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Corn Families of South Dakota

A.N. Hume

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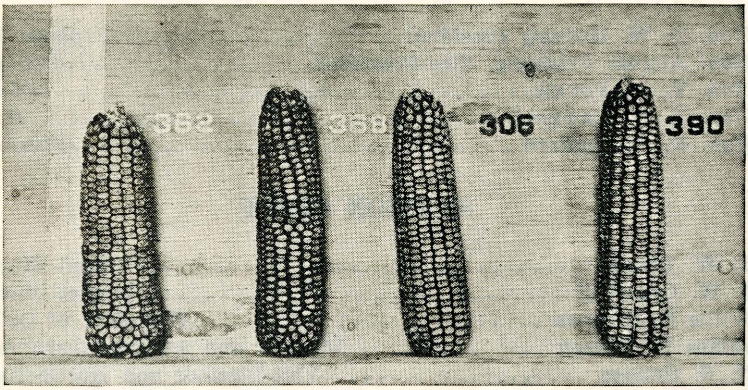
CORN FAMILIES OF SOUTH DAKOTA



"ALL DAKOTA"—A "VARIETY" OF CORN PRODUCED FROM PEDIGREED EARS

Number 362, is pure "Golden Glow," (Wenz.)

Number 368, had an ear of Codington County Yellow (146 L. Mc) for its maternal grandmother.

Number 306, is only half Golden Glow. Its paternal grandfather was Minnesota 13 (198) and its maternal grandmother was Fulton Yellow Dent (120 H.E.D.).

Number 390, had for its paternal grandmother an ear of Minnesota 13. The common variety characteristic is capacity for high production of dry corn.

Contribution from

Agronomy Department

A. N. Hume

Head of Department

AGRICULTURAL EXPERIMENT STATION

SOUTH DAKOTA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS

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SUMMARY

1. It is submitted as an expedient of corn breeding, that the mother-ears selected for starting a breeding plot should not only be as numerous as practicable but should also represent as many sources as practicable from among those likely to excel in qualities desired. Page 121.

   For the same reason mother-ears should be systematically introduced into the detasseled rows of the breeding plot in succeeding seasons from stocks of other corn breeders and other sources where excellent strains are likely to be found. Page 121.

2. It is submitted as another expedient of corn breeding that high yielding tested remnants should be utilized as largely as possible in making and carrying out plans for corn-breeding by selection. Page 122.

3. Detasseling all the even-numbered rows in the breeding plot insures that the progeny of these rows will be cross-bred. Page 124.

4. All of the twelve odd-numbered (sire) rows in any given quarter of the breeding plot can be planted from one single ear, providing the rows in the breeding plot are short—(ten hills). This sire ear may be selected from the highest yielding row of another quarter, according to plan. Page 122 to 124.

5. The foregoing expedients may be employed in securing the production of seed corn, which is the product of crossing strains that are selected for high yield (or any quality)' that are selected continuously and whose sires and dams may have approached a homozygous condition.

6. It is practically possible to record the ancestry of ears of corn from such a breeding plot to preserve a working pedigree record of such ancestry. Page 124.

7. The 'variety" of corn named "All Dakota" produced according to the foregoing expedients should ultimately represent a combination of high-yield characters now existant in varieties that are successful in eastern South Dakota; such as Golden Glow, Minnesota 13, Fulton Yellow Dent and Wimple's. At the time of writing, the surplus (15 acres) from the 1918 breeding plot is growing on the farm of Percy Ullman, in Brookings County.

CORN FAMILIES OF SOUTH DAKOTA

By

A. N. Hume

It is the slow and patient care and selection, day by day, which permanently ameliorate and improve the vegetable world. Nature starts the work; man may complete it.—L. H. Bailey.

It is recognized that corn breeding has developed a goodly number of unknown factors in science and practice. The number of fundamental principles that one observes today in developing a breeding plot is not great, nor are all the principles yet discovered. The few principles that are now recognized as fundamental have been discovered through patient and accurate observation not only of experimenters but of practical corn growers who were firstly interested in higher production.

Thus even though a corn breeding plot today might consist of a very simple ear-row-system it would nevertheless take some account of not only of differences in the productive power of ears, but also of the need for the avoidance of inbreeding.

One of the most intelligent corn breeders in the country in an early day started a corn breeding plot with kernels from a single ear, planted in an isolated locality. He has learned long since that his aims in selection were defeated by inbreeding and close-breeding. Neither the early corn breeder in question nor anyone else would now attempt to begin practical corn breeding with a single ear. More knowledge has been added to practice in the course of time.

In 1916 the South Dakota Experiment Station, Agronomy Department, installed a system of ear-to-row corn breeding which has been continued independently for three successive seasons.

This system is conducted with 96 separate rows in an ear-row breeding plot, the total of 96 being divided into 4 quarters of 24 rows each. These 24 rows in each quarter are again divided into two groups, of odd numbered rows and even numbered rows. The even numbered rows are always detasseled and the odd numbered rows are not detasseled. It is convenient to call the even numbered detasseled rows "dam rows" and the odd numbered tasseled rows "sire rows."

It is the purpose largely to report observations concerning yields secured from the rows of this corn breeding system in the several seasons, and also to call attention to the fact that with such a system it is possible to conduct a corn breeding plot by means of which a pedigree of several "corn families" can be preserved.

The following table of yields will put down the amount of corn harvested from separate rows of the breeding plot from 1916 to 1918 inclusive:

TABLE I.

Row Yields (actual) in Bushels of Corn Per Acre, in Three Successive Years, of an Ear-row Corn Breeding Plot

Field Row No.	1916 Register Number of Mother-ear Planted	1916 Yield in Lbs. Ear Corn Per Row	1916 Bushels Ear Corn Per Acre	1917 Register Number of Mother-ear Planted	1917 Yield in Ozs. of Shelled Corn Per Row	1917 Bushels of Shelled Corn Per Acre	1918 Register Number of Mother-ear Planted	1918 Yield in Lbs. Ear Corn Per Row	1918 Bushels Ear Corn Per Acre
1	101	14.8	37.6	188	......	......	298	8.3	57.3
2	102	11.5	29.3	**104**	**82**	**17.7**	**202**	**10.4**	**71.6**
3	103	11.0	28.0	188	......	......	298	8.3	57.3
4	**104**	**12.1**	**30.9**	**112**	**55**	**11.9**	212	8.4	58.0
5	105	17.5	44.6	188	......	......	298	8.8	60.4
6	106	8.8	22.3	120	48	10.4	**218**	**10.5**	**72.5**
7	107	9.8	24.9	188	......	......	298	7.5	51.8
8	**108**	**9.6**	**24.5**	108	44	9.5	**204**	**9.8**	**67.3**
9	109	10.3	26.1	188	......	......	298	8.1	56.0
10	110	7.4	18.8	116	18	3.9	**225**	**9.8**	**67.3**
11	111	6.3	15.9	188	......	......	298	8.9	61.2
12	**112**	**14.0**	**35.7**	**122** L. Mc	**59**	**12.7**	**220**	**8.7**	**60.0**
13	113	13.0	33.1	188	......	......	298	7.3	50.4
14	114	3.9	9.9	104	64	13.8	202	8.4	58.0
15	115	18.8	47.8	188	......	......	298	7.3	50.0
16	**116**	**7.0**	**17.9**	**112**	**69**	**14.9**	**212**	**9.4**	**65.1**
17	117	10.8	27.4	188	......	......	298	6.3	43.1
18	118	8.6	22.0	**120** HED	**58**	**12.5**	218	8.6	59.5
19	119	13.5	34.4	188	......	......	298	7.8	53.5
20	**120** HED	**9.8**	**24.9**	**108**	**58**	**12.5**	I.E.L.	4.3	29.7
21	121	17.8	45.3	188	......	......	298	7.4	50.9
22	**122** L. Mc	**10.0**	**25.5**	116	33	7.1	Wimple's 12-Flint	9.4	54.7
23	123	15.3	38.9	188	......	......	298	8.0	55.2
24	124 M. 13	16.3	41.4	122 L. Mc	51	11.0	N.W.D. Eureka	3.4	23.3

TABLE I (Continued)

Row Yields (actual) in Three Successive Years of an Ear-row Breeding Plot

SECOND QUARTER OF PLOT

	1916			1917			1918		
Field Row No.	Register Number of Mother-ear Planted	Yield in Lbs. Ear Corn Per Row	Bushels Ear Corn Per Acre	Register Number of Mother-ear Planted	Yield in Ozs. of Shelled Corn Per Row	Bushels of Shelled Corn Per Acre	Register Number of Mother-ear Planted	Yield in Lbs. Ear Corn Per Row	Bushels Ear Corn Per Acre
25	125	9.5	24.2	112	......	......	252	11.5	79.4
26	**126**	**15.3**	**38.9**	152	49	10.6	**236**	**10.5**	**72.5**
27	127	12.0	30.6	112	......	......	252	12.8	88.0
28	128	14.0	35.7	160	41	8.9	240	9.0	62.1
29	129	14.0	35.7	112	......	......	252	14.5	100.1
30	**130**	**12.3**	**31.2**	170	49	10.6	246	9.0	62.1
31	131	13.5	34.4	112	......	......	252	13.1	90.5
32	132	10.5	26.8	158	32	6.9	**238**	**9.1**	**62.9**
33	133	17.0	43.3	112	......	......	252	10.8	74.2
34	134	12.7	32.8	**166**	**50**	**10.8**	**244**	**10.5**	**72.5**
35	135	19.0	48.4	112	......	......	252	11.1	76.7
36	**136**	**14.0**	**35.7**	**174** **M.** 13	**59**	**12.7**	248	8.6	59.5
37	137	13.8	35.1	112	......	......	252	12.6	87.1
38	138	10.5	26.8	**152**	**57**	**12.3**	**236**	**11.8**	**81.1**
39	139	13.3	33.8	112	......	......	252	11.3	77.6
40	**140**	**15.6**	**39.8**	**160**	**53**	**11.4**	**240**	**12.6**	**86.7**
41	141	13.3	33.8	112	......	......	252	8.7	60.0
42	142	6.0	15.3	170	49	10.6	246	8.8	60.8
43	143	14.0	35.7	112	......	......	252	10.5	72.5
44	**144** HED	**11.3**	**28.7**	**158**	**70**	**15.1**	White Dent IEL	7.7	53.0
45	145	12.8	32.5	112	......	......	252	10.9	75.4
46	**146** **L. Mc**	14.0	**35.7**	**166**	**53**	**11.4**	Wimple's 8-Flint	**15.9**	**95.3**
47	**147**	......	......	112	......	......	252	10.8	74.2
48	148 M. 13	12.5	31.9	174	77	16.6	Eureka N.W. Dent	8.1	56.4

TABLE I (Continued)

Row Yields (actual) in Bushels Per Acre in Three Successive Years of An Ear-Row Breeding Plot

THIRD QUARTER OF PLOT

	1916			1917			1918		
Field Row No.	Register Number of Mother-ear Planted	Yield in Lbs. Ear Corn Per Row	Bushels Ear Corn Per Acre	Register Number of Mother-ear Planted	Yield in Ozs. of Shelled Corn Per Row	Bushels of Shelled Corn Per Acre	Register Number of Mother-ear Planted	Yield in Lbs. Ear Corn Per Row	Bushels Ear Corn Per Acre
51	151	......	......	166	......	......	202	8.6	59.5
52	**152**	**19.5**	**49.7**	**126**	**74**	**16.0**	252	4.4	30.2
53	153	9.3	23.6	166	......	......	202	15.8	109.1
54	154	15.5	39.5	**136**	**67**	**14.5**	**256**	**10.8**	**74.2**
55	155	7.3	18.5	166	......	......	202	10.5	72.5
56	156	13.5	34.4	**144**	**61**	**13.2**	262	9.3	63.8
				HED					
57	157	5.5	14.0	166	......	......	202	9.3	63.8
58	**158**	**15.5**	**39.5**	130	26	5.6	**254**	**10.5**	**72.5**
59	159	9.2	23.2	166	......	......	202	9.0	62.1
60	**160**	**15.5**	**39.5**	**140**	**64**	**13.8**	**260**	**10.0**	**69.0**
61	161	4.6	12.0	166	......	......	202	8.5	58.7
62	162	10.8	27.4	**146**	**57**	**12.3**	**266**	**11.5**	**79.4**
				L. Mc					
63	163	5.2	13.1	166	......	......	202	9.9	68.5
64	164	15.0	38.2	126	44	9.5	**252**	**10.1**	**69.8**
65	165	9.1	23.2	166	......	......	202	8.1	56.0
66	**166**	**18.0**	**45.9**	**136**	**52**	**11.2**	256	9.4	65.1
67	167	......	......	166	......	......	202	8.6	59.5
68	168	14.5	37.0	144	43	9.3	**262**	**9.6**	**66.0**
69	169	9.8	24.9	166	......	......	202	9.0	62.1
70	**170**	**15.8**	**40.2**	130	21	4.5	White	8.4	58.0
	HED						Dent IEL		
71	171	......	......	166	......	......	202	10.0	69.0
72	172	15.3	38.9	140	......	......	....	......	......
	L. Mc								
73	173	7.6	19.4	166	......	6.9	202	9.0	62.1
74	**174**	**17.0**	**43.3**	146	32	6.9	Eureka	7.3	50.0
	M. 13						N.W. Dent		

TABLE I (Concluded)

Row Yields (actual) in Bushels of Ear Corn Per Acre, in Three Successive Years of an Ear-Row Breeding Plot

FOURTH QUARTER OF PLOT

	1916			1917			1918		
Field Row No.	Register Number of Mother-ear Planted	Yield in Lbs. Ear Corn Per Row	Bushels Ear Corn Per Acre	Register Number of Mother-ear Planted	Yield in Ozs. of Shelled Corn Per Row	Bushels of Shelled Corn Per Acre	Register Number of Mother-ear Planted	Yield in Lbs. Ear Corn Per Row	Bushels Ear Corn Per Acre
75	175	10.3	26.1	140	......	......	248	8.0	55.2
76	176	12.0	30.5	178	43	9.3	**280**	**9.9**	**68.1**
77	177	9.9	25.2	140	......	......	248	12.1	83.6
78	**178**	**13.5**	**34.4**	186	......	......	**290**	**9.5**	**65.6**
79	179	11.5	29.3	140	......	......	248	9.6	66.0
80	**180**	**14.0**	**35.7**	**194**	**59**	**12.7**	**296**	**10.1**	**69.4**
				HED					
81	181	8.0	20.4	140	......	......	248	10.3	71.1
82	182	12.5	31.9	**180**	**52**	**11.2**	282	8.6	59.5
83	183	10.1	25.8	140	......	......	248	8.4	57.8
84	184	13.5	34.4	188	50	10.8	294	8.0	55.2
85	185	11.6	29.6	140	......	......	248	11.5	79.4
86	**186**	**14.5**	**37.0**	198	45	9.7	298	8.8	60.8
87	187	9.5	24.2	140	......	......	248	9.2	63.3
88	**188**	**15.5**	**39.5**	178	......	......	**280**	**10.6**	**73.4**
89	189	11.5	29.3	140	......	......	248	10.0	69.0
90	190	14.0	35.7	**186**	**92**	**19.9**	**290**	**9.2**	**63.4**
91	191	13.1	33.4	140	......	......	248	9.0	62.1
92	192	12.3	31.2	194	40	8.6	**296**	**10.1**	**69.8**
93	193	6.3	15.9	140	......	......	248	10.3	70.7
94	**194**	**15.5**	**39.5**	**180**	**54**	**11.7**	White Dent IEL	7.5	51.8
	HED								
95	195	7.1	18.1	140	......	......	248	10.5	72.5
96	196	16.3	41.4	**188**	**64**	**13.8**	....	......	......
	L. Mc								
97	197	9.9	25.2	140	......	......	248	10.4	71.6
98	**198**	**7.5**	**44.6**	**198**	**94**	20.3	Eureka N.W. Dent	6.5	44.9
	M. 13								

In the foregoing table the numbers and yields from the even numbered rows selected as "high yielders" are put down in heavier type. Generally speaking the rows thus denominated "high yielders" are the six rows in each of the several quarters which are found to produce the greatest number of bushels per acre of ear corn (70 pounds). Exceptions to this rule were made only in cases where the corn harvested was obviously immature or where it was very deficient in quality for some other reason.

Plan of the Breeding Plot

It has been stated that the corn breeding plot which we are describing consists of a total of 96 rows and that it is divided into 4 quarters of 24 rows each. It is possible to regard these four separate quarters as entirely independent from one another so far as their position of planting on the ground is concerned. As a matter of fact and as may be seen from Table 1, the first quarter of the plot in 1916 was planted with the use of 24 separate mother-ears of seed corn; 27 hills per row and 2 kernels per hill. In 1917, 25 hills were planted per row. In 1918, 10 hills were planted per row. In this particular breeding plot the hills were spaced 36 inches apart each way. It may also be observed from Table 1, that the field rows in the first quarter are numbered consecutively from 1 to 24 and also that the register numbers of the ears planted in any given row indicate the year of the breeding plot and number of field row in which the given ear was planted.

The same things are true of the second quarter of the plot for the year 1916 except that the field-row numbers continue from 25 to 48 inclusive and the register numbers accorded to mother-ears correspond. Between the second and third quarters, field row numbers 49 and 50 are omitted and in the third quarter according to Table 1, the field rows 51 to 74 inclusive may be found with register numbers for mother-ears that correspond to them. The fourth quarter consists of field row numbers 75 to 98 inclusive, also with the corresponding register numbers of mother ears.

Sources of Seed for Starting a Breeding Plot

Nearly all of the 96 individual mother-ears with which this breeding plot was started in 1916 were secured from the Golden Glow seed stocks of Alfred Wenz, Bath, South Dakota. This Golden Glow traces in turn to the Agronomy Department of the Wisconsin Experiment Station. The writer was pleased to secure a sufficient number of ears of this corn from Mr. Wenz partly because it had already gained a reputation for earliness and high yield, deep kernel and excellent quality, but also because it has been tested under South Dakota conditions pretty well north in the state. It is to note, however, that not everyone of the 24 rows in each quarter of the breeding plot was planted with these Golden Glow mother-ears. The exceptions are important in as much as they were intended to serve as introductions of strains from outside of the general stock. In 1915 one row in each of the 4 quarters was planted with an ear of Fulton Yellow Dent, the well known South Dakota corn developed by H. E. Dawes, of Fulton, Hanson County. The rows thus planted with Fulton Yellow Dent mother-ears may be observed from Table 1, numbers 120, 144, 170 and 194. In similar manner one row in each of the quarters was planted with an ear from the seed stocks of Leslie McElhaney of Watertown, Codington County, the ears being secured through County Agent, Andrew Palm. The register numbers of the latter ears taken from Table 1 are 122, 146, 172 and 196. Four ears of Minnesota 13 from the breeding plot at Brookings field were also introduced; their register numbers being 124, 148, 174 and 198. These several introductions of mother-ears from prominent and successful strains were made under the hypothesis that the ear-row breeding of corn is or may be largely a matter of selection. The writer guessed that Golden Glow from Brown County would be a very desirable strain with which to start a breeding plot for securing high yield in east-central South Dakota but had no way of proving the guess in advance. Accordingly introductions of other strains were made at the start in order to leave the possibility for observing which source of seed actually gives best results under conditions where it is intended to propogate the corn. It is relevant in this connection to observe from Table 1, that some of these mother-ears introduced from seed stocks other than the prevailing Golden Glow (Wenz) produced outstanding yields of good quality and were consequently chosen for further propogation in the breeding plot of the following year. These outstanding ears (numbered in heavy type, Table 1) were 120, (H. E. D.); 122 (L. Mc); 144 (H. E. D.); 146 (L. Mc); 170 (H. E. D.); 174 (M. 13); 194 (H. E. D.); 198 (M. 13).

It is evident that if all mother-ears for starting the breeding plot had been selected from the prevailing Golden Glow stock the foregoing mother-ears, apparently more prolific, would have been missed entirely. **It is submitted as an apparent expedient of corn breeding, that the mother-ears selected for starting a breeding plot, should not only be as numerous as practicable but should also represent as many sources as practicable, from among those likely to excel in the qualities desired.** If natural selection, and all selection "is a sieve" it is reasonable to get the greatest number of possible selections into the sieve at starting.

In 1916, the first year of the breeding plot, all even-numbered rows were detasseled; which accords with the system as it is carried out every year. It is evident that all the remaining odd-numbered rows were able to mature pollen; and incidentally they all were ears taken from the basic Golden Glow (Wenz) stock. It follows that the introductions brought into the breeding plot from other sources were first planted in even-numbered rows, and consequently detasseled. As a result it was possible to secure comparative yields from them before permitting them to mature pollen in the breeding plot. If such introductions prove very valuable they or their progeny may be continued in the breeding plot in following years. If they prove inferior they may be dropped without having contaminated other rows with their pollen.

Use Remnants of Tested Ears

With examining the numbers under 1917 in Table 1, it is to observe that the seed ears used in the breeding plot for the second year bear the same register number as those of the six highest yielding even-numbered rows for the preceding year 1916; the exception being in the fact that all sire rows are planted with an ear-remnant previously used in another quarter of the plot. As to order of planting, a guide system is employed copied from Illinois Bulletin 100; this system is used in general to provide: that dam-rows (even numbers) shall be planted according to order with seed ears out of the same quarter of the breeding plot; sire rows of the first quarter with an ear taken from the fourth; sire rows of the second quarter with an ear taken from the third; sire rows of the third, with an ear taken from the first; sire rows of the fourth, with an ear taken from the second.

To return to the fact in Table 1 that the numbers planted in the second year are those of the high-yielders of the first year; this means that all remnants of even-numbered ears planted in 1916 were preserved, in order to plant the breeding plot of 1917, mainly with tested remnants of the six highest-yielding ears in each quarter for 1916.

It is here submitted as another expedient that high-yielding-tested remnants should be utilized as largely as possible in making and carrying out plans for corn breeding by selection.

The Use of the Highest Yielding Ears for Planting Sire Rows

It may be observed by looking at Table 1, that in the years 1917 and 1918 that is after the first year of the breeding plot, one single ear was used to plant all odd-numbered (sire) rows of the breeding plot, in each quarter. The present system calls for the use of an ear (or remnant) from the highest yielding row of the fourth quarter for planting the sire rows of the first quarter for the following year; an ear (or remnant) from the highest yielding row in the third quarter, for planting the sire rows in the second; an ear (or remnant) from the highest yielding row of the first quarter for planting the sire rows in the third; and an ear (or remnant) from the highest yielding row of the second quarter for planting the sire rows of the fourth.

It is the assumption that the use of a single ear of apparently the highest yielding capacity for planting sire rows in each quarter will give rise to the highest available yielding power in the progeny.

The following table of average yields secured in 1918 is arranged in order to get comparison between yields from these sire rows, planted with supposedly the highest yielding ears as referred to above, and yields from the remaining dam rows (even-numbered):

TABLE 2.

Average Yields in Bushels of Ear Corn Per Acre, from (a) Sire Rows and (b) Dam Rows (1918.)

	Average yield in Bushels, 70 lbs. ear-corn (air dry) from given quarter of breeding plot in 1918				
	1	2	3	4	Av.
Average yield of Sire Rows	53.9	79.6	66.9	68.5	67.2
Average yield of all Dam Rows	58.1	68.8	63.5	62.0	63.1
Average yield of Dam Rows exclusive of introductions made in 1918	64.4	68.9	65.6	65.2	66.0

By carefully examining Table 2, it is to ascertain that the sire rows (odd-numbered) in three of the four quarters of the breeding plot in 1918 yielded higher than the average yield of all dam rows, in the same quarters. The exception comes in the first quarter; the exception neither proves the rule nor disproves it. The ears used for planting all sire rows, were chosen from the supposedly highest yielding rows in the four separate quarters of the breeding plot. If cornbreeding by selection is a tenable proposition, these ears should be found to be comparatively high producers. In three of the four quarters of the breeding plot the comparative yields produced, accorded with such a hypothesis. The yield of sire rows in 1918 produced from ears that have the highest productive power according to our system was 4.1 bushels per acre higher than that of the dam rows which themselves were from representative strains of corn. The yield from these rigidly selected sire ears was 1.2 bushels per acre higher than that of dam rows which had previously received the same kind of selection.

Another bit of evidence that may be computed in this connection concerns the variability of the yields from the sire rows (all planted from a single ear in each quarter) and from the dam rows (planted usually from six separate mother-ears in each quarter). The following table gives the coefficients of variability in yields for comparison:

TABLE 3.

Coefficients of Variation in Yield from Sire Rows, (All planted from the Same Ear) and Dam Rows (Planted with Six Different Ears) in 1918.

	Coefficient of variation in yield for given quarter of the breeding plot (1918)			
	1	2	3	4
Coefficients for sire rows	.0899 = .012	.125 = .0172	.202 = .0278	.115 = .0158
Coefficients for dam rows	.256 = .0352	.182 = .0250	.204 = .0293	.133 = .0191

A comparison of these coefficients in Table 3, gives us the bit of information that in all quarters of the breeding plot for 1918, the yields from the sire rows varied either as little or actually less than the yields from the dam rows. That indicates that there is some consistency in the yields from ears of corn; which in turn would indicate the utility of the common practice of selecting seed ears from high yielding rows.

The greater the degree of certainty with which it can be established that the many kernels from a given mother-ear of corn produce yields that are consistent with one another, as compared with yields from kernels having several sources, the firmer will be the evidence that the ear, may serve as a practical unit for selection in corn breeding.

Practical corn breeders have usually thought of the ear as the practical basis for selection. They desire to know whether they have employed their time correctly or not in this respect; and whether an ear of corn may represent a strain that will produce not only occasionally high yields, but produce them consistently. As previously indicated Tables 2 and 3 furnish some information to support the hypothesis that individual ears of corn taken from high yielding ear-rows may be expected to yield **consistently** higher than ears from strains less rigorously selected.

Pedigreed Ears

The fact that corn cross-pollenates under ordinary cultural conditions is fully appreciated by corn breeders. Under ordinary circumstances it is possible to give a number for the "mother-ear" from which any given ear or kernel of corn has grown, with no way possible however to keep track of the source of pollen that fertilized it. The only way to be certain about the parentage of corn, is to resort to the slow processes of hand pollenation, and subsequent covering of the silk.

It is nevertheless possible to multiply the chances many times that all ears in the several quarters of a breeding plot shall be pollenated from any given sire ear. This can be accomplished by planting as previously described in this bulletin—all odd-numbered, sire rows in each quarter **with kernels from the same ear,** all even-numbered, dam rows with kernels from the respective mother-ears, these latter rows being rigidly detasseled at the appropriate time. This use of a single sire ear for planting all sire rows in a quarter will obviously not insure that no pollen will blow in or be carried in from other sources. It is the observation of the writer that corn kernels maturing in a given quarter of the breeding plot are likely to be pollenated with pollen grains, also maturing in the same quarter. Some statistical data can be secured sometime on this point.

If one may count within practical limits that corn kernels will be pollenated from pollen also maturing within the same quarter it is possible within the same limits of accuracy to arrange an actual pedigree showing the parentage of corn ears. Such pedigrees of corn ears have more than mere passing interest, providing it is established that ears having high yielding ancestry can be depended upon to produce relatively high yielding progeny.

The ears that are chosen for planting the breeding plot of 1919, on account of their coming from the six highest yielding even-numbered rows in their several quarters, are put down in pedigree form as follows:

PEDIGREED EARS SELECTED FOR PLANTING BREEDING PLOT ROWS 1919

FIRST QUARTER

No. of Ears to be in 1919	Sire and Dam Planted in 1918	Grand-sires and Grand-dams Planted in 1916 and again as remnants in 1917
		112
	248	174 (M. 13)
392 (All sire rows planted with above number)		140
	296	188
		198 (M. 13)
	298	140
302		188
	202	104
		198 (M. 13)
	298	140
308		188
	204	112
		198 (M. 13)
	298	140
312		188
	220	108
		198 (M. 13)
	298	140
306		188
	218	120 (H. E.D.)
		198 (M. 13)
	298	140
310		112
	225	112
		198 (M. 13)
	298	140
316		188
	212	122 (L. Mc)

SECOND QUARTER

	202	188 104
362 (All sire rows planted with above number)	266	166 166 136
326	252	166 126
	236	112 174 (M. 13)
334	252	166 126
	244	112 158
340	252	166 126
	240	112 160
332	252	166 126
	238	112 152
338	252	166 126
	236	112 174 (M. 13)
346	252	166 126
	8-rowed flint Wimple's	Wimple's 8-rowed Flint

THIRD QUARTER

302................ (All sire rows planted with above number)..	298................	140 198 (M. 13)
	202................	188 104
354................	202................	188 104
	256................	166 144 (H. E. D.)
360................	202................	188 104
	260................	166 140
364................	202................	188 104
	252................	166 126
358................	202................	188 104
	254................	166 136
362................	202................	188 104
	266................	166 136
368................	202................	188 104
	262................	166 146 (L. Mc)

FOURTH QUARTER

340 (All sire rows planted with above number)	252	166
		126
	240	112
		160
376	248	112
		174 (M. 13)
	280	140
		194 (H. E. D.)
380	248	112
		174 (M. 13)
	296	140
		188
390	248	112
		174 (M. 13)
	290	140
		186
378	248	112
		174 (M. 13)
	290	140
		186
388	248	112
		174 (M. 13)
	280	140
		194 (H. E. D.)
392	248	112
		174 (M. 13)
	296	140
		188

The question logically arises whether such pedigrees are of any practical value. Of what utility is it, direct or indirect to know the pedigree of an ear of corn? The similar question has arisen time out of mind in connection with all plant and animal breeding, and within human families. It has been rather assumed that "blood will tell," and that it is worth while to have good ancestry.

If good ancestry is worth having it is because there is some correlation between the performance records of ancestry and progeny. We may accordingly examine the yield-records of the ancestry of the high-yielding ears whose pedigrees are put down in detail on the foregoing pages; and then compare them with the yield records of the ancestry of ears that produced comparatively lower yields. This comparison is put down in the following Table 4. It will be seen that the average yields put down are the yields from the dam rows—in as much as only one ear is used for planting all sire rows in each of the several quarters, and would thus figure into all row yields in the same quarter on the same theoretical basis. For comparative purposes the yields from sire rows may accordingly be left out of the calculation.

TABLE 4.

Comparative Row Yields from the Ancestry of Ears from (a) High-yielding Rows and (b) Low-yielding Rows Harvested in 1918.

FIRST QUARTER OF BREEDING PLOT

Number of Ears from Highest Yielding Rows, 1918 to be Planted in 1919	Dam Number	Dam Number	Yield of Dam in Given Year			Number of Ears from Lowest Yielding Rows, 1918 to be Planted in 1919	Dam Number	Dam Number	Yield of Dam in Given Year		
			1916	1917	Av.				1916	1917	Av.
302 ...	202	104	30.9	17.7	24.3	304	212	122 L. Mc	25.5	12.7	19.1
308 ...	204	112	35.7	11.9	23.8	314	202	104	30.9	17.7	24.3
312 ...	220	108	24.5	12.5	18.5	318	218	120	24.9	12.5	18.7
306 ...	218	120 HED	24.9	12.5	18.7	320	Lees White				
310 ...	225	.....	.....	.....	.....	322	Wimple's Flint				
316 ...	212	122 L. Mc	25.5	12.7	19.1	324	N. W. Dent				
			28.3	13.5	20.9				27.1	14.3	20.7

SECOND QUARTER OF BREEDING PLOT

Number of Ears from Highest Yielding Rows, 1918 to be Planted in 1919	Dam Number	Dam Number	1916	1917	Av.	Number of Ears from Lowest Yielding Rows, 1918 to be Planted in 1919	Dam Number	Dam Number	1916	1917	Av.
326 ...	236	174 M. 13	43.3	12.7	28.0	328	240	160	39.5	11.4	25.5
332 ...	238	152	49.7	12.3	31.0	330	246	166	45.9	11.4	28.6
334 ...	244	158	39.5	15.1	27.3	336	248	174 M. 13	43.3	16.6	29.9
338 ...	236	174 M. 13	43.3	12.7	28.0	342	246	166	45.9	11.4	28.6
340 ...	240	160	39.5	11.4	25.4	344	Lees White				
346 ...	Flint					346	Flint				
			43.1	12.8	27.9				43.6	12.7	28.1

THIRD QUARTER OF BREEDING PLOT

Number of Ears from Highest Yield ing Rows, 1918 to be Planted in 1919	Dam Number	Dam Number	Yield of Dam in Given Year 1916	1917	Av.	Number of Ears from Lowest Yield-ing Rows, 1918 to be Planted in 1919	Dam Number	Dam Number	Yield of Dam in Given Year 1916	1917	Av.
354 ...	256	144 HED	28.7	13.2	20.9	352	252	126	38.9	16.0	27.4
358 ...	254	136	35.7	14.5	25.1	356	262	146 L. Mc	35.7	12:3	24.0
360 ...	260	140	39.8	13.8	26.8	366	256	144 HED	28.7	13.2	20.9
362 ...	266	136	35.7	11.2	23.4	370 White IEL					
364 ...	252	126	38.9	16.0	27.4	372 Flint					
368 ...	262	146 L. Mc	35.7	12.3	24.0	374 Eureka N.W .Dent					
			35.7	13.5	24.6				34.4	13.8	24.1

FOURTH QUARTER OF BREEDING PLOT

376 ...	280	194 HED	39.5	12.7	26.1	382	282	180	35.7	11.2	23.4
378 ...	290	186	37.0	19.9	28.4	384	294	180	35.7	11.7	23.7
380 ...	296	188	39.5	13.8	26.6	386	298	198 M. 13	44.6	20.3	32.4
388 ...	280	194 HED	39.5	12.7	26.1	394 White Dent					
390 ...	290	186	37.0	19.9	28.4	396 Flint					
392 ...	296	.188	39.5	13.8	26.6	398 N.W .Dent					
			38.7	15.4	27.0				38.7	14.4	26.5

The averages from Table 4, are abstracted therefrom in order to construct the following Table 5, which makes it easier to compare yields from the ancestors of the (a) high-yielding and (b) low-yielding strains respectively.

TABLE 5.

Average Actual Yields in Bushels of Ear Corn Per Acre, of Ear-Rows of 1916 and 1917, Out of Which the Mother-ears for Planting in 1918 Were Chosen, from Which in Turn the Supposedly High-yielding Mother-ears for Planting in 1919 are Selected.

Quarter of Plot	Average Row-yields of Predecessors of Higher Yielding Rows			Average Row-yields of Predecessors of Lower Yielding Rows		
	1916	1917	Av.	1916	1917	Av.
1st	28.3	13.5	20.9	27.1	14.3	20.7
2nd	43.1	12.8	27.9	43.6	12.7	28.1
3rd	35.7	13.5	24.6	34.4	13.8	24.1
4th	38.7	15.4	27.0	38.7	14.4	26.5
Av.	36.4	13.8	25.1	35.9	13.8	24.8

A comparison of the averages in the preceding Table 5, brings out the fact that in three of the four quarters of the breeding plot the progenitors of higher yielding rows yielded slightly higher than those of the lower yielding rows from the same quarters. A comparison of the general average yields in the lower line shows these yields to be very close together, namely 0.3 bushels per acre higher in case of the progenitors of the higher yielding rows.

It should be kept in mind while making these comparisons that all ears chosen in 1917, for planting in 1918, came out of comparatively high yielding rows; accordingly, it would be expected that only slight differences would be found between yields of the progenitors of the highest and those proving to yield slightly lower.

It was not the intention in the beginning of this corn breeding plot three years ago to prove that high yielding progeny may be expected to grow from high yielding ancestry. Said proposition however must be found to obtain under the usual conditions of establishing ear-to-row plots for practically increasing corn yields or such systems themselves will not stand. The justification for recommending any given ear-row system of corn breeding by selection, practically is that yields may be increased thereby and other desirable qualities attained. The indications are that this kind of selection is effective.

SOME REFERENCES

"The Old and the New in Corn Culture."—H. Howard Biggar, Year Book of the Department of Agriculture—1918.

"The Distinction Between Heredity and Inbreeding."—E. M. East, American Naturalist, March, 1909.

"Heterozygosis in Evolution and in Plant Breeding."—Bureau of Plant Industry, Bulletin 243.

"Hybridization Methods in Corn Breeding."—G. H. Shull, American Breeder's Magazine, (The Journal of Heredity) April-June, 1910, p. 98.

"Importance of Broad Breeding in Corn."—G. N. Collins, Bureau of Plant Industry, Bulletin 141.

"Increased Yields of Corn from Hybrid Seed."—Collins, Year Book of the Department of Agriculture, 1910, p. 319.

"A Pure Line Method of Corn Breeding."—Shull, American Breeders Magazine, Vol. 5, p. 51.

"Methods in the Artificial Pollenation of Corn."—Genert, American Breeders Association, Vol. 7 and 8, p. 353.

"Corn Crossing."—McCluer, Illinois Experiment Station, Bulletin 21.

"Progress in Methods of Producing Higher Yielding Strains of Corn."—C. P. Hartley, Year Book of the Department of Agriculture, 1909, p. 309.

"Corn Culture."—South Dakota Bulletin 181.

"Outline of a Plan for Corn Breeding."—L. H. Smith, Illinois Experiment Station Circular 221.

"Corn Breeding and Registration."—C. G. Williams, Ohio Experiment Station Circular 66.

"Principles of Breeding."—Davenport, Ginn & Co.

ANNUAL RAINFALL BY MONTHS AT THE SEVERAL STATIONS

BROOKINGS

	1905	1906	1907	1908	1909	1910	1911
Jan.	0.22	0.17	1.06	0.26	1.20	1.07	0.61
Feb.	1.00	0.02	0.28	1.80	1.57	0.40	0.53
Mch.	0.68	0.58	0.55	1.16	0.37	0.35	0.53
Apr.	1.01	1.40	1.67	2.10	1.16	2.34	1.62
May	6.14	3.51	2.36	6.46	4.85	0.87	1.90
June	6.09	4.89	5.65	6.35	2.29	1.85	3.78
July	0.98	1.86	3.77	4.69	2.44	1.68	3.32
Aug.	4.54	4.28	1.41	2.37	3.39	2.46	3.81
Sept.	2.16	5.13	1.28	3.89	1.67	0.96	3.08
Oct.	1.50	3.01	0.96	1.43	1.71	0.38	5.12
Nov.	2.45	0.89	0.10	1.30	0.65	0.17	0.23
Dec.	T	0.52	1.12	0.42	1.14	0.10	0.42
Total	22.77	26.26	20.21	32.17	22.44	12.63	24.95

BROOKINGS

	1912	1913	1914	1915	1916	1917	1918
Jan.	0.28	0.02	0.22	0.18	1.47	1.54	0.19
Feb.	0.24	0.09	0.40	1.12	0.32	0.47	0.14
Mch.	0.26	0.45	0.42	0.18	0.50	1.09	0.44
Apr.	3.36	2.24	1.64	2.03	2.95	3.09	1.28
May	6.98	3.60	4.16	2.12	3.72	3.08	3.40
June	2.09	1.96	6.67	3.28	4.27	3.49	1.85
July	2.52	2.99	1.62	3.04	0.40	2.03	3.95
Aug.	4.68	1.33	3.16	3.52	2.03	1.20	4.19
Sept.	1.61	1.55	3.32	2.68	0.84	2.89	0.72
Oct.	0.96	1.18	2.21	1.37	0.45	0.12	1.56
Nov.	0.00	0.81	T	0.28	0.03	0.04	1.61
Dec.	0.20	0.09	0.33	0.62	0.36	0.31	1.09
Total	23.18	16.31	24.15	20.42	17.34	19.35	20.42

COTTONWOOD

	1910	1911	1912	1913	1914	1915	1916	1917	1918
Jan.	0.66	T	0.17	0.16	0.03	0.39	0.04	0.45	0.32
Feb.	0.97	0.15	0.05	0.10	1.18	1.57	0.02	1.50	1.50
Mch.	0.76	T	3.00	0.43	0.35	0.46	0.04	0.31	0.34
Apr.	1.06	0.85	3.32	1.15	2.26	2.80	0.81	0.80	2.27
May	2.54	1.10	1.18	2.95	2.35	6.61	3.87	3.30	2.78
June	1.30	0.64	0.95	0.59	1.64	4.79	1.83	0.62	1.37
July	1.11	0.59	2.42	0.81	1.04	4.58	1.80	0.90	2.29
Aug.	0.48	2.41	3.42	1.84	1.88	2.51	2.22	2.00	3.43
Sept.	0.82	3.59	1.30	1.15	1.19	2.42	0.18	1.17	1.43
Oct.	0.32	1.15	0.11	0.76	2.23	0.90	0.57	0.14	0.28
Nov.	0.53	0.20	T	0.14	0.02	T	0.15	0.39	0.11
Dec.	3.00	0.42	0.12	0.38	0.84	0.10	0.14	0.50	0.25
Total	12.65	11.10	16.04	10.46	15.28	27.31	11.67	12.08	16.37

EUREKA

	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Jan.	0.10	0.60	0.50	0.25	0.10	0.22	0.90	0.79	0.40	0.14
Feb.	0.45	1.70	0.73	0.40	0.03	0.05	1.08	0.13	0.20	0.50
Mch.	0.14	1.23	0.62	1.05	0.09	0.13	0.23	1.78	1.46	0.58
Apr.	0.50	0.82	2.24	1.29	0.68	2.07	1.83	0.88	2.18	1.98
May	2.65	0.42	0.97	3.37	1.97	2.20	2.58	3.57	1.30	1.97
June	3.35	3.80	1.29	1.50	2.91	4.28	4.66	4.16	1.61	0.93
July	2.21	0.53	0.43	2.19	2.16	1.25	3.38	—	1.04	1.03
Aug.	1.39	2.60	3.27	3.27	1.53	2.11	2.47	4.62	0.93	1.77
Sept.	1.25	3.65	1.15	1.43	0.54	0.70	3.74	1.05	0.67	0.36
Oct.	0.17	0.18	0.61	0.07	1.52	0.87	3.10	0.29	0.06	0.55
Nov.	0.60	T	0.88	T	0.06	T	0.56	0.14	2.00	0.53
Dec.	2.40	0.25	0.80	0.11	0.52	0.53	0.36	0.06	0.75	0.20
Total	15.21	15.78	13.79	14.93	12.11	14.41	24.89	17.47	12.60	10.54

HIGHMORE

	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Jan.	T	0.26	0.82	0.11	0.13	0.05	0.13	0.43	1.40	1.12	0.60
Feb.	0.53	0.34	0.19	0.39	0.11	0.30	0.62	1.28	0.27	0.52	0.25
Mch.	0.00	0.13	0.58	2.54	0.27	0.87	0.45	0.37	0.74	1.27	0.45
Apr.	1.35	0.30	1.40	0.32	1.05	1.27	3.65	2.50	0.89	2.79	2.57
May	2.68	4.72	0.94	2.31	2.20	4.56	2.23	3.48	4.15	2.04	3.57
June	5.78	1.69	3.74	0.09	1.31	0.97	4.09	4.87	4.54	2.04	1.59
July	2.49	1.81	0.85	2.69	1.44	1.79	2.01	5.55	2.10	1.91	5.26
Aug.	3.53	3.74	0.66	2.52	3.39	1.20	1.16	0.78	4.10	0.68	1.88
Sept.	0.62	1.70	0.89	3.06	0.71	0.53	1.01	2.36	2.75	2.03	0.62
Oct.	2.19	1.04	0.24	1.05	0.20	0.61	1.92	1.15	0.58	0.06	0.49
Nov.	1.39	0.71	0.40	0.35	0.00	0.03	—	0.32	0.13	0.07	1.10
Dec.	0.31	1.41	0.44	0.44	0.35	0.28	0.25	0.20	0.47	0.27	0.86
Total	28.87	17.85	9.05	15.87	12.00	12.46	17.52	23.29	22.12	14.80	19.24

VIVIAN

	1915	1916	1917	1918
Jan.	0.50	1.00	1.35	1.10
Feb.	1.77	0.04	0.18	0.50
Mch.	1.19	0.29	1.00	0.50
Apr.	2.62	1.08	2.38	3.92
May	3.02	3.46	5.20	3.33
June	4.31	4.49	1.18	1.70
July	6.76	3.53	1.02	2.07
Aug.	1.12	3.52	2.01	3.32
Sept.	3.16	0.90	2.64	0.75
Oct.	1.12	0.57	0.00	0.82
Nov.	0.38	0.12	—	0.22
Dec.	0.03	0.04	0.32	0.90
Total	25.98	19.04	17.28	19.13

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105. Stock Food for Pigs.
106. Sugar Beets in South Dakota.
107. Sheep Scab.
111. A Study of South Dakota Butter with suggestions for improvement.
114. Digestion Coefficient of Grains and Fodders for South Dakota.
129. Growing Pedigreed Sugar Beet Seed in South Dakota.
130. Some New Fruits.
131. Scabies (Mange) in Cattle.
132. Effects of Alkali Water on Dairy Products.
134. More Winter Dairying in South Dakota.
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143. Roughage for Fattening Lambs.
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164. Making Butter and Cheese on the Farm.
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180. Root Crop Culture in South Dakota.
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182. Corn Silage for Beef Production.
183. Barley Culture in South Dakota.
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185. Making Ice on the Farm.

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