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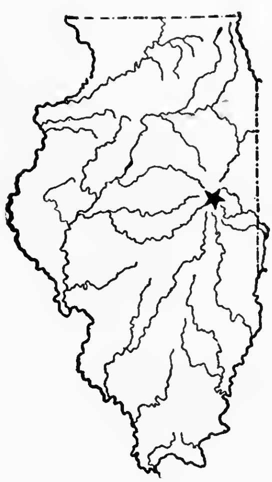
DIRECTIONS FOR THE BREEDING OF CORN, INCLUDING METHODS FOR THE PREVENTION OF IN-BREEDING

By CYRIL G. HOPKINS, LOUIE H. SMITH, and EDWARD M. EAST.



URBANA, ILLINOIS, MARCH, 1905.

Summary of Bulletin No. 100.

1. Nine years of corn breeding at the Illinois Experiment Station have proven the possibilities of corn improvement in both yield and quality. Page 601.

2. The investigations have shown that continued cross-breeding by detasseling alternate rows in the breeding plot increases the yield of corn more than 10 bushels after the first year. Page 610.

3. A method has been worked out and adopted which gives a perpetual system of planting designed to avoid in-breeding. Page 617.

4. All seed corn selected is produced by cross-breeding. Page 616.

5. Breeding plots should be started with the best obtainable seed corn. It is recommended that ninety-six ears be planted in the breeding plot. Plant by the row system, that is, corn from a single ear in each row. Page 614.

6. Examination of seed corn for improvement in composition may be made by mechanical methods described. Page 611.

7. The Experiment Station offers to analyze composite samples of the seed and crop from breeding plots for systematic corn breeders of Illinois. Page 614.

8. Plant corn from detasseled rows, according to a guide system for both "sire" and "dam" seed. Detassel all even-numbered rows. Select seed only from the best-yielding detasseled rows. Page 619.

9. Mix all good selected seed not required for the breeding plot, and plant in a multiplying plot. Page 621.

10. Plant commercial fields, from which to sell pedigreed seed corn, from the best seed obtained from the multiplying plot. Page 621.

11. Keep a pedigree register of all seed ears planted and of all rows harvested in the breeding plot. The Experiment Station will furnish blank forms to any Illinois farmer who wishes to become a seed corn breeder. Page 620.

12. The Illinois Agricultural Experiment Station has no seed corn for sale. Page 623.

13. This bulletin will be sent free of charge to any one interested in Illinois agriculture upon request to E. Davenport, Director, Agricultural Experiment Station, Urbana, Illinois; and, if so requested, the name of the applicant will be placed upon the permanent mailing list of the Experiment Station, so that all bulletins will be sent to him as they are issued.

DIRECTIONS FOR THE BREEDING OF CORN, INCLUDING METHODS FOR THE PREVENTION OF IN-BREEDING

By CYRIL G. HOPKINS, Chief in Agronomy, LOUIE H. SMITH, Chief Assistant in Plant Breeding, and EDWARD M. EAST, First Assistant in Plant Breeding.

It is now nine years since one of the writers began investigations with a view to the improvement of corn by breeding. Credit belongs to Dr. T. J. Burrill and to Director Eugene Davenport for the original suggestions as to the possibilities of such improvement and its importance to the industries related to corn. The investigations have included the breeding of corn for increased yield and for improved quality; and the results which have been achieved have far surpassed our original expectations; for not only was it discovered and clearly established that corn could be bred for increased power to yield and for higher protein content or higher oil content, as may be desired, but, as soon as these practical scientific facts were fully ascertained and the methods of corn breeding worked out, progressive seed corn growers of Illinois united themselves into the world's first seed corn breeders association, and at once began the business of corn breeding on a commercial scale. Subsequently seed corn breeders associations have been organized in nearly every important corn-growing state.

The Illinois Seed Corn Breeders Association was organized in 1900 and began breeding corn in 1901. At the same time the Illinois Experiment Station began searching for possible obstacles, or improvements, in the methods of corn breeding which we had employed, and which had been adopted by the commercial corn breeders. The most important improvement which we have thus far made in the system of corn breeding is that which relates to the prevention of in-breeding.

In the row system of corn breeding, in which each field row is planted with seed from a separate ear, the performance record of the plants from each individual seed ear can be observed and accurately measured; and it thus becomes possible to base our subsequent seed selected upon the performance records of the progeny from individual mother ears.

In this system of planting we not only have the usual possibility of corn being self-pollinated, but we have an unusual possibility of considerable corn being close-pollinated. (In self-pollination the pollen from a given tassel falls upon the silk of the same plant. In close-pollination the pollen from a given plant falls upon the silk of another plant in the same row, both of which grew from seed from the same mother ear. In cross-pollination the pollen from the tassel of one plant falls upon the silk of another plant in a different field row, which grew from seed from a different mother ear.)

Because of the well-known principle, established by the investigations of Darwin and others, that injurious effects are produced from the self-pollination of plants which are naturally cross-pollinated, many investigators have conducted miscellaneous detasseling experiments in corn growing, during the past twenty years or more. The plan commonly followed has been to detassel alternate rows in an ordinary corn field and to compare the yields of the tasseled and detasseled rows. The combined data from all such experiments point to no marked effect produced by detasseling.

In the investigations which we have carried on at the Illinois Station during the past four years, including one year's work on a small scale, we have systematically detasseled the even-numbered rows in breeding plots and have then successively planted the even-numbered rows with seed selected from the best detasseled rows and have planted the odd-numbered rows with seed selected from the highest yielding tasseled rows. For three years this system has been practised on two large breeding plots, containing 44 field rows in each plot,* the two plots being conducted entirely independent of each other. The system in each of these plots is really a double system, one set of 22 rows being conducted without detasseling, in all respects like an independent breeding plot of 22 rows, the seed being saved each year from the 10 highest yielding rows. But alternating with these tasseled rows were detasseled rows of corn, which however could scarcely exert any influence upon the breeding of the tasseled rows.

On the other hand, the 22 detasseled rows are necessarily cross-bred each year, although it should be borne in mind that the pollen for these detasseled rows was always furnished by the 22 tasseled rows, which are themselves becoming more or less in-bred. If benefits are produced from this imperfect system of cross-breeding, which we were compelled to adopt in order to obtain comparative data from alternating rows in the same field, it seems probable that even greater benefit will result from a practical commercial system which we have now adopted in which the seed for both sire and dam is cross-bred. The results obtained from three years' work with these two large breeding plots are given in detail in Tables 1 to 6.

For detailed comparison there are given from every individual row in each plot in each year the actual yield, the actual increase in yield,

*Only 40 rows the first year.

the percent of stand, and the yield and increase in yield calculated to 100 percent stand. Where there was a lower yield from the detasseled row it is indicated by the minus (—) sign. There is also given the average of the tasseled rows and of the detasseled rows, for each plot and for each of the three years, 1902, 1903, and 1904. The register number and the dam number of each seed ear are given. These numbers also show the field row in which each ear grew, the row in which each seed ear is planted, and the number of years it has been bred, as fully explained in the following pages.

For example the last row in the high-protein plot in 1904 (see Table 3) produced 100.8 bushels of corn, actual yield per acre, with 96.4 percent stand, which would make 104.6 bushels if calculated to 100 percent stand. The register number of the seed ear which was planted in this row is 344, which means year 3 in the history of its breeding and row 44 in which it was planted. This seed ear was produced the previous year (year 2 of its breeding) in row 34 of the breeding plot as shown by the dam number 234. Referring to Table 2 we find that row 34 produced 80.8 bushels of corn per acre in 1903, and that ear 234 grew in row 12 the previous year, as shown by the dam number 112. In Table 1 we see that row 12 produced 88.5 bushels of corn per acre in 1902. Thus we have the complete pedigree:

Ear No. 344 (in year 3, row 44) produced 100.8 bushels. The dam, Ear No. 234 (in year 2, row 34) produced 80.8 bushels. The grand dam, Ear No. 112 (in year 1, row 12) produced 88.5 bushels.

The results reported in columns 3 and 6 in the tables, under the heading "Bushels increase by detasseling" are obtained by comparing the weight of each row with the average of the two adjoining rows, except with the first and last rows, which are compared with the one adjoining row.

TABLE 1. EFFECT OF DETASSELING; FIRST YEAR'S BREEDING.
High-Protein Leaming; Mechanical Selection; Grown in 1902.

Dam No.	Register No.	Calculated to actual stand. Corn, bushels per acre.	Calculated to actual stand. Bushels increase by detasseling.	Percent of stand.	Calculated to 100 percent stand. Corn, bushels per acre.	Calculated to 100 percent stand. Bushels increase by detasseling.
	101	81.8	-7.5	97.5	83.9	-5.3
	102	74.3	-7.9	94.5	78.6	-5.9
	103	82.5	-3.6	97.0	85.1	-3.9
	104	83.5	**4.9**	99.6	83.8	**3.4**
	105	74.6	**8.5**	98.7	75.6	**14.3**
	106	82.6	**2.1**	96.2	85.9	**3.8**
	107	86.4	-2.1	97.5	88.6	-0.9
	108	86.0	**3.2**	96.2	89.4	**1.3**
	109	79.1	**6.7**	90.3	87.6	**0.3**
	110	85.6	**5.4**	99.1	86.4	**0.7**
	111	81.3	**5.8**	97.0	83.8	**4.4**
	112	88.5	**5.3**	98.3	90.0	**5.5**
	113	85.1	**3.2**	100.0	85.1	**4.3**
	114	88.0	**6.2**	99.1	88.8	**6.9**
	115	78.4	**8.1**	99.6	78.7	**8.8**
	116	85.0	**3.5**	98.7	86.1	**4.1**
	117	84.5	-1.4	99.1	85.3	**0.1**
	118	87.1	-1.7	96.2	84.3	-3.5
	119	81.1	**4.1**	89.8	90.3	-3.1
	120	89.2	**5.6**	99.1	90.0	**1.7**
	121	86.0	**3.3**	99.6	86.3	**3.4**
	122	89.4	**2.4**	100.0	89.4	**2.2**
	123	88.0	-1.2	100.0	88.0	-0.5
	124	84.1	-3.6	98.3	85.6	-7.5
	125	87.3	-2.4	89.0	98.1	-12.3
	126	85.6	**1.7**	99.6	85.9	-3.9
	127	80.4	**5.9**	98.7	81.5	**6.7**
	128	86.9	**6.5**	96.2	90.3	**7.0**
	129	80.4	**5.2**	94.5	85.1	**2.7**
	130	84.2	**4.8**	98.7	85.3	**1.3**
	131	78.3	**2.0**	94.5	82.9	-2.1
	132	76.3	-1.8	100.0	76.3	-5.5
	133	77.9	**2.8**	96.6	80.6	**0.7**
	134	85.1	**2.7**	98.7	86.2	**2.0**
	135	86.9	-3.9	99.1	87.7	-3.5
	136	80.8	-4.6	98.3	82.2	-3.8
	137	83.9	-4.3	99.6	84.2	-2.0
	138	78.3	-6.7	95.3	82.2	-4.1
	139	86.1	-6.0	97.5	88.3	-6.2
	140	81.9	-4.2	100.0	81.9	-6.4
Average of detasseled,		84.1			85.4	
Average of tasseled,		82.5			85.3	
Average increase,		1.6			0.1	

TABLE 2.—EFFECT OF DETASSELING; SECOND YEAR'S BREEDING.
High-Protein Leaming; Mechanical Selection; Grown in 1903.

Dam No.	Register No.	Calculated to actual ctand.		Percent of stand.	Calculated to 100 percent stand.	
		Corn, bushels per acre.	Bushels increase by detasseling.		Corn, bushels per acre.	Bushels increase by detasseling.
103	201	63.3	−2.9	98.6	64.2	−1.8
122	202	60.4	**3.2**	96.8	62.4	**2.2**
117	203	51.0	**14.5**	90.9	56.1	**11.4**
108	204	70.5	**17.9**	97.3	72.5	**16.1**
135	205	54.1	**16.2**	95.5	56.7	**15.2**
114	206	70.0	**12.6**	98.2	71.3	**11.8**
103	207	60.6	**12.3**	97.3	62.3	**11.6**
126	208	75.7	**15.9**	99.1	76.4	**14.7**
117	209	58.9	**14.0**	96.4	61.1	**12.6**
108	210	70.0	**12.9**	98.6	71.0	**11.1**
135	211	55.2	**13.9**	94.1	58.7	**12.1**
114	212	68.1	**6.0**	96.4	70.6	**6.0**
107	213	68.9	**3.6**	97.7	70.5	**5.2**
126	214	76.8	**23.6**	95.0	80.8	**8.8**
121	215	37.4	**39.9**	50.9*	73.5	**7.4**
108	216	77.7	**26.1**	95.9	81.0	**9.9**
137	217	65.8	**9.9**	95.9	68.6	**9.2**
116	218	73.6	**8.7**	98.6	74.6	**7.1**
107	219	63.9	**6.6**	96.4	66.3	**6.2**
128	220	67.4	−1.9	95.9	70.3	−0.6
121	221	74.7	−4.0	99.1	75.4	−2.7
110	222	74.0	**8.2**	98.6	75.0	**7.9**
137	223	56.8	**16.0**	96.8	58.7	**16.1**
116	224	71.5	**2.2**	95.9	74.6	**2.6**
107	225	81.8	−5.4	95.9	85.3	−6.6
128	226	81.3	**12.2**	98.2	82.8	**9.9**
123	227	56.3	**19.5**	93.2	60.4	**17.5**
110	228	70.3	**10.4**	96.4	72.9	**9.3**
139	229	63.4	**10.6**	95.0	66.7	**9.7**
120	230	77.7	**18.6**	97.3	79.9	**17.5**
113	231	54.8	**16.5**	94.5	58.0	**16.1**
134	232	64.9	**4.7**	95.0	68.3	**4.6**
125	233	65.6	**7.3**	94.5	69.4	**5 4**
112	234	80.8	**22.2**	99.5	81.2	**18.8**
123	235	51.5	**21.4**	93.2	55.3	**18.7**
120	236	64.9	**3.2**	97.3	66.7	**2.8**
139	237	71.8	−4.1	99.1	72.5	−3.5
112	238	69.4	**6.5**	97.3	71.3	**7.1**
125	239	53.9	**13.3**	96.4	55.9	**13.2**
120	240	65.0	**4.5**	97.3	66.8	**4.5**
113	241	67.1	**2.3**	97.7	68.7	**3.4**
134	242	73.8	**9.5**	95.5	77.3	**8.3**
139	243	61.4	**16.1**	98.6	69.3	**10.7**
122	244	81.2	**19.8**	98.2	82.7	**13.4**
Average of detasseled,		72.0			74.1	
Average of tasseled,		61.9			64.8	
Average increase,		10.1			9.3	

* Yields discarded from average (one row).

TABLE 3.—EFFECT OF DETASSELING; THIRD YEAR'S BREEDING.
High-Protein Leaming; Mechanical Selection; Grown in 1904.

Dam No.	Register No.	Calculated to actual stand.		Percent of stand.	Calculated to 100 percent stand.	
		Corn, bushels per acre.	Bushels increase by detasseling.		Corn, bushels per acre.	Bushels increase by detasseling.
219	301	81.5	9.4	97.7	83.4	8.8
214	302	90.9	12.3	98.6	92.2	11.1
213	303	75.7	13.2	98.2	77.1	14.8
244	304	86.9	10.6	95.0	91.5	10.9
201	305	76.8	16.7	91.4	84.0	12.5
208	306	100.0	20.2	98.6	101.4	16.2
241	307	82.8	12.3	95.9	86.3	10.3
234	308	90.1	10.5	98.2	91.8	9.2
217	309	76.3	13.0	96.8	78.8	12.0
242	310	88.5	21.9	98.6	89.8	6.1
233	311	56.8	33.2	64.1*	88.6	2.7
208	312	91.5	22.2	98.6	92.8	4.4
213	313	81.8	12.2	92.7	88.2	9.5
244	314	96.5	17.2	94.1	102.6	18.5
237	315	76.7	16.0	95.9	80.0	16.4
222	316	88.9	4.3	98.6	90.2	3.5
225	317	92.5	−0.2	99.1	93.3	0.7
214	318	95.6	7.8	97.7	97.8	8.6
229	319	83.0	9.4	97.7	85.0	9.3
242	320	89.2	8.4	98.2	90.8	7.9
221	321	78.6	5.6	97.3	80.8	6.7
216	322	79.2	−0.2	94.1	84.2	1.6
225	323	80.1	7.7	95.0	84.3	7.4
222	324	96.4	12.6	97.3	99.1	11.3
219	325	87.5	6.5	95.9	91.2	5.0
230	326	91.6	8.5	98.2	93.3	5.9
229	327	78.7	14.1	94.1	83.6	10.9
218	328	94.0	11.0	98.2	95.7	9.2
237	329	87.2	6.8	97.7	89.3	6.7
226	330	94.0	5.0	97.7	96.2	5.5
221	331	90.7	0.8	98.6	92.0	1.9
218	332	89.0	4.6	97.3	91.5	5.6
213	333	78.0	16.9	97.7	79.8	17.3
234	334	100.8	20.7	98.2	102.7	20.1
217	335	82.2	16.7	96.4	85.3	15.7
214	336	97.0	11.6	97.7	99.3	10.5
241	337	88.5	−0.1	95.9	92.3	2.9
230	338	79.8	−12.1	87.7	91.0	−4.1
201	339	95.2	−8.4	97.3	97.8	−4.1
226	340	93.7	5.0	97.3	96.3	5.0
233	341	82.1	6.5	96.8	84.8	9.3
216	342	83.5	5.1	90.9	91.9	10.7
219	343	74.7	17.5	96.4	77.5	20.8
234	344	100.8	26.1	96.4	104.6	27.1
Average of detasseled,		91.7			94.9	
Average of tasseled,		82.4			85.4	
Average increase,		9.3			9.5	

* Yields discarded from average (one row).

TABLE 4.—EFFECT OF DETASSELING; FIRST YEAR'S BREEDING.
Low-Protein Leaming; Mechanical Selection; Grown in 1902.

Dam No.	Register No.	Calculated to actual stand.		Percent of stand.	Calculated to 100 percent stand.	
		Corn, bushels per acre.	Bushels increase by detasseling.		Corn, bushels per acre.	Bushels increase by detasseling.
	101	45.6	−4.0	80.5	56.6	**5.2**
	102	41.6	−13.3	67.3*	61.8	−2.9
	103	64.1	−17.1	88.1	72.8	−11.0
	104	52.3	−12.2	84.7	61.8	−11.1
	105	64.8	−6.8	88.9	72.9	−7.5
	106	63.7	−1.9	92.3	69.0	−4.4
	107	66.4	−3.5	90.0	73.8	−2.9
	108	62.0	−1.4	85.2	72.8	**1.4**
	109	60.4	−2.7	87.7	69.8	**1.8**
	110	53.4	−6.1	77.9*	68.5	−26.0
	111	58.5	−4.5	48.7*	120.1	−53.2
	112	54.5	−2.6	83.5	65.3	−30.5
	113	55.7	**2.5**	77.9*	71.5	−3.9
	114	61.8	**5.9**	88.6	69.8	**0.4**
	115	56.1	**5.5**	83.5	67.2	**1.6**
	116	61.4	−1.7	90.7	67.7	−3.3
	117	70.0	−10.7	93.6	74.8	−7.4
	118	57.2	−12.3	85.2	67.1	−11.6
	119	71.0	−12.1	86.0	82.6	−13.8
	120	60.6	**2.9**	86.0	70.5	−9.6
	121	44.3	**11.1**	57.2*	77.5	−13.7
	122	50.1	**5.3**	87.7	57.1	−19.2
	123	45.2	**10.5**	60.2*	75.1	−11.3
	124	61.2	**16.1**	86.9	70.4	**1.6**
	125	45.0	**10.6**	72.0*	62.5	**5.0**
	126	50.0	**4.6**	77.5*	64.5	**4.8**
	127	45.8	**2.8**	80.5	56.9	**7.4**
	128	47.2	**2.8**	73.7*	64.0	−0.6
	129	42.9	**4.9**	59.3*	72.3	−11.4
	130	48.4	**0.0**	83.9	57.7	−14.0
	131	53.8	−8.8	75.8*	71.0	−12.3
	132	41.5	−17.4	69.5*	59.7	−11.9
	133	64.0	−18.0	88.6	72.2	−17.6
	134	50.4	−10.5	84.7	59.5	−0.7
	135	57.7	−5.7	84.7	68.1	−6.1
	136	53.6	−4.9	83.1	64.5	−5.2
	137	59.2	−4.3	83.1	71.2	−5.2
	138	56.1	−5.7	83.1	67.5	−6.3
	139	64.4	−7.9	84.3	76.4	−4.3
	140	56.8	−7.6	74.1*	76.7	**0.3**
Average of detasseled,		56.6			65.8	
Average of tasseled,		60.7			70.4	
Average increase,		−5.9			−5.4	

* Yields discarded from average (thirteen rows).

TABLE 5.—EFFECT OF DETASSELING; SECOND YEAR'S BREEDING.
Low-Protein Leaming; Mechanical Selection; Grown in 1903.

Dam No.	Register No.	Calculated to actual stand.		Percent of stand.	Calculated to 100 percent stand.	
		Corn, bushels per acre.	Bushels increase by detasseling.		Corn, bushels per acre.	Bushels increase by detasseling.
103	201	59.4	24.3	72.7*	81.7	7.2
114	202	83.7	24.9	94.1	88.9	16.2
109	203	58.2	24.9	91.4	63.7	27.8
124	204	82.5	11.9	87.7	94.1	15.0
119	205	85.0	6.5	90.0	94.4	3.8
106	206	100.4	23.1	98.2	102.2	6.8
103	207	69.6	15.6	72.3*	96.3	1.1
116	208	69.9	–2.6	75.5*	92.6	5.3
109	209	75.4	9.9	96.4	78.2	18.1
124	210	100.7	16.2	100.0	100.7	10.1
133	211	93.6	–5.9	90.9	103.0	–10.1
106	212	74.6	–7.9	87.7	85.1	–7.1
111	213	71.3	12.4	87.7	81.3	8.2
138	214	92.7	35.3	96.8	95.8	29.7
105	215	43.4	59.3	85.5	50.8	54.2
108	216	112.6	52.9	98.6	114.2	48.0
111	217	76.0	27.2	93.2	81.5	24.3
116	218	93.8	12.2	96.4	97.3	8.1
133	219	87.2	1.4	90.0	96.9	9.4
108	220	83.3	24.9	72.3*	115.2	18.4
137	221	29.5	64.4	30.5*	96.7	16.6
118	222	104.5	45.8	94.1	111.1	15.4
105	223	87.8	11.7	92.7	94.7	10.8
138	224	94.4	19.3	94.5	99.9	1.7
107	225	62.4	33.3	61.4*	101.6	–0.1
116	226	96.9	22.9	94.1	103.0	–6.9
137	227	85.5	4.3	94.5	90.5	5.2
114	228	82.6	0.2	93.6	88.3	3.0
117	229	79.3	3.0	99.1	80.0	8.1
120	230	81.9	2.7	93.2	87.9	3.7
109	231	79.0	2.6	89.5	88.3	1.8
106	232	81.3	3.7	88.2	92.2	–6.9
139	233	76.2	14.6	92.7	82.2	16.2
120	234	100.2	32.4	95.9	104.5	18.0
139	235	59.4	27.7	65.5*	90.7	9.4
112	236	73.9	–0.5	77.3*	95.6	4.0
117	237	89.4	–6.0	96.8	92.4	3.6
140	238	92.9	7.0	96.4	96.4	3.0
107	239	82.3	13.1	87.3	94.3	6.4
118	240	97.8	32.4	93.2	104.9	13.6
139	241	48.5	15.4	55.0*	88.2	26.5
112	242	30.0	–10.4	24.1*	124.5	25.8
119	243	32.2	30.6	29.5*	109.2	1.5
140	244	95.5	63.3	98.6	96.9	–12.3
Average of detasseled,		92.7			98.0	
Average of tasseled,		78.0			84.8	
Average increase,		14.7			14.2	

* Yields discarded from average (eleven rows).

TABLE 6.—EFFECT OF DETASSELING; THIRD YEAR'S BREEDING.
Low-Protein Leaming; Mechanical Selection; Grown in 1904.

Dam No.	Register No.	Calculated to actual stand: Corn, bushels per acre.	Calculated to actual stand: Bushels increase by detasseling.	Percent of stand.	Calculated to 100 percent stand: Corn, bushels per acre.	Calculated to 100 percent stand: Bushels increase by detasseling.
219	301	56.3	**16.9**	90.0	62.6	**12.3**
210	302	73.2	**14.2**	97.7	74.9	**10.8**
231	303	61.7	**17.3**	94.1	65.6	**15.6**
226	304	84.7	**25.4**	96.8	87.5	**23.6**
205	305	56.8	**22.1**	91.4	62.1	**19.9**
244	306	73.1	**9.9**	95.5	76.5	**8.2**
219	307	69.6	**1.1**	93.6	74.4	**0.5**
234	308	68.2	−0.4	93.2	73.2	−1.0
227	309	67.5	**6.7**	91.4	73.9	**3.9**
224	310	80.2	**14.3**	97.3	82.4	**11.0**
231	311	64.3	**14.5**	93.2	68.8	**12.5**
218	312	77.3	**4.3**	96.4	80.2	**3.0**
237	313	81.7	−11.5	95.5	85.5	−5.3
244	314	63.0	−12.0	78.6*	80.2	**0.8**
211	315	68.3	**3.9**	93.2	73.3	**9.9**
234	316	81.3	**16.6**	94.6	85.9	**15.3**
223	317	61.1	**24.0**	90.0	67.9	**20.9**
218	318	88.8	**18.5**	96.8	91.7	**15.3**
229	319	79.5	**1.3**	93.6	84.9	−1.3
224	320	72.8	−0.6	96.4	75.5	−2.4
233	321	67.3	**14.7**	95.0	70.8	**12.6**
210	322	91.2	**23.4**	100.0	91.2	**19.1**
239	323	68.3	**20.2**	93.2	73.3	**17.0**
226	324	85.7	**29.7**	95.9	89.4	**11.7**
205	325	43.7	**42.4**	53.2*	82.1	**8.5**
240	326	86.4	**28.8**	94.1	91.8	**13.1**
219	327	71.4	**9.2**	95.0	75.2	**9.0**
222	328	74.8	**5.9**	97.7	76.6	**4.7**
227	329	66.4	**15.5**	96.8	68.6	**14.9**
206	330	89.0	**26.1**	98.6	90.3	**24.3**
231	331	59.3	**18.9**	93.6	63.4	**23.0**
226	332	67.4	−0.6	81.8	82.4	**11.1**
237	333	76.7	−1.8	96.8	79.2	**5.6**
240	334	82.4	**9.2**	96.4	87.1	**10.2**
211	335	69.7	**15.4**	93.6	74.5	**13.6**
216	336	87.8	**20.3**	98.6	89.0	**17.3**
223	337	65.2	**17.9**	94.6	68.9	**16.5**
210	338	78.4	**6.9**	95.9	81.8	**7.0**
229	339	77.8	**4.4**	96.4	80.7	**4.8**
222	340	85.9	**9.3**	96.4	89.1	**7.7**
233	341	77.3	**5.8**	94.1	82.1	**5.7**
206	342	80.2	**2.3**	92.7	86.5	**4.7**
239	343	78.5	**3.6**	96.4	81.4	**6.0**
216	344	83.9	**5.4**	95.0	88.3	**6.9**
Average of detasseled,		80.6			84.3	
Average of tasseled,		68.8			73.2	
Average increase,		11.8			11.1	

* Yields discarded from average (two rows).

A study of the yields of individual rows shows results similar to those commonly obtained in corn breeding; namely, that each separate mother ear possesses a distinct individuality which is stamped upon the offspring, as shown by the performance record when the yield is measured. Thus, in the high-protein plot in 1902 row 5 produced 74.6 bushels and row 7 produced 86.4 bushels per acre; and in 1904 row 22 produced 79.2 bushels and row 24 produced 96.4 bushels per acre.

In the high-protein plot in 1902 the average of all tasseled rows is 82.5 bushels, and the average of all detasseled rows is 84.1 bushels, showing an average increase of 1.6 bushels in favor of detasseling. On the low-protein plot the average increase was minus 5.9 bushels. Thus, the first year's results are similar to those commonly reported from a single year's experiment in detasseling corn, no uniform effect being produced. On the contrary, we have obtained some very striking results in 1903 and 1904, when we have the effects due to breeding for one year and two years, respectively. In 1903 the average yield of 44 tasseled rows (including both plots) was 70.0 bushels, while 82.4 bushels was the average yield from the 44 detasseled rows, an average increase of 12.4 bushels in favor of detasseling. In 1904 the corresponding yields were 75.6 bushels and 86.2 bushels of corn per acre, making an average increase of 10.6 bushels in favor of detasseling.

This evidence in favor of detasseling the rows which are to furnish future seed seems so conclusive that we are now detasseling alternate rows in our corn breeding plots, and selecting all seed ears from detasseled rows only; and, in order to obtain the greatest possible benefit from cross-breeding of plants of no relation or of the most distant relation, we have worked out and adopted a mathematical arrangement of seed ears for planting which is designed continuously to maintain these desirable conditions.

Corn improvement should embrace both quantity and quality. But, because of the great importance of increased yield per acre, all selection looking toward improvement should be first based upon yield, this to be followed, so far as practicable, with efforts which aim toward higher standards of quality. It is with these ideas that the following methods for corn breeding are arranged.

PHYSICAL SELECTION OF SEED CORN.

The most perfect ears obtainable of the variety of corn which it is desired to breed should be selected. As a rule, these seed ears should be obtained from some reliable seed corn breeder in preference to starting with unknown and unimproved corn.

In making the selection for desirable ears, as judged from the physical characteristics, the larger the number of ears examined the better can be the selection. If the breeder wishes to improve the quality (chemical composition) of the grain, as well as the yield and type of his corn, it is recommended that he choose at least 200 ears of the desired physical type to be further examined as to quality.

CHEMICAL SELECTION BY MECHANICAL EXAMINATION.

The following table fairly illustrates the results obtained by the use of the method of mechanical examination in the selection of high-protein seed ears.

TABLE 7.—RESULTS OF SELECTION FOR PROTEIN IN CORN BY METHOD OF MECHANICAL EXAMINATION.

Selected by	Total number ears examined.	Ears selected as high in protein.		Ears Rejected as not high in protein.	
		Number of ears.	Ave. % protein.	Number of ears.	Ave. % protein.
Ill. Exp. Station (1902)	200	42	12.14	42*	10.67
Ralph Allen (1902)	165	15	13.56	150	12.10
Ralph Allen (1903)....	225	15	13.15	210	11.51
A. L. Woodhams	187	36	11.59	151	10.29
Hunt Bros.	200	40	10.94	160	10.88
William Berg	200	25	11.59	175	11.29
H. A. Winter	134	26	11.37	108	10.78
W. G. Griffith	(?)	24	10.64	(?)	9.94
Ohio Exp. Station.	4 bushels	14	11.71	(?)	9.70

*Selected for low protein from same lot of 200 ears.

The success of this method in the hands of several practical farmers is demonstrated. We notice that in every case there was a gain made in average protein content of the selected ears, and in some of these cases the gains were very decided.

METHOD OF MECHANICAL EXAMINATION.

The method of making a chemical selection of ears of seed corn by a simple mechanical examination of the kernels is based upon the fact that the kernel of corn is not homogeneous in structure, but consists of several distinct and readily observable parts of markedly different chemical composition. (See Plates 1 and 2.) For a complete detailed study of "The structure of the corn kernel and the composition of its different parts," see Bulletin No. 87.

For our particular purpose of judging from the structure of the kernel as to its composition, we need consider but three principal parts, namely:

HIGH-PROTEIN KERNELS (Much horny part; little white starch). | LOW-PROTEIN KERNELS (Little horny part; much white starch).

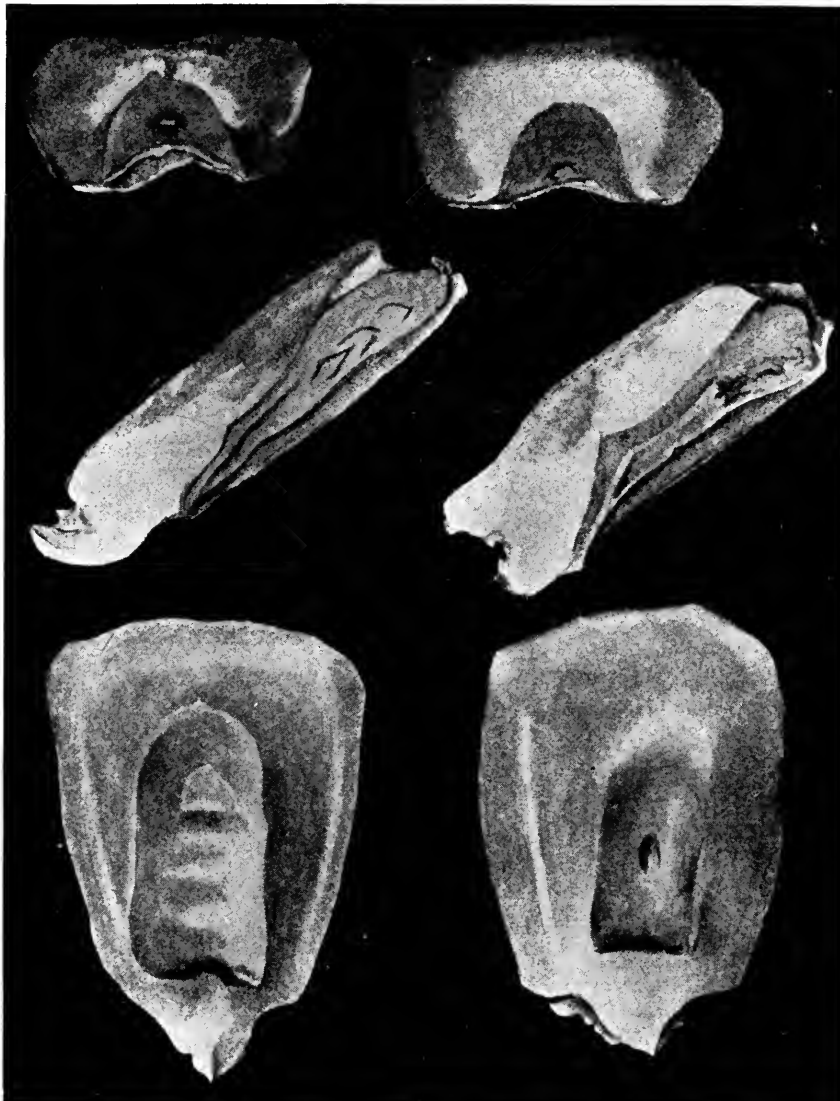


PLATE 1.

1. The darker colored and rather horny layer lying next to the hull, principally in the edges and toward the tip end of the kernel. This part is fairly rich in protein and contains from one-half to two-thirds of all the protein of the kernel. (See Plate 1.)

HIGH-OIL KERNELS (Large germs). LOW-OIL KERNELS (Small germs).

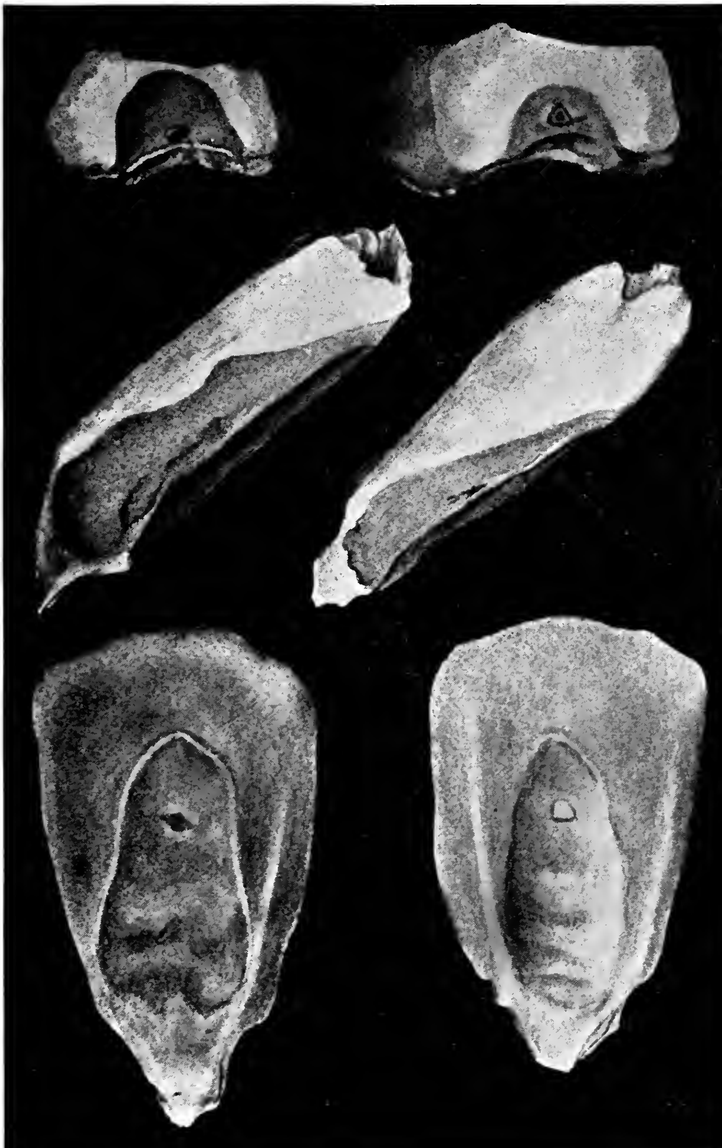


PLATE 2.

2. The white, starchy-appearing part occupying the crown end of the kernel and usually also immediately surrounding, or partially

surrounding, the germ. This part is poor in both protein and oil, consisting mainly of starch. (See Plate 1.)

3. The germ itself, which occupies the central part of the kernel toward the tip end. This is very rich in oil. More than four-fifths of the entire oil of the kernel resides in the germ. It is also rich in protein, containing nearly one-fifth of all the protein in the kernel, although the germ itself constitutes only about one-tenth of the weight of the kernel. (See Plate 2.)

In selecting seed corn by mechanical examination for improvement in composition, we remove from the ear a few average kernels, cut these kernels into cross sections, preferably near the tip end of the kernel (see longitudinal sections), and examine these sections as they are cut, usually simply with the naked eye, selecting for seed those ears whose kernels show the qualities desired.

SAMPLES FOR ANALYSIS.

In order that the breeder may know what he has accomplished in his work of mechanical selection, the Experiment Station offers to analyze for any Illinois farmer who wishes to improve the quality of his corn by breeding according to these directions and who agrees to make the best selection of seed possible, two composite samples representing each of the two lots of ears; that is, the selected lot and the rejected lot.

One composite sample should be made by taking 10 average kernels from each of the selected ears (96 ears preferred), and another sample should be made by taking 10 average kernels form each of the rejected ears (100 ears or more). Each of these two samples should be put in a separate sack, properly labeled, and sent to the Plant Breeding Laboratory, Agricultural Experiment Station, Urbana, Ill.

Of course, if the breeder desires to breed for physical type and increased yield only, then no chemical analysis is needed, and all that is necessary to begin work is to select the 96 most nearly perfect ears obtainable for the breeding plot.

SIZE OF BREEDING PLOT.

The best number of ears to use in a breeding plot is as yet an unsettled question. There are several conflicting factors entering into the consideration. On the one hand, the smaller the number of ears taken, the choicer can be the selection of the seed planted; while on the other hand the larger the number of breeding rows to choose from, the better can be the selection of seed for the next crop. Then again, there is undoubtedly some danger of evil effects from too close in-breeding, by the use of too small a number of ears.

From our present knowledge we believe, however, that 96 ears is a safe number to use, so far as in-breeding is concerned, and this is the number that we suggest in these directions, it being understood that alternate rows are to be detasseled and all seed corn selected from detasseled rows.

PLANT BY THE ROW SYSTEM.

The 96 selected seed ears are planted in 96 separate rows. These rows should be at least 100 hills long, but they may well be 40 rods long, as the amount of seed will usually permit this.

It is recommended that these 96 seed ears be numbered* from 1 to 48 and from 51 to 98, the numbers 49 and 50 being omitted; also that ears 1 to 48 be planted in one half of the plot and ears 51 to 98 be planted in the other half, preferably end-to-end with the first half, leaving one hill unplanted to mark the line between the two halves, also leaving one row unplanted to mark the line between rows 24 and 25 and between rows 74 and 75; that is, between quarters.

In this way row 51 (planted with seed from ear 51) is a continuation of row 1 (planted with seed from ear 1) and the two rows may well extend 80 rods, across a 40-acre field. The breeding plot can be planted with a corn planter, although it will require some time and patience, and if the planter is an edgedrop it will be necessary to put a suitable cone or inverted funnel in each seed box so as to keep the small amount of corn to the outside. Place the shelled corn from ear No. 1 in one box and from ear No. 2 in the other; drive to the middle line of the plot, thus planting rows 1 and 2; clean out the boxes; move forward one hill; put in the corn from ears 51 and 52; use the foot-trip till the corn begins to drop; then drive on and plant rows 51 and 52. Turn at the end; clean out the seed boxes; put in ears 53 and 54; plant back to the middle; clean out, put in ears 3 and 4, and then plant on back to the beginning line, thus continuing until the breeding plot is all planted. The planting may then be continued for the commercial field, using the same variety of corn, which should be of similar breeding, finishing, perhaps, with the multiplying plot on the opposite side of the field from the breeding plot.

Each one of the breeding plot rows should be numbered to correspond with the "register number" of the ear from which it is planted, as will be explained under the heading of "Pedigree Register."

The breeding plot should be well protected from foreign pollen, by being planted as far away as possible from other varieties of corn.

DETASSELING.

From the data which we have secured and are securing upon the subject, we now strongly recommend that every alternate row of corn in the breeding plot be completely detasseled before the pollen matures

*These numbers would be 101 to 148 and 151 to 198 the first year, 201 to 248 and 251 to 298 the second year, etc., etc. (See under Register Number, page 621.)

and that all of the seed corn to be taken from the plot be selected from these 48 detasseled rows. This method absolutely prohibits self-pollination or close-pollination of the future seed. By self-pollination is meant the transfer of pollen from the male flower (tassel) of a given plant to the female flower (silk) of the same plant; and by close-pollination is meant the transfer of pollen from the male flower of one plant to the female flower of another plant in the same row, both of which grew from kernels from the same seed ear. It is recommended that no plants in any of the rows which appear imperfect, dwarfed, immature, barren, or otherwise undesirable, should be allowed to mature pollen. Occasionally an entire row should be detasseled because of the general inferiority of the row as a whole. Detasseling is accomplished by going over the rows as many times as may be necessary and carefully pulling out the tassels as they appear. Indeed, great care should be exercised in this part of the work in order not to injure the plants and thereby lower the yields. The tassels should not be cut off, as this produces an external injury and at the same time the stalk is often deprived of several undeveloped leaves. But the tassel should be allowed to develop far enough so that it can be separated alone at the top joint by a careful pull. It is now fully determined that the detasseling of the breeding rows is necessary. This insures cross-pollination and markedly increases the yield of succeeding crops.

SELECTION OF FIELD ROWS AND SEED EARS.

As the crop matures, the corn from each of the detasseled breeding rows is now harvested. First, all of the ears on the row which appear to be good ears and which are borne on good plants, in a good position, and with good ear shanks and husks, are harvested, placed in a bag, with the number of the row, and finally weighed, together with the remainder of the crop from the same row. No seed ears should be taken within two or three rods of the inside ends of the rows. The total weight of ear corn which every detasseled row yields should be determined and recorded, for the yield is the primary factor in determining the rows from which all of the ears for the next year's seed selection must be taken. Each lot of ears from each of the detasseled rows, and finally each single ear of the 96 seed ears ultimately selected is kept labeled with the number of the row in which it grew and finally with its own ear number also, and permanent records are made of the number and the description of the ear, the performance record of the row, etc., so that as the breeding is continued an absolute pedigree is established, on the female side, for every ear of corn which may be produced from this seed so long as the records are made and preserved. We also know absolutely that we have good breeding on the male side, although the exact individual pedigree of the males cannot be known and recorded.

PLANTING FOR CROSS-POLLINATION.

In order to insure cross-breeding to the greatest possible extent the plan given in Table 8 should be adopted.

TABLE 8.—PLAN FOR PLANTING THE BREEDING PLOT TO AVOID IN-BREEDING.

The numbers given in the "Guides" designate the field rows from which the seed ears are taken. (All even-numbered rows are detasseled.)

Field row No.	Guide system for even years.	Guide system for odd years.	Model example for an even year.	Field row No.	Guide system for even years.	Guide system for odd years.	Model example for an even year.
1	76	78	76	51	2	4	4
2	2	2	4	52	52	52	52
3	80	82	84	53	6	8	10
4	6	6	10	54	56	56	58
5	84	86	90	55	10	12	16
6	10	10	16	56	60	60	66
7	78	76	80	57	4	2	8
8	4	4	8	58	54	54	56
9	82	80	86	59	8	6	14
10	8	8	14	60	58	58	60
11	86	84	92	61	12	10	20
12	12	12	20	62	62	62	68
13	78	76	80	63	4	2	8
14	2	2	4	64	52	52	52
15	82	80	86	65	8	6	14
16	6	6	10	66	56	56	58
17	86	84	92	67	12	10	20
18	10	10	16	68	60	60	66
19	76	78	76	69	2	4	4
20	4	4	8	70	54	54	56
21	80	82	84	71	6	8	10
22	8	8	14	72	58	58	60
23	84	86	90	73	10	12	16
24	12	12	20	74	62	62	68
25	52	54	52	75	26	28	30
26	26	26	30	76	76	76	76
27	56	58	58	77	30	32	36
28	30	30	36	78	80	80	84
29	60	62	66	79	34	36	42
30	34	34	42	80	84	84	90
31	54	52	56	81	28	26	34
32	28	28	34	82	78	78	80
33	58	56	60	83	32	30	38
34	32	32	38	84	82	82	86
35	62	60	68	85	36	34	46
36	36	36	46	86	86	86	92
37	54	52	56	87	28	26	34
38	26	26	30	88	76	76	76
39	58	56	60	89	32	30	38
40	30	30	36	90	80	80	84
41	62	60	68	91	36	34	46
42	34	34	42	92	84	84	90
43	52	54	52	93	26	28	30
44	28	28	34	94	78	78	80
45	56	58	58	95	30	32	36
46	32	32	38	96	82	82	86
47	60	62	66	97	34	36	42
48	36	36	46	98	86	86	92

In this plan the breeding plot is considered by quarters. Each quarter contains 24 rows and each row is planted with corn from a separate seed ear. All even-numbered rows are detasseled and seed for the next year's breeding plot is taken from the six best-yielding detasseled rows in each quarter, four ears being taken from each selected row, making 96 ears in all.

For convenience we use the term "sire seed," or "sire ears," to designate the ears which are to be planted in odd-numbered rows to produce tassels (the male flowers) and to furnish pollen; and we use the term "dam seed" or "dam ears" to designate the ears to be planted in the even-numbered rows to produce future seed ears. Of the four seed ears taken from each selected field row, two are used for sire seed and two for dam seed.

In the column headed "Guide system for even years" is given a key or guide, by which to work out the actual plan for planting in all even-numbered years, and under the heading "Model example for an even year" is given an actual plan which has been worked out, using four seed ears from six selected rows from each quarter of the breeding plot.

In the guide system, for the sake of simplicity, we use four seed ears from each of the first six even-numbered rows in each quarter, a selection which would probably never occur in actual practice.

It will be observed that the dam seed ears for each quarter are ears which grew in the same quarter, while the sire seed is always brought from another quarter. For the first quarter (rows 1 to 24), sire ears are brought from the fourth quarter. For the second quarter, sire seed is brought from the third. In each of these cases sire seed is carried diagonally across the breeding plot. For the third quarter sire seed is brought from the first quarter, and for the fourth, from the second, the sire seed being carried lengthwise of the breeding plot in these cases.

It will also be observed that there is a definite order of planting for "even years" and another definite order for "odd years." Thus, in the first quarter, the even-numbered rows are planted in ascending order with dam seed selected from rows numbered: 2, 6, 10, 4, 8, 12, 2, 6, 10, 4, 8, 12.

The alternating even numbers are repeated in sets of three and six. The odd-numbered rows are planted with sire seed selected from rows numbered: 76, 80, 84, 78, 82, 86, 78, 82, 86, 76, 80, 84.

This is the same order as for the dams except that the two sets of three are reversed in the second set of six. The only change required for odd-numbered years is to transpose the two sets of six in planting the sire seed. Exactly the same system is used in each quarter of the breeding plot.

ARRANGING SEED EARS FOR PLANTING.

By referring to the "Model example for an even year" it will be seen that it becomes an easy matter to follow the "Guide system" in arranging seed ears for planting. Suppose, for example, that in 1905 the best six rows in the first quarter of the breeding plot are 4, 8, 10, 14, 16, 20. Then for the dam seed for planting the first quarter in 1906 these numbers, in ascending order, are to be substituted for the numbers 2, 4, 6, 8, 10, 12, which are given in the "Guide system."

Thus: For 2, substitute 4; for 4, substitute 8; for 6, substitute 10; for 8, substitute 14; for 10, substitute 16; for 12, substitute 20.

Arranging these for planting the field rows, we have:

ROW No.	GUIDE SYSTEM.	ACTUAL PLAN.
2	2	4
4	6	8
6	10	10
8	4	14
10	8	16
12	12	20
14	2	4
16	6	8
18	10	10
20	4	14
22	8	16
24	12	20

If the best six rows in the fourth quarter of the 1905 breeding plot are 76, 80, 84, 86, 90, 92, then for the sire seed for planting the first quarter in 1906 these numbers are to be substituted in regular order for the numbers 76, 78, 80, 82, 84, 86, which are given in the "Guide system." Arranging these by threes as indicated in the "Guide system" we have the order for planting the odd-numbered rows in the first quarter: 76, 84, 90, 80, 86, 92, 80, 86, 92, 76, 84, 90.

Thus we have both the dam and sire seed ears for the first quarter, arranged exactly as shown under the heading "Model example" in Table 8. The seed ears are arranged for each quarter of the breeding plot in a similar manner by following the "Guide system" and substituting in regular ascending order the actual numbers of the best-yielding rows for the numbers given in the "Guide system" in Table 8.

It will be seen that with this selection of best rows, as given in this "Model example," we would take the four best seed ears from row No. 4 (1905) and plant two as dam ears in rows 2 and 14 and the other two as sire ears in rows 51 and 69 (1906); we would take the four best seed ears from row No. 84 (1905) and plant two as dam ears in rows 78 and 90 and the other two as sire ears in rows 3 and 21 (1906).

In arranging seed ears selected from the 1906 breeding plot for planting the 1907 breeding plot, we are to follow the "Guide system" for odd-numbered years, again returning to the system for even-numbered years for 1908.

CORN REGISTER

OF EARS PLANTED AND ROWS HARVESTED IN SEASON OF 1905.

Breeder....................................

Variety....................................

Strain....................................

Distance between hills..........................

Number of hills in row..........................

	DESCRIPTION OF INDIVIDUAL SEED EARS.																PERFORMANCE RECORD OF FIELD ROWS.							
	Register No.	Dam No.	Annual ear No.	Length of ear.	Tip circumference of ear.	Butt circumference of ear.	Number rows of kernels.	Number kernels in row.	Weight of ear.	Weight of cob.	Tip circumference of cob.	Butt circumference of cob.	Percent protein in grain.	Percent oil in grain.			Planted in field row No.	Corn pounds per row.	Corn bushels per acre.	Number of ears in row.	Percent protein in grain.	Percent oil in grain.		
Average.....																								

Remarks:

Average yield multiplying plot { (*Year* 1905) .... (*Year* 1906) ....

Average yield commercial field { (*Year* 1905) .... (*Year* 1906) .... (*Year* 1907) ....

Multiplying Plot.

Seed for a multiplying plot of ten acres or more should be taken only from the selected rows of the breeding plot, and may include all good seed corn which is not required for the breeding plot. This seed should be well mixed together and planted on the multiplying plot. The corn grown in the multiplying plot should be carefully protected from foreign pollen and all inferior stalks may be detasseled. The exact yield of the multiplying plot should be determined and registered.

Commercial Field.

The seed for the commercial field should be only the best obtainable seed corn from the multiplying plot. The exact yield of the commercial field should be determined and registered. From the commercial field the finest ears may be selected and sold to the trade as pedigreed seed corn.

Pedigree Register.

The Experiment Station has adopted a form for registering the numbers and descriptions of all the seed ears used in corn breeding and also for recording their performance records.

In this form there is provided space only for those measurements and data which now seem to be essential, as well as of general practicability in breeding up valuable strains of corn. There are some extra columns which may be used for any special points upon which any breeder may be working.

Description of Individual Ears.

Register Number.—As soon as any ear of a given variety and strain is selected to be planted in a breeding plot by a given breeder it is given a "Register Number," which must, of course, represent that particular ear only and for all time. By using a certain system of numbering we are not only able to accomplish this purpose, but can show at the same time the year of its breeding or the number of its generation, and the field row in which it is planted. This we do by starting the first year in the 100 series, numbering the ears to be planted in succession from 101 to 148 and 151 to 198, and the second year starting the 200 series, running from 201 to 248 and 251 to 298, and so on, starting each succeeding year with a higher hundred.

Dam Number.—The "Dam Number" is the "Register Number" of the parent ear and is useful in tracing the pedigree record from year to year back to the source.

Annual Ear Number.—In order to designate the 200 or more ears selected from the field, each one is given an "Annual Ear Number," which runs in a series from 1 up to 200 or more. This number is only temporary, to serve while working on the corn for the final selection of seed ears, and when the seed ears are selected to be planted, each is given a permanent "Register Number," as explained under that heading.

LENGTH OF EAR.—This is the measurement in inches of the total length from butt to tip.

TIP CIRCUMFERENCE OF EAR.—This is the measurement in inches at two inches from the tip end of the ear.

BUTT CIRCUMFERENCE OF EAR.—This is the measurement in inches two inches from the butt end of the ear.

NUMBER OF ROWS OF KERNELS.—This is self-explanatory.

NUMBER OF KERNELS IN ROW.—This is the average number of kernels in the row from tip to butt.

WEIGHT OF EAR.—This is taken in ounces after it has become thoroughly air-dried.

WEIGHT OF COB.—This is taken in ounces after the kernels have been shelled off.

TIP CIRCUMFERENCE OF COB.—This is the measurement in inches, two inches from the tip end.

BUTT CIRCUMFERENCE OF COB.—This is the measurement in inches, two inches from the butt end.

PERCENT PROTEIN IN GRAIN.—There are being bred some varieties in which every individual seed ear is subjected to an exact chemical analysis for the protein content of the grain, and this column is provided for the result of such tests.

PERCENT OIL IN GRAIN.—There are being bred some varieties in which a chemical oil test is made of each individual seed ear, and this column provides for the records of such data.

PERFORMANCE RECORD OF FIELD ROWS.

PLANTED IN FIELD ROW NUMBER.—The field row or breeding row numbers should, for the sake of convenience, correspond with the register numbers of the ears planted; for example, ear "Register No." 101 should be planted in "Field Row No." 1.

CORN POUNDS PER ROW.—The total yield of ear corn of every breeding row of the plot should be recorded in pounds.

CORN BUSHELS PER ACRES.—This is computed from "corn pounds per row," and from the "distance between hills" and "number of hills in row," as recorded in the upper right hand corner of the sheet. The full number of hills per row should always be used in this computation unless otherwise noted. The number of pounds per bushel should be estimated as fairly as possible, depending upon the condition of the crop at the time of harvest. (Commonly 75 or 80 pounds are used after the corn is dry enough to crib safely.)

NUMBER OF EARS IN ROW.—This includes nubbins, as well as good ears. The total weight of ears and the total number give sufficient data to determine the average weight. Some breeders also desire to record the number of good seed ears produced. Such records can be placed in the blank columns.

PERCENT OF PROTEIN IN GRAIN.—This column is provided for those varieties in which an exact chemical control is being kept of the parent ears and their offspring, and for averages when seed ears are selected by mechanical examination.

PERCENT OF OIL IN GRAIN.—The same note applies here as above.

On the same sheet with the complete year's record of the breeding plot appear the records of the multiplying plot for the same year, and for the next year following, and also the records of the commercial field for the same year and for the next two years. If the record sheet is for the breeding plot for 1905 it is important to finally record on the same sheet the record of the multiplying plot for 1906 and of the commercial field for 1907, and for convenience and comparison it is well to record on the same sheet the yield of the multiplying plot for 1905, and the yields of the commercial field for 1905 and 1906. If a breeding plot were started in 1905, the breeder could have both a breeding plot and a multiplying plot in 1906, and a breeding plot, multiplying plot, and commercial field in 1907; and from the 1907 crop on the commercial field he could sell seed corn with a registered pedigree of three years, one year in the breeding plot, one year in the multiplying plot, and one year in the commercial field. In 1910 he could sell seed corn from his commercial field with a registered pedigree of six years—four years in the breeding plot (1905, 1906, 1907, and 1908), one year in the multiplying plot (1909), and one year in the commercial field (1910).

At the bottom of the corn register sheet is a space under "Remarks," in which any irregularities concerning the data of the sheet may be explained; or there can be placed here any short notes that it may be desirable to record in regard to the soil of the plot, the weather, or any other conditions affecting growth.

These corn register sheets may be secured upon application to the Experiment Station by any Illinois farmer who wishes to start a breeding plot.

THE EXPERIMENT STATION HAS NO SEED CORN FOR SALE.

On account of the numerous calls that are constantly being received by us for seed corn, it is thought well to explain here that the Experiment Station has no seed of any kind for distribution. It is the particular province of the Experiment Station to investigate and to demonstrate principles. Others make the commercial application of these principles whenever they are proved to be of commercial importance.

For the sake of the definite knowledge to be gained, investigations are often carried on to determine what we should avoid doing in practical agriculture, as well as to discover what we should do for improving agricultural conditions or practices. The station has demonstrated the possibility, through selection and breeding, of improving corn both as to yield and as to quality. Marked changes have been produced in the composition of corn. We recognize the fact, however, that there may be a limit beyond which these changes in composition cannot be carried without interfering with the physiological functions of the seed and plant to the extent of impairing the yield. Therefore these experiments are being carried on still farther to determine if possible where the danger limits lie, in order that we may be able to point out such limits to practical corn breeders who follow along in these lines of corn improvement.

For our first experiments in corn breeding, which began some nine years ago, we selected a variety of corn of medium size and of safe maturity for this latitude with which to work out methods, and to ascertain the possibilities of corn improvement. This variety was well adapted to our purpose, but is was not one of our largest or highest-yielding varieties of corn. This preliminary work was necessarily carried on on a small scale and the original experiments are still being continued on about the same scale. While we have definitely determined, for example, that the protein of corn can be increased by breeding, we now wish to determine whether this might be carried to such an extent as to result in impaired constitution or vigor of growth or reduced yield. If there is such a danger point, then the Experiment Station should discover the fact before it is actually reached by the practical corn breeders.

As soon as we had demonstrated that the improvement of corn by breeding was both possible and practicable, a considerable number of the most successful seed corn producers in Illinois adopted our methods of corn improvement, and for several years they have been systematically breeding corn on a large scale. Thus it happens that while the methods and principles have been worked out and demonstrated by the Experiment Station on plots of small area and with corn of medium size and yield, the commercial seed corn breeders are now applying these principles to hundreds or even to thousands of acres, and while they began some years after the first experiments were undertaken by us, they began with all of the different leading varieties of corn grown in the state, and, moreover, they are breeding different varieties of corn especially adapted to different sections of the state.

Furthermore, several members of the Illinois Seed Corn Breeders Association, recognizing the importance of producing corn especially adapted to special purposes, have taken up the work of improving the quality of their varieties along different lines, following the methods established by the Experiment Station. Thus they are breeding, first, for improvement in yield, and, second, for improvement in composition.

Some of them are breeding to increase the protein content, and others to increase the oil content in their corn, while some varieties or strains are being bred for a combination of high protein and high oil.

There is another point which has a bearing on this work, namely, we selected a variety of corn of average composition; and from this we began breeding in several different directions, one for high protein and one for low protein, another for high oil and still another for low oil. This variety of corn was not especially high in protein when we began with it, not so high, in fact, as some other varieties which we were growing at the time and which are now being bred for high protein by some of the Illinois seed corn breeders.

For information concerning Illinois seed corn breeders and the varieties of corn they are breeding, the reader is referred to their secretary, Mr. John R. Clisby, Arcola, Illinois.

CORRECTION

On page 619, under the heading "Actual Plan," the order of numbers should read: 4, 10, 16, 8, 14, 20, 4, 10, 16, 8, 14, 20.