acre. The corn from the lowest-yielding ear row scored 73 points. There was little difference in the quality and grade of the corn produced on the other rows, the score ranging from 85 to 88 points. Twenty-one ears selected from the product of six of the high-producing ears of the previous season were planted in the Silvermine breeding plot in 1905. This test discovered marked differences in the product of the several breeding ears, contrasting somewhat with the results of the previous season. The yields of the different ear rows varied from 41.9 to 72.6 bushels per acre, the percentage of good ears varied from 46 to 78 per cent, while the total score ranged from 72 to 90 per cent. The ear-breeding plot made an average yield of 53.4 bushels per acre, while the general field yield was only 45.3 bushels per acre.

In 1906, thirty-four choice ears selected from eleven of the high-producing ear rows of the previous season were planted in the Silvermine breeding plot. These ears were selected with especial regard to uniform type, as well as for high yielding character. Uniformity of type and purity of breed or variety has always been given great consideration in the selection of breeding ears in all the ear-row breeding trials. Thus the high-yielding rows seed should produce not only a greater yield of corn than the seed selected from the general field, but also corn of more uniform type, size, and finish of ears, and a larger number of seed ears than the general field seed which has not been so carefully bred and selected.

A study of the records of the above test shows that the yield from individual ear rows varied from 28.2 to 62.7 bushels per acre. The percentage of good corn ranged from 66 to 90 per cent, while the score varied from 50 to 82 per cent. The Silvermine corn was planted on new alfalfa breaking and promised a very large crop early in the season, but the corn was injured by drought in July and August. The general field yield (about six acres) was determined as 50.2 bushels per acre, while the average yield of the ear-breeding plot was 50.7 bushels per acre.

Duplicate plots which were planted with the high-yielding rows seed gave an average yield of 53.0 bushels per acre, while an adjacent plot planted with first-grade, general-field seed yielded only 40.15 bushels per acre. The plot planted with the better bred seed produced, on the average, 24.8 per cent more first-grade seed ears per row than the other plot.

BREEDING KANSAS SUNFLOWER CORN

Two samples of Kansas Sunflower corn were planted in the variety trial in 1903. One of these samples, bulletin No. 5, was secured from the Barteldes Seed Company, and the other, bulletin No. 6 was secured from John Moody, Eudora, Kan., the originator of this variety. Our present breeding stock of Kansas Sunflower corn has descended from these two samples. Adjacent plots of each sample were planted in a separate field in 1903, and six of the better ears from the Moody sample were planted in separate rows in an ear-row breeding plot. With only a small number of breeding ears, this first breeding trial was a remarkable success, since it discovered a great individual ear, a high yielder and a prepotent breeder, which after four years of ear-row breeding has become the mother ear of eight out of ten of the largest-producing ears planted in the 1906 ear test No. 1.

The breeding work with the Kansas Sunflower corn has beer less extensive than with other varieties. Only a few of the very choice ears from the highest-producing rows have been pla'nted in the breeding plot each season, until 1906, when a second ear-test plot was started with new ears selected from the general field in 1905. All the breeding ears in ear test No. 1 in 1906 trace directly to two of the six original ears, planted in 1903. Table XX has been prepared in order to illustrate more clearly this method of line breeding and also to present the interesting results of these breeding trials with the Kansas Sunflower corn. This table also presents a simple plan of numbering by which the breeding of an individual ear may be traced back to the original mother ear, namely, cut off the right-hand figure of and ear number and the remaining figures is the number of the mother ear of the previous generation. When more than nine original mother ears are used, a bar should be placed over the digits which indicate the number of such ear, and the bar may be used in the same manner when more than nine ears are selected for breeding stock from the product of a single mother ear. For example: 112310 would be interpreted as follows: Ear No. 112310 was the tenth breeding ear selected from mother ear No.1123, which was the third breeding ear selected from mother ear No. 112, which was the second breeding ear selected from the original mother ear No. 11. New breeding ears which are introduced into the ear test should be numbered in regular order, the same as would have been the case had they been included when the ear test was started. Thus in 1905 thirteen new ears were planted in Kansas Sunflower ear-test

No. 2 and these ears were given numbers as follows: 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19.*

In table XX are given the yield, percentage of good corn, and total grade or score f the corn produced from each ear-test row in each of the four breeding trials. The mother ears for each succeeding generation and the number of breeding ears selected from each mother ear are denoted in separate columns. while the asterisks in table XX mark the mother ears from which no breeding ears were selected for future planting.

The breeding ears for 1907 were planted May 8 a few- weeks before this bulletin was published. Thirty-five ears were selected as shown in table XX, and it will be observed that twenty-seven of these ears trace directly to the highest-producing mother ear, both in 1904 and in 1903, while the other eight ears trace directly to the second highest-producing mother ear in 1903. The record made by these three mother ears indicates that these individual ears not, only had a capacity to produce large yields, but also that they were superior breeders: with power to transmit their desirable characters to succeeding generations. Observe also that the highest-producing ear (No. 2233) in the 1906 ear test has a direct line of descent through each of the highest-producing mother ears of the three preceding generations, while the second highest producing ear (No. 2252) in 1906 traces back through the second highest-producing mother ear in 1905 to the highest-producing mother ears in 1904 and 1903 a further proof that like will produce like with plants as well as with animals, and that the ear-row, method of breeding is an efficient and practical means of improving the breeds of corn.

The reader will observe that the highest ear-row yields were secured in 1903, the first year of the test. However, a comparison of ear-row yields in different seasons can hardly be made with fairness because of the variation in climatic and soil conditions. The field yields for each of the four years, 1903, 1904, 1905, and 1906, have been determined as follows: 66.7 bushels, 44.9 bushels, 54.4 bushels, and 59.3 bushels, respectively. For the past three seasons the Kansas Sunflower corn has been grown on the rotation plots, and the ear-test corn has been planted each year in plots in the same field which have grown corn continuously, but which were not included in the comparative rotation experiment. Since corn after corn has not given as large yields as corn after some

*Not given in table XX.
†Eleven ears were selected from two of the high-producing mother ears in ear-test No. 2, but are not included in table XX.
‡See report of rotation experiments, page 256.

TABLE XX.—Breeding record of Kansas Sunflower corn.

1903.

Ear No.	Yield per acre, bu.
1	75.0
2	95.2
3	67.9
4	58.0
5	76.7
6*	31.7

1904.

Breeding ears, selected from ear No.	Ear No.	Yield per acre, bu.	Percentage of good corn.
1	11*	28.0	75
2	21*	31.3	62
	22	57.1	70
	23*	31.8	78
	24	48.5	76
3	31*	44.8	55
	32*	32.9	82
4	41*	36.7	60
	42*	37.2	65
5	51	44.2	79
	52*	49.6	75

1905.

Breeding ears, selected from ear No.	Ear No.	Yield per acre, bu.	Percentage of good corn.	Total score, per cent.
22	221	48.0	50	75
	222*	44.7	55	70
	223	60.4	51	73
	224*	36.1	55	75
	225	58.8	40	70
24	241*	51.2	50	75
	242*	42.1	49	77
	243*	41.5	45	70
	244*	40.4	41	75
	245*	43.1	44	73
	246*	34.0	65	73
51	511*	42.1	36	70
	512*	43.7	42	74
	513	52.8	53	75

1906.

Breeding ears, selected from ear No.	Ear No.	Yield per acre, bu.	Percentage of good corn.	Total score, per cent.
221	2211*	64.7	79	80
	2212*	59.7	79	86
223	2231	68.4	86	83
	2232	67.1	85	82
	2233	74.6	75	78
	2234*	54.8	71	79
225	2251	68.4	74	73
	2252	74.1	76	81
	2253*	63.1	78	80
	2254	69.6	84	87
513	5131	72.7	76	70
	5132*	62.1	82	78
	5133	68.2	76	70
	5134*	62.9	80	77

1907.

Breeding ears, selected from ear No.	Ear No.
2231	22311
	22312
	22313
	22314
	22315
2232	22321
	22322
	22323
	22324
	22325
2233	22331
	22332
	22333
	22334
2251	22511
	22512
	22513
2252	22521
	22522
	22523
	22524
2254	22541
	22542
	22543
	22544
	22545
	22546
5131	51311
	51312
	51313
	51314
	51315
5133	51331
	51332
	51333

*Discarded the product of this ear and made no selection for further breeding.

other crops, this may have given the rotation experiment field somewhat the advantage of the ear-breeding plots. The average yield of the ear-test plots in 1904 and in 1903 was less than the yield of the general field for the same years, but in 1906 the average yield of ear-test plot No. 1, was 65.5 bushels per acre, or 5.2 bushels more than the average yield of all the rotation plots. (Twenty-four plots; about eight acres.)

OTHER BREEDING TRIALS

The McAuley corn has been bred by the ear-row method for three years, the Boone County White and Legal Tender varieties have been bred two years, and the Hogue Yellow Dent, one year. The results of these trials are interesting, but similar in most respects to those already presented. The White Injun is a cross-bred corn which has not get become sufficiently fixed in type to be called a pure-bred variety.

One feature brought out more strongly by the Boone County White ear test than by the other ear tests is that detasseling is apt to injure the corn and result in a lower yield of less perfect ears from the detasseled rows than may be secured from adjacent tasseled rows. In 1903 the highest yielding ear row (No. 12) was not detasseled, the second and third highest yielding rows (Nos. 2 and 8) were detasseled, while the ear rows (Nos. 4, 6, 7, 1) ranking fourth, fifth, sixth and seventh in yield were not detasseled. It was decided to select breeding ears both from the high yielding tasseled and detasseled rows, and twenty-one ears were selected from the tasseled and twenty-two from the detasseled ear rows for future planting. These ears were carefully arranged in pairs and planted in such order that the ears from the detasseled "mother" rows alternated with the ears from the tasseled "male" rows.

The alternate rows planted with seed from the detasseled rows of the previous season were again detasseled in 1906, while the tassels were left on the rows planted with seed from the tasseled rows of the 1905 ear test. The results were remarkable. The eight highest-producing ear rows in 1906 were the tasseled rows from seed directly descended from tasseled rows, ears 1, 7, 11 and 12 of the 1905 ear test. The yield of these eight highest-producing ear rows ranged from 94.1 to 63.9 bushels per acre, while the highest-producing detasseled row yielded only 61.3 bushels per acre. The average yields were determined as follows:

Yield from the detasseled rows, 44.1 bushels per acre.
Yield from the tasseled rows. 58.2 bushels per acre.
Average yield for ear-test plot, 31.2 bushels per acre.
Average yield for remainder of field (3 acres). 44 bushels per acre.

Similar results, though not so marked, have been observed in other ear tests with other varieties of corn. Many corn breeders have urged the necessity of detasseling part of the breeding ear rows and selecting seed ears from the detasseled plants in order to prevent self-fertilization and to close line-breeding. It appears, however, that actual injury may result from detasseling; at least no great harm will result by allowing the tassels to remain on all desirable plants on all the breeding rows for the first two or three years of ear-row breeding. Later "new blood" should be introduced by planting "new" ears which have been proved desirable in a preliminary ear test, when it may be desirable to detassel some of the better-bred ear rows in order to insure crossing with other desirable ears used as males.

NICE EARS VS "GOOD" BREEDERS

Some farmers object to the use of the score-card in selecting seed-corn, claiming that the "nice" ears of corn which would be scored high by the judge may not be "good" breeders. It is true that the highest scoring ears of corn are not necessarily the best breeders, but it is equally true, as shown by the breeding experiments described above, that high producers are usually high scoring ears, namely, a "nice" ear is not always a "good" breeder, but a "good breeder is always a "nice" ear of corn. Well-formed ears and well-developed kernels, as required by the score-card, are certainly associated with a large yield and a good quality of grain. Moreover, the actual facts, as presented in the ear test, bear out this statement. With few exceptions, the high-yielding corn has always been the corn which scored high. Not only does the record of the breeding show this but the writer made a careful observation on this point last season and in examining some four hundred piles of corn, the product of four hundred different ears of several breeds, it was often easy to observe without scoring the corn that the largest piles contained the breediest and most uniform looking ears.

SUGGESTIONS ON SELECTING AND SAVING SEED-CORN

Although the breeding of corn and the distribution of pure seedcorn by the Experiment Station is a very important step toward the improvement of corn in this State, yet permanent improvement in the yield and quality of this crop will come only through the work of the farmers themselves in the practice of better methods of selecting and saving seed-corn. Many farmers husk corn late in the fall, throw it into cribs where it is exposed to cold, snow, and vermin, and after feeding or selling a large part

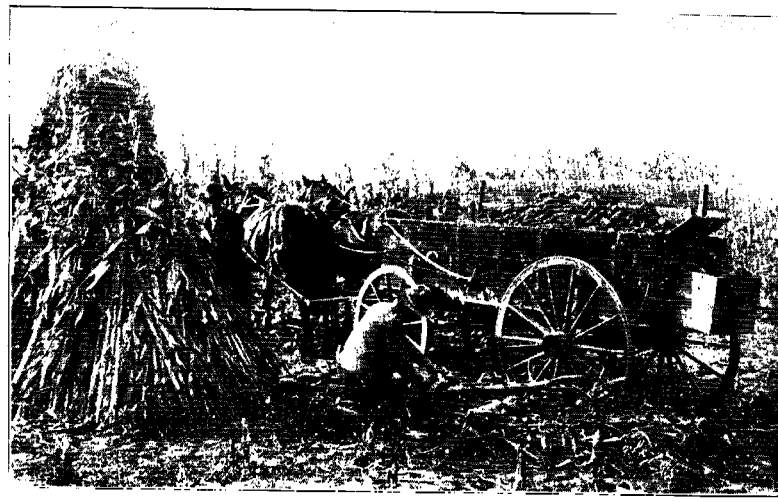


PLATE XIV.—Harvesting the crop—illustrating one method of selecting seed ears.

PLATE XV.—A heap of good seed ears—seed-corn drying racks in rear.

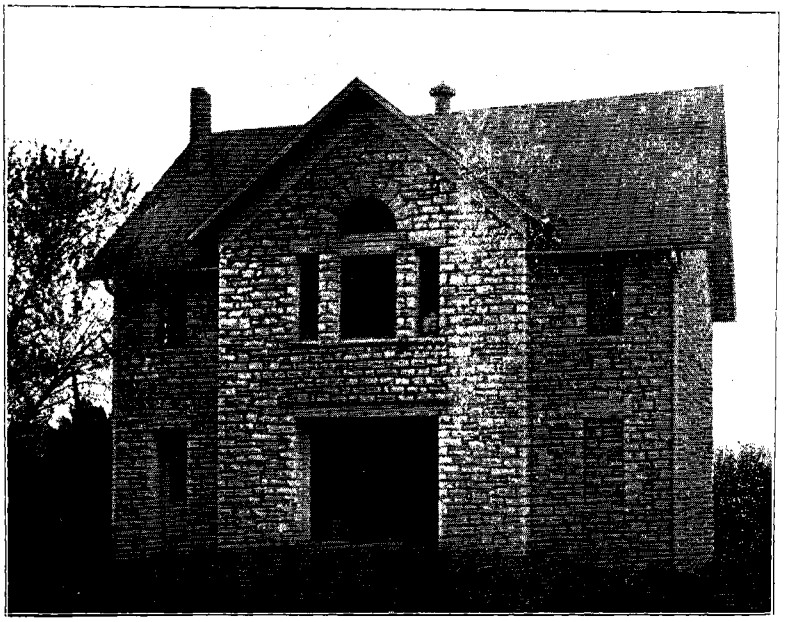


PLATE XVI.—The new seed house at the Kansas State Agricultural College.

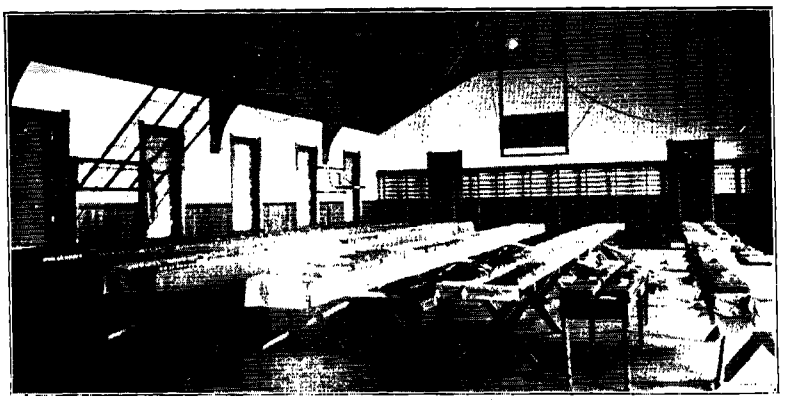


PLATE XVII.—Annual exhibit Boys' State Corn Growing Contest and Kansas Corn Breeders' Association held at the Agricultural College January 1 and 2, 1907. The corn shows and contests have played an important part in the progress of corn improvement.

of the crop they select seed-corn from what is left the following spring, often only a few days before planting. Corn cannot be improved by such a method of seed selection, and many times the farmer is put to a great loss or expense by the fact that the corn sprouts poorly, giving a thin stand or no stand at all, necessitating replanting.

In the breeding of corn it is very important that the seed ears be selected from the field after the corn is fully mature, but before hard freezing weather occurs. Observe the stalk as well as the ear, choosing ears which are placed at a proper height, on vigorous, leafy stalks. Select the large, well-developed ears which bend downward rather than those which point upward, and have very large shanks, making them hard to break off the stalk. On the other hand, ears which have long, slender shanks are not desirable. Select for uniformity in maturity, and if the corn is inclined to be late in maturing, it is well to choose the choice, earlier-maturing ears.

In picking seed-corn it is important to select for a well-developed good type of ear and kernel, but even more care should be taken to select from a good plant, and to select for uniformity in type of stalk, height of ear on stalk, and maturity of corn. A more careful study of corn may be made during the winter, when the farmer has the time, and the choicer ears selected for future planting.

Choose ears which are cylindrical in shape, nine to eleven inches in length, and seven to nine inches in circumference, according to the variety. Do not pick the long, slim ears, because this type of ear invariably has a relatively large cob and shallow kernels. Select ears having straight rows of deep, medium rough, slightly wedge-shaped kernels, and which are well filled at the butts and tips. The corn should be firm on the cob. Avoid ears with smooth kernels, which tend to become round or peg-shaped near the tips of the ears. A smooth ear usually has a shallow kernel, while a deep kernel goes with a rough or medium rough indentation. Kansas Experiment Station Bulletin No. 139, "A Study of Corn," gives further information regarding the selection of seed ears by the use of the score-card.

A good plan to follow in picking seed-corn from the field is to begin selecting several rods from the border of the field. (The corn on the outside of the field is more apt to be crossed with pollen from other fields.) Carry a sack or basket, and examine the ears which appear to be suitable, picking the choicer ears. Take two rows at a time, and at the end of the field empty the

seed ears into sacks or a wagon-box. In this way one man should pick the seed ears from several acres of corn in a day, and if a farmer is picking seed-corn for his own use only, one day's picking should secure an abundant supply of good seed-corn for the next season's planting. If you have a good, pure variety of corn, it will pay you to save plenty of seed. Sort the corn over carefully during the winter, retaining the better ears for your own planting, selling the second grade to your less provident neighbors who have failed to select seed-corn in the fall. There is always a sale for good seed-corn at a fair price.

Seed-corn should be thoroughly dried and kept dry until planting time. Dry corn which is stored in a dry place will not be injured by freezing. Hang the corn in a well-ventilated room. The kitchen attic is a good place to cure seed-corn, or a shed will do, provided birds, chickens, rats, mice and other vermin can be kept from injuring the corn. In a couple of months when the corn is well dried, the ears may be put into sacks and the sacks hung by wires in the attic, tool-house, wood-shed, corn-crib, or any dry place. Do not store seed-corn in the barn or stable, because the corn is apt to absorb moisture and be injured by freezing. Corn breeders who make a business of growing and selling seed-corn will require special rooms and crates or drying racks for curing and handling a large amount of seed-corn.

Seed-corn should not be shelled until near planting time, but early in the spring the germination of the corn should be tested, the poor ears discarded and the good ears shelled and the corn made ready for planting.

TESTING THE GERMINATION

A general test of the vitality of seed-corn may be made by selecting four or five kernels from different parts of a number of ears, say one hundred ears. Imbed these kernels in a box of wet sand or soil and cover with several folds of wet paper, laying boards over the top of the box to retain the moisture. Place the box near the kitchen stove or in a moderately warm place. After four or five days count the kernels which have germinated and in this way determine the percentage of germination. If more than five per cent of the kernels fail to germinate, it is advisable to make a germination test of each ear of corn which you intend to plant.

Make a number of shallow boxes, about two or three inches deep, and from two to four feet square. Fill these even full with sand or soil and stretch small copper wires over the box, nailing the wire at the ends, making rectangles, by crossing the wires,

about two inches square. Number each box, and also introduce a system of numbering the squares, which may be as follows: Each of the horizontal columns may be lettered a, b, c, d, etc., while each of the vertical columns may be numbered 1, 2, 3, 4, 5, etc., according to the number of vertical columns in the box. (See plate XVIII.)

Lay the ears of corn in a row on a floor or table against the wall; beginning at one end of the row remove six kernels from each ear, taking two from near the tip, two from near the middle

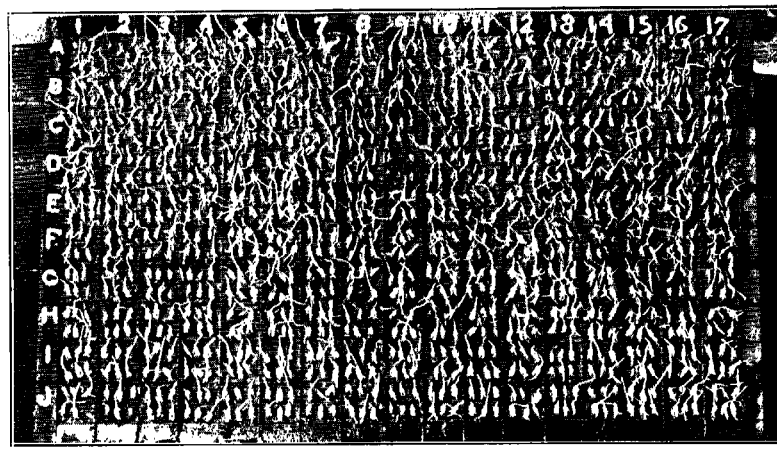


PLATE XVIII.—A germination test of 170 ears of corn.

and two from near the butt of each ear. Place these kernels in one of the squares in the box, taking care to fill the box in regular order, beginning with square a-1, a-2, etc.

When the kernels from each ear in the row have been placed in the germinator in consecutive order, then lay a board or strips of cloth or twine on top of the first row of ears and place a second row above the first, removing the kernels from the ears in the second row and placing them in the germinator in consecutive order, as already described. This method may be repeated until you have built up a rank of corn several ears high. Cover the germinator with two or three folds of wet cloth or paper, after the sand or soil has been thoroughly wet and the kernels have been pressed into it, and over the cloth place boards to prevent the moisture from evaporating.

Set the box in a warm place, and after four or five days examine the corn, noting the number of kernels which have germinated for each square. When more than one of the kernels in a square

fails to germinate. the ear should not be considered fit for planting, and when the test has been completed, remove the corn ear by ear, and tier by tier, referring constantly to your record of the germination, and discard the ears which show a low percentage of germination.

Plate XVIII is a photo-engraving of an actual germination test of one hundred seventy ears of Reid Yellow Dent corn. The photograph was taken on the fourth day after the kernels had been placed in the wet sand. Only fourteen of the one hundred seventy ears tested showed a germination of less than $66^{2}/_{3}$ per cent, namely, two or more kernels out of the six failed to germinate. Some of the ears giving a low percentage of germination were as follows: a-15, b-3, c-17, d-9, g-3, h-8 and i-13. (See plate XVIII) All of these ears were readily found and discarded. Another important point discovered by this test was the fact that the kernels of some of the ears were low in vitality and did not show a strong germination and such ears are often unfit to plant, because when placed under less favorable conditions, kernels of low vitality may fail to germinate. In the above test ears of low vitality were: b-12, c-4, c-12, g-4, h-4, i-2, j-2, and j-6. Altogether twenty-four ears of the one hundred seventy ears tested, or fourteen per cent of the total number, were discarded as unfit to plant. Ninety-three per cent of all the kernels germinated, although some did not show a strong germination, as stated above. It is safe to assume that the discarding of fourteen per cent of the poor seed ears in this lot will have an effect to improve the stand of corn at least ten per cent. The corn tested was a good grade of seed-corn selected from the field.

The Agronomy Department has tested the germination of the kernels of some eleven thousand ears of corn during the past spring. These tests have shown that even in the best seed-corn there are some ears the kernels of which will not germinate, and the ear-test method of germination is the only way in which these ears may be discovered and removed. It will pay every corn grower to carefully test the germination of seed-corn and discard the poor ears before planting.

Summary

1. As a rule the experiments reported in this bulletin have been carried on four years —1903 to 1906, inclusive.

2. During the four years, one hundred twelve varieties of corn have been tested in the trials of varieties. A number of those which have proven superior in productiveness may be named as follows: Hildreth, Kansas Sunflower, McAuley, Forsythe Favorite, Golden Row, Hammett, Leaming, U. S. P. B. Selection No. 77, Hogue's Yellow Dent, Sander's Improved, White Salamander, Red Cob White Dent, White Injun, Legal Tender, Warner, Mammoth Golden Yellow, Dyche, Meinhardt, and Hiawatha Yellow Dent.

3. The number of days required to mature corn in 1905 varied from one hundred twenty-one to one hundred forty-three, with an average period of one hundred twenty-nine days.

4. Of the thirty-five better-producing varieties tested for four years, sixteen varieties which have matured in one hundred twenty-six days or less made an average yield of 61.45 bushels per acre, while nineteen varieties, requiring one hundred twenty-seven or more days to mature, yielded on the average 64.94 bushels per acre. The later-maturing varieties have given somewhat the larger yields.

5. In preparing the seed bed for corn, as an average for the four years, the method of listing early in the spring and splitting the ridges at planting time has given an increased yield of 5.02 bushels per acre when compared with the land which received no early cultivation. The early listing has given better results than early disking, and the listing has also conserved more water in the soil than the disking.

6. In a comparison of methods of planting, as an average for the four seasons, surface-planted corn has yielded 6.65 bushels more corn and 469 pounds more stover per acre than the listed corn. The surface planting has given the best results in the wetter seasons, while the drier seasons favor the listing method of planting.

7. In a single trial in 1905, surface planting with the disk furrow opener attachment gave larger yields in three fields than was secured by ordinary surface planting or listing. The average yields compare as follows: 53.24, 51.94, 48.33 bushels per acre, respectively.

8. The soil-moisture studies in connection with the different methods of planting show without exception, that listing corn favored the conservation of soil moisture in the latter part of the season as compared with surface-planting corn. This may be due in part to the fact that the roots of listed corn lie relatively deeper in the soil, allowing for somewhat deeper cultivation. Also the listed corn was laid by with level cultivation while the level-planted corn was slightly hilled.

9. As an average for two seasons, in an experiment to determine the best date to plant corn, the largest average yields were secured by planting May 26. The May plantings gave larger yields on the average than the April plantings, and the experiments appear to favor rather late planting as compared with early planting of corn.

10. No very definite conclusions may be drawn from the results of the different methods of cultivating corn. The average yields for the four seasons from the several plots have not varied more than might be the case from duplicate plots cultivated by the same method. The small difference in yields indicates that the exact method of cultivation, whether deep or shallow, is not of so great importance as the conditions of soil or season as related to the proper time to cultivate. The soil moisture determinations also show no marked variation in the moisture content of the soil of the several plots.

11. In the comparative trial of fertilizers in 1906, the largest yield of corn, 56.83 bushels per acre, was secured by the application of barn-yard manure at the rate of thirteen tons per acre. The next largest yield, 40.00 bushels per acre, was secured from the plot treated with sodium nitrate. Other commercial fertilizers gave less yields, the unfertilized corn yielding on the average 33.21 bushels per acre.

12. The rotation of corn with other crops has resulted as follows: Corn after potatoes, as an average for the four years, 69.98 bushels per acre; corn after soy-beans, 67.55 bushels per acre; corn after corn, 60.74 bushels per acre; while corn after small grains, wheat, barley, oats, and emmer, has given less yields than corn after corn, but the lowest yields of corn were produced after Kafir-corn and sorghum.

13. In value of total products in four years, the rotation of corn following Kafir-corn has been second, namely, $34.46 per acre. The rotation of corn with potatoes ranked first, $43.47 per acre, while the corn-sorghum rotation ranked third, $31.15 per acre, and corn continuously ranked fourth, $31.07 per acre. In these rotations corn alternated with other crops every other year.

14. The experiment to determine the shrinkage of corn in the crib has been carried on three seasons. A summary of the results show a shrinkage of 3.26 per cent for first four months after the corn was placed in the crib, 5.16 per cent for the first six months, 6.80 per cent for the first eight months, 7.44 per cent for the first ten months, and 8.62 per cent for the first twelve months. Yellow corn has given the greatest average shrinkage, namely, 11.21 per cent in twelve months, the next greatest shrinkage occurring in the cribs of white corn, 8.48 per cent in twelve months, while the mixed corn (samples of many varieties) decreased in weight only 6.18 per cent during the first twelve months after being placed in the crib.

15. The average result of all shrinkage trials indicates that when corn is cribbed fairly dry and in good condition, the shrinkage during the winter months should not be over five per cent. It should be observed, however, that in these experiments great care was exercised to prevent loss of corn by other than natural means.

16. Corn breeding by the ear-row method was begun in 1903. Nine different varieties were grown and bred in 1906, as follows: Reid Yellow Dent, Silvermine, Boone County White, Legal Tender, Hogue Yellow Dent, Hildreth, McAuley, Kansas Sunflower, and White Injun.

17. Some eighty acres were used for breeding corn and growing corn for seed production in 1906, and four hundred forty breeding ears were planted in separate rows in the several breeding plots. During the last two years the Agronomy Department has sold and distributed among the farmers of the State several hundred bushels of selected, well-bred seed-corn.

18. The difference in the yields from different ear rows have been very marked, varying in some tests more than four hundred per cent. Comparisons made in 1906 between the high-yielding-rows seed and first-grade seed selected from the general field gave results as follows: The Silvermine high-yielding-rows seed-plot yielded 32 per cent more corn and 24.8 per cent more first-grade seed ears than the plot planted with first-grade seed. The Hildreth high-yielding-rows seed-plot yielded 10.36 per cent more corn and 40 per cent more first-grade seed ears than the plot planted with first-grade seed of this variety. There has been a similar improvement in the grade and quality of the corn.

19. This breeding work has proven that there are great individual ears of corn which are better breeders and better producers than other ears of the same variety, which may become the foun-

dation stock for improved strains of a particular breed or variety. For instance, after four years breeding, all of our breeding stock of Kansas Sunflower corn traces back to two original mother ears.

20. Germination tests indicate that ears of corn vary greatly in vitality, even when the seed has been well selected and preserved. It will pay the farmer, as a rule, to make a germination test of each ear of seed-corn which he intends to plant in order to discover and remove the ears of low vitality.

ACKNOWLEDGMENTS

Mr. David H. Zuck, farm foreman, has had charge of much of the field work of the experiments reported in this bulletin. Asst. V. M. Shoesmith resigned in December, 1906, and was succeeded by M. D. Snodgrass, who was employed as special assistant in crop work in 1906. Mr. Snodgrass has given valuable assistance in preparing the data for the ground work of this bulletin, especially that relating to corn breeding.

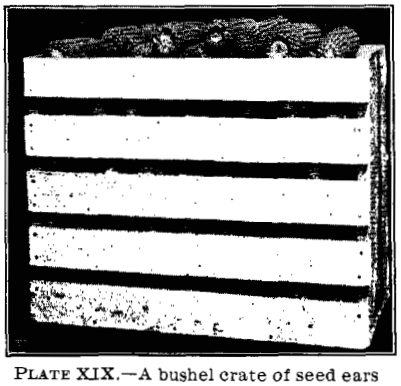


PLATE XIX.—A bushel crate of seed ears

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