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EAR TYPE SELECTION AND YIELD IN CORN

BY

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INTRODUCTION

Superficially, nothing could be much more plausible than the corn score card. The man who feeds corn, hence, the man who puts it to its ultimate use, when confronted with samples of ear corn will select the one that represents the *largest amount* of *sound corn*. Therefore the man who grows corn aims to produce that type which fulfils this requirement. It can very readily be demonstrated that the maximum possible yield of shelled corn is to be found in an ear which is large, cylindrical in shape, has deep kernels, minimum space between the rows of kernels, and maximum filling of butts and tips. What, then, would seem more reasonable than to have before one a standard, a mental score card, embodying these features, and to select carefully toward it, in the hope of producing a crop consisting of that type of ears?

The man who attempted to improve his corn by this type of selection, however, frequently found his immediate results disappointing. The yields from ears which approached the score-card ideal were not strikingly superior to those produced by mediocre ears. Furthermore, no marked increase in the percentage of these "near ideal" ears in the progeny of ears of corresponding parentage was noted.

The failure to obtain immediate results was readily explainable on the basis of the open pollination of the corn plant, which renders impossible any knowledge of the male parent of any selected ear. Furthermore, when ear selection was carried on without any reference to the character of the plant itself, knowledge even of the female was, at best, imperfect. These facts, however, are not sufficient to explain failure to obtain results when the selection is continued for some time. The percentage of ears approaching the ideal should increase as a result of continued selection, and unless this type of ear is definitely correlated with some undesirable plant character, the hoped-for increase in yield should be obtained regardless of the above facts.

The failure on the part of earlier corn breeders to obtain indications of progress, therefore, has suggested the need of definite experimental tests, directly attacking the question of the relation of ear type to yield. Experimentation of this nature began about twelve years ago. The final results of the most extensive investigations have been reported within the last few years. In the main they are corroborated by the results presented in this bulletin, which embodies data of a

somewhat different character from those collected by other investigators and describes investigations covering a period of eleven years.

The reasons why ear selection is attended with results of the character indicated are now pretty well understood by students of heredity. An attempt is made in this bulletin to explain these in a way that will help clear up the otherwise rather perplexing question in the mind of the corn breeder.

REVIEW OF PREVIOUS WORK

Definite investigation of the relation between ear characters and yield seems to date back to about 1904. Montgomery (1909) reported a comparison between a rather long, smooth type of ears selected from Reid's Yellow Dent, and the standard type of this variety, which was much less elongated and comparatively rough. As an average of four years, beginning with 1905, selection having been begun in 1904, a difference of 4.4 bushels per acre in favor of the smooth type was obtained.

In the same publication, Montgomery also reported a study of the relation between size of ear and yield. In 1906, 204 ears were planted by the ear-to-row method, each ear having first been weighed. A part of each ear was saved and planted in the same way in 1907. No relation between the weight of the parent ears and the yield of respective rows was found in either year. Another test of this relation was made by determining the average weight of ears in each of the progenies during both years. This test, like the first, brought out no relation. Low-yielding rows averaged as high in size of ears as high-yielding ones, and the percentage of large ears was as high in low-yielding as in high-yielding rows.

The first comprehensive and exhaustive test of the relation of ear characters to yield was made by Williams and Welton (1909, 1915). The types used were long and short, cylindrical and tapering, bare and filled tips, rough and smooth dented, heavy and light, high and low shelling percentage, high, low, and medium number of rows. The following, in brief, are the results reported.

Long vs. short ears.—As an average for ten years there was a difference of 1.39 bushels per acre in favor of the long ears. This difference was regarded by the authors themselves as "no greater than might have been expected had the seed used been identical."

Cylindrical vs. tapering.—A difference of 1.65 bushels in favor of tapering ears was obtained as an average for nine years. The authors regarded this as being within the limits of experimental error.

Bare vs. filled tips.—As an average for eight years a difference of 0.34 bushels was shown. The authors concluded that "this sort of selection . . . has been barren of important results."

Rough vs. smooth dented.—As an average for seven years a difference of 1.76 bushels in favor of the smooth type was found. In their conclusions the authors state that "it would seem that if ears are in all other particulars suitable for seed purposes, smoothness of type should not be regarded as sufficient grounds upon which to discard them."

Heavy vs. light ears.—Two tests, an ear-to-row test and a plot test, were reported in 1909. Continued trial was not reported in 1915. In the ear-to-row test the heaviest 40 per cent of 400 ears was compared with the lightest 40 per cent. A difference of 2.08 bushels in favor of the heaviest was obtained as an average for three years. The authors regarded this as significant.

The plot test consisted of a comparison between 50 representative heavy ears and 50 representative light ears. A difference of 1.93 bushels in favor of the heavy ears was obtained as an average for two years. The authors were unwilling to draw a positive conclusion from this test alone, but stated that "the two tests taken together would seem to indicate a value for the heavy-weight ear."

High vs. low shelling percentage.—As an average for six years a difference of 0.42 bushel in favor of the ears of low shelling percentage was recorded. This practically amounts to no difference.

High, low, and medium number of rows.—Ears with 14, 16, and 18 rows, respectively, were compared for a period of five years. The test was carried on at three stations. At two of them the 14-row ears led while at the other the highest yield was obtained from the 16-row ears. The authors concluded that "with this as with the other ear characters the yield is but slightly affected by this type of selection."

Pearl and Surface (1910) presented the following comparison which is typical of several reported in their bulletin. A group of five excellent ears of sweet corn was compared with a group of five very inferior ones. The two groups are illustrated in their paper and the difference between them is very striking. The resulting yields of each of these groups showed a difference of 1.1 bushels per acre in favor of the good type.

These ears were also compared with reference to the amount of good corn produced by each. It was found that the crop from the good ears showed no larger percentage of the total shelled corn on ears of A-1 quality than did the crop from the poor ears. Again, the crop from the good ears produced essentially the same percentage of its total shelled corn on ears too poor for seed, as did the crop from the poor ears.

Pearl and Surface have also collected a large number of data bearing on the relation of weight of ears to yield. Not all of these have

been compiled. The writers have made certain compilations from them, which are presented in another part of this bulletin. They show no relation.

The following partial quotation of these investigators is extremely pointed, "The large, well-tipped, beautifully shaped ear is just as likely as not to be a poor yielder when planted. This result means that the external visible characters are a very unreliable indication of its worth for seed purposes."

Love (1912) reported on correlation studies involving several ear characters and yield per stalk. His test included two varieties and covered a period of two years. The following are the characters studied and the results obtained:

Length of ear and yield.—"A slight advantage in favor of the long ear." Computations indicate a positive correlation which, however, is of doubtful significance.

Weight of ear and yield.—A slight advantage for the heavy ears is indicated in three out of four comparisons. The author's figures show that the average difference amounts to 1.6 bushels per acre in favor of the heavier ears, on the basis of a yield of 50 bushels per acre.

Number of rows and yield.—In three cases the advantage is with the smaller number of rows and in one with the larger number. In other words, the correlation is negative in three instances and positive in one. The correlation is of a significant degree in only one or possibly two cases, however. Therefore, as the author himself concludes ". . . the number of rows does not have much influence upon yield."

Average weight of kernel and yield.—No relation is indicated.

Ratio of tip circumference to butt circumference and yield.—Are tapering or cylindrical ears the highest yielding? No relation is indicated. Shape of ear has no influence on yield. Data for one year only are presented.

Shelling percentage and yield.—Data for one year only and with one variety only, show slight negative correlation.

Funk (1912), in comparing a smooth with a rough type, found that in one test the smooth outyielded the rough six years out of seven, and in another the smooth led five years out of seven.

Cunningham (1915) made a study of the following ear characters as related to yield: Length, circumference, filling of tips, rounding of butts, roughness or smoothness of kernel indentation, shelling percentage, and number of rows. The data were compiled into three groups representing respectively upper, lower, and average ears with reference to each of the above characters. Several varieties entered into the test. The results were as follows:

Long, medium, and short ears, as an average of nine varieties, gave practically equal yields. The author noted, however, that of the earlier maturing ears the longer ones led, while of the later maturing ones the opposite was true.

With reference to circumference, a slight advantage in favor of the smaller ones was noted.

Results for filling of tips and for rounding of butts indicated no influence upon yield.

Comparison of very rough, medium rough, and smooth types showed that while the smooth outyielded the rough in all of the eight varieties, the medium rough led both in the majority of them.

Between shelling percentage and yield no relation was indicated. Number of rows bore a negative or inverse relation to yield in four of the seven varieties. In the other three, the ears with average or medium number of rows led. The author noted that the latter were comparatively early maturing varieties.

While this bulletin deals with ear characters only, it is of interest to note in this connection an investigation which has been made into the relation between other corn plant characters and yield, since the principle illustrated is the same in both cases.

The most complete investigation of this kind, as far as the writers are aware, is that by Ewing (1910). He worked with the following characters: diameter of stalk, length of leaf, breadth of leaf, height of mature plant, height of seedlings, number of internodes below the ear, length of ear at appearance of silks, and number of branches in the tassel. He used weight of grains per stalk as his measure of yield. Among his conclusions, those which are pertinent to the present discussion are as follows: "In the case of none of the characters discussed above has the coefficient of correlation with yield been found sufficiently great to be of much value as an index to selection. No single character has shown itself so closely connected with yield of grain as to stand out as a safe guide to the breeder."

INVESTIGATION AT THE MINNESOTA EXPERIMENT STATION

The investigation involves data obtained from two distinct lines of experimental work: (1) A series of breeding experiments in which the primary object was the general improvement by ear-to-row selection of certain varieties of corn. Score card data were obtained for each ear used in the ear-to-row test, as well as the comparative yields of the progeny. (2) An experiment planned and carried out for the specific purpose of determining the relation between certain ear types and yield. As the two sources of data are unlike in nature the descrip-

tion of the methods and results of the two lines of experimental work will be given separately.

PART I. THE EAR-TO-ROW TEST

The ear-to-row test comprises data obtained at University Farm, Willmar, West Concord, and Cokato. The test at University Farm was by far the most extensive. Two varieties were used, Minnesota No. 13 and Minnesota No. 161. The tests at the other stations include the same varieties, and at Cokato an additional one, Minnesota No. 332.

The variety Minnesota No. 13 was originally obtained from a St. Paul seed company in 1893. It has been bred by the ear-to-row method since 1898, at University Farm. The breeding plot has been handled in the following way:

1. From the forty to seventy-five rows grown annually, the best ten to twenty were selected on a yield basis.

2. From each of these ten to twenty rows, from six to ten ears were selected from the field by inspection.

3. Since 1902 new blood has been introduced once by planting another selection of this variety in rows alternating with the breeding rows, which were detasseled.

4. The selected ears were scored and measured according to the following score card and scheme:

Maturity	25	Length of ear (inches)
Form of ear	20	Circumference (inches)
Variety character	15	Weight of ear (grams)
Tips	5	Weight of shelled corn (grams)
Butts	5	Percentage of shelled corn (by weight)
Kernel uniformity	10	
Percentage of corn to ear	20	
Total score	100	

5. The selected ears which received the highest total score were used in the ear-to-row work of each succeeding year.

The data concerning Minnesota No. 13 are for the years 1906 to 1914, inclusive, except 1908. Other years are omitted in some of the comparisons, as will be noted in the tables.

The variety Minnesota No. 161 was obtained from William Mulbrand, Le Sueur, in 1898. It was handled in the same way as Minnesota No. 13, except that no new blood was ever introduced. Data for Minnesota No. 161 are given for the years 1906 to 1913, inclusive, except 1908 and 1912. In some of the comparisons other years are omitted because of the incompleteness of the data for those years.

The variety Minnesota No. 332, which was used in the tests at Cokato, came from a selection made by Emil Titrud, of Cokato. It was handled in the same way as Minnesota No. 161 but for a shorter

period, as were also the other tests carried on at the three outlying stations.

PRESENTATION OF DATA

Table I shows the general character of the data and the first step in the compilation. A description of each of the ears planted in 1911 is included, together with its yield in bushels per acre. The description is the score of each of the ears and its measurements according to the score card and scheme already described. Not all of the score-card points appear in the table, as all are not involved in the studies with which this bulletin deals. Thus ear No. 4705 has a total score of 74. Only 20 of this appears in the table. The other 54 points represent the total for maturity, form of ear, and shelling percentage (page 10).

A similar table is compiled for each year included in the test.

Relation of length of ear to yield.—Examination of the column for length of ear, in Table I, shows a range of variation of this character from 6.5 inches to 8.75 inches. On the basis of this variation, the ears have been separated into groups or classes, each group or class being represented by a part of the range covered by all of the ears. Table II illustrates this.

The forty-two ears included in Table I have been grouped into quarter-inch classes for length of ear in Table II. The yields of the progeny of those ears whose lengths fall in a particular class have been entered under the class heading in the table. Then averages were obtained for the yield of each class for length of ear, and the number of ears which appear in any particular class is recorded. This compilation is made for each year, and the averages thus obtained are brought together in Table III.

The final analysis of the data is given in Table III. Here all of the original classes are combined first into three groups, the "lower," "middle," and "upper" third, and then into two, the "lower" and "upper" half. This shows whether there is any relation between the character in question and yield. The grouping is brought about in the following way: Taking the 1911 figures again, for illustration, we find there are 42 ears represented. Each of the three classes, therefore, will consist of 14 ears. The 14 ears in the lower third class consist of the one ear in the 6.50 class, the two ears in the 7.00 class, the one ear in the 7.25 class, the nine ears in the 7.50 class, and one of the ten ears in the 7.75 class. The yield in each of these classes is multiplied by the number of ears in the class, the products added together, and the result divided by 14, thus:

$$(68.3\times1)+(65.0\times2)+(58.7\times1)+(62.3\times9)+(62.2\times1)=62.8$$

TABLE I

TYPICAL DESCRIPTION OF EARS PLANTED, MINNESOTA NO. 161 CORN, 1911

Ear Number	Score: Variety character	Score: Tips	Score: Butts	Score: Kernel uniformity	Score: Total	Length of ear	Circumference of ear	Weight of ear	Shelling percentage	Yield per acre
						In.	In.	Gr.		Bu.
4705	11	1	2	6	74	7.50	6.25	233.8	84.1	59.3
4709	12	1	2	6	71	7.50	6.50	240.3	81.0	59.9
5108	13	4	2	7	85	7.75	6.00	231.3	81.1	65.1
5112	14	3	4	7	89	7.50	6.50	258.8	84.1	63.7
5307	11	3	2	6	73	6.50	6.00	198.9	79.4	68.3
5310	9	0	2	4	71	8.00	6.50	265.5	84.7	70.8
5312	13	3	3	7	85	8.00	6.75	286.6	81.8	67.1
5605	13	3	3	7	84	8.25	6.25	290.2	82.8	58.3
5607	12	0	3	6	77	7.50	6.25	234.0	85.4	63.1
5608	10	1	3	5	72	7.75	6.25	266.8	80.0	53.1
5610	13	2	4	7	85	7.75	6.25	254.2	84.6	64.2
5611	14	3	3	6	87	7.50	6.00	229.5	85.6	72.6
5612	12	0	2	6	80	7.00	6.25	226.7	86.1	62.1
5613	10	1	2	7	72	7.75	6.25	244.2	83.0	54.5
5708	12	1	3	6	80	8.25	6.50	259.6	82.5	66.5
5709	12	0	1	5	71	8.75	6.25	276.3	80.7	67.4
5710	13	2	2	6	83	8.00	5.75	234.3	85.7	63.2
5712	11	2	3	5	73	8.25	6.50	286.3	77.2	65.5
5713	12	2	3	6	77	8.00	6.50	262.7	84.4	53.9
5806	13	0	3	6	82	8.00	6.00	237.6	83.8	64.5
6305	12	2	2	7	83	7.00	6.75	256.9	84.9	67.8
6309	14	3	3	8	87	8.25	6.25	287.7	82.9	72.0
6708	11	3	3	6	79	7.50	6.25	240.7	82.4	64.3
7706	11	2	3	6	77	7.50	6.75	246.1	84.7	57.9
8005	12	3	3	6	82	8.75	6.25	279.4	85.1	63.8
8009	14	4	2	7	86	8.00	6.25	275.0	84.2	63.1
8106	13	2	4	7	83	8.00	6.25	262.1	82.3	75.4
8109	12	4	3	6	81	7.75	6.50	277.8	83.1	64.7
8705	12	1	2	6	77	7.50	7.00	299.6	83.0	68.7
8706	13	2	3	5	75	7.75	6.50	263.0	81.2	71.9
8708	13	2	4	7	81	7.75	6.75	264.1	81.5	65.5
8809	12	1	3	6	82	8.00	6.25	242.4	84.4	59.1
8813	11	4	3	6	81	7.25	6.50	250.0	82.5	58.7
8907	13	0	2	7	76	7.75	6.50	254.1	82.4	62.6
8909	13	3	4	7	83	7.75	6.25	258.1	81.7	54.0
8910	11	0	0	6	68	8.00	6.50	268.5	81.9	64.0
9007	12	4	3	7	78	8.25	6.50	292.3	79.5	61.7
9012	10	4	3	6	82	8.25	6.50	285.3	85.2	62.3
9107	13	0	3	6	82	7.75	6.25	251.2	83.8	66.5
9109	13	0	2	7	82	8.00	6.75	288.1	85.2	65.4
9308	13	2	3	8	85	7.50	6.50	259.4	84.7	52.2
9310	11	0	2	7	71	8.75	6.00	233.3	83.0	61.0

Table III shows that there is a slight progressive increase in yield from the lower to the upper third classes in the case of both Minnesota No. 13 and Minnesota No. 161. The difference in favor of the upper third over the lower third class is 0.8 bushel for Minnesota No. 13 and 1.2 bushels for Minnesota No. 161. In estimating the significance of this difference and of the progressive array of the final averages, other comparisons afforded by the table are of interest. We

find, for instance, when we examine each of the six yearly results for Minnesota No. 13 that the lower third class leads in three years, the middle third in one, and the upper third in two. This apparently represents a mere chance array of the annual results. That is to say, the array is about the same as would be expected had each of the three groups represented a random selection of ears from a lot of corn. The deviation from such expectation is in the opposite direction from that indicated by the final averages.

TABLE II

RELATION OF LENGTH OF EAR TO YIELD, MINNESOTA NO. 161—1911

	Length classes, inches									
	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75
	Bu.	....	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	....	Bu.
	68.3	....	62.1	58.7	59.3	65.1	70.8	58.3	....	67.4
	....	....	67.8	....	59.9	53.1	67.1	66.5	....	63.8
	....	....	....	....	63.7	64.2	63.2	65.5	....	61.0
	....	....	....	....	63.1	54.5	53.9	72.0	....	....
	....	....	....	....	72.6	64.7	64.5	61.7	....	....
	....	....	....	....	64.3	71.9	63.1	62.3	....	....
	....	....	....	....	57.9	65.5	75.4	....	....	....
	....	....	....	....	68.7	62.6	59.1	....	....	....
	....	....	....	....	52.2	54.0	64.0	....	....	....
	....	....	....	....	....	66.5	65.4	....	....	....
Average	68.3	....	65.0	58.7	62.3	62.2	64.7	64.4	....	64.1
Number of ears	1	....	2	1	9	10	10	6	....	3

Applying the same analysis to Minnesota No. 161, the results are found to support the indication of direct or positive relation found in the final averages. The upper third class leads in three years and the middle class in the fourth year.

Another analysis of the data is afforded by a direct comparison of the original classes in the body of the table. Thus, for Minnesota No. 13 we have a six-year average for each class from 7.50 to 8.25, inclusive. This comparison shows a tendency toward a positive relation, the yield for the 7.75 class being the only exception. When the 1914 yields are excluded, however, so as to include one more class, the 7.25, in the comparison, little or no such tendency is exhibited. Similarly, when the comparable classes in the Minnesota No. 161 table are noted (classes 7.00 to 8.00 inclusive), no regular tendency, but mere fluctuation, is found to exist.

In the data from the outlying stations, Table IV, it is apparent at once that no relation is suggested. The average ears (middle third class) are found to lead in all cases except one, in which the middle and upper third classes are identical. Comparison of the upper and lower third classes, shows that each leads in two out of the four cases.

TABLE III

RELATION OF LENGTH OF EAR TO YIELD—UNIVERSITY FARM

Year	Length classes, inches																				Lower third	Middle third	Upper third	Lower half	Upper half
	6.25		6.50		6.75		7.00		7.25		7.50		7.75		8.00		8.25		8.50		8.75						
	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.					
Minn. 13		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
1909.....	1	63.0	1	64.5	..	....	6	63.9	8	66.6	12	65.2	7	68.5	5	68.0	1	66.0	..	....	..	....	65.0	65.4	67.9	65.1	67.1
1910.....	..	....	..	....	..	....	..	....	5	44.5	12	47.2	7	45.5	11	44.7	2	50.7	2	46.3	..	....	46.2	45.9	45.9	46.1	45.9
1911.....	..	....	..	....	3	50.6	4	54.0	8	53.8	10	57.7	8	58.5	3	55.4	2	58.4	..	....	..	....	53.1	56.8	57.7	54.5	57.5
1912.....	..	....	1	55.0	2	45.1	8	46.9	6	45.5	9	45.8	5	40.7	7	46.1	3	46.6	3	47.8	..	....	46.8	44.7	45.8	46.0	45.5
1913.....	..	....	1	57.9	3	71.9	3	67.4	4	70.0	16	68.1	4	68.2	2	69.0	1	62.2	2	63.9	..	....	68.7	68.1	67.1	68.6	67.4
1914.....	..	....	..	....	..	....	..	....	..	....	4	64.7	12	66.1	8	67.4	5	69.5	5	61.1	1	61.2	65.6	66.8	65.2	66.0	65.7
Average	..	....	..	....	..	....	..	....	..	....	..	58.1	..	57.9	..	58.4	..	58.9	..	....	..	....	57.5	58.0	58.3	57.7	58.3
Av. all years except 1914	..	....	..	....	..	....	..	....	..	56.1	..	56.8	..	56.3	..	56.6	..	56.7	..	....	..	....	....	....	....	....	....
Minn. 161																											
1908.....	..	....	..	....	..	....	4	68.8	5	67.3	7	63.3	9	65.6	14	66.8	3	63.8	6	73.0	1	63.3	65.9	66.1	68.3	66.0	68.0
1910.....	..	....	..	....	1	46.7	5	49.3	10	50.4	6	50.9	8	46.4	14	48.4	4	57.1	2	47.6	..	....	49.9	48.2	50.4	49.3	49.7
1911.....	..	....	1	68.3	..	....	2	65.0	1	57.8	9	62.3	10	62.2	10	64.7	6	64.4	..	....	3	64.1	62.8	63.1	64.4	62.9	64.0
1913.....	..	....	..	....	5	71.3	4	67.1	5	72.1	9	70.2	9	70.6	1	66.7	..	....	..	....	..	....	69.9	70.7	70.2	70.2	70.4
Average	..	....	..	....	..	....	..	62.6	..	61.9	..	61.7	..	61.2	..	61.7	..	....	..	....	..	....	62.1	62.0	63.3	62.0	62.9

TABLE IV

RELATION OF LENGTH OF EAR TO YIELD—WEST CONCORD, WILLMAR, AND COKATO

Variety and place	Year	Length classes, inches: 6.00		6.25		6.50		6.75		7.00		7.25		7.50		7.75		8.00		8.25		8.50		8.75		Lower third	Middle third	Upper third	Lower half	Upper half
		Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.					
			Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13 W. Concord ..	1910	1	21.4	1	21.4	2	40.4	1	30.2	6	30.4	3	33.6	11	34.0	2	35.8	1	31.5	1	27.7	..	....	..	....	30.6	33.5	33.5	31.3	33.6
W. Concord ..	1909	..	....	..	....	..	....	3	47.0	1	34.7	3	26.3	9	40.9	1	44.0	2	35.8	1	22.0	..	....	..	....	36.9	40.2	37.0	37.7	38.3
Average	....	..	....	..	....	..	....	..	38.6	..	32.6	..	30.0	..	38.0	..	39.9	..	33.7	..	24.9	..	....	..	....	33.8	36.9	35.3	34.5	35.9
Minn. 161 Willmar..	1906	..	....	..	....	..	....	..	....	..	....	..	....	1	47.2	6	49.9	7	43.3	1	32.4	4	39.4	4	33.5	47.8	41.6	36.3	47.0	37.6
Willmar..	1907	..	....	..	....	2	48.4	4	44.9	4	46.6	3	50.3	6	45.3	3	51.9	..	....	..	....	..	....	..	....	46.2	48.0	48.1	46.6	48.1
Willmar..	1908	1	60.7	1	59.2	4	61.7	1	60.0	4	64.3	3	72.3	4	57.9	1	72.1	..	....	..	....	..	....	..	....	61.0	66.0	63.2	61.8	65.0
Willmar..	1909	..	....	..	....	..	....	..	....	3	32.8	2	34.2	6	32.3	4	45.9	2	38.1	1	39.9	..	....	..	....	33.2	34.6	42.3	32.9	40.5
Average	....	..	....	..	....	..	....	..	....	..	....	..	....	..	45.7	..	55.0	..	....	..	....	..	....	..	....	47.1	47.5	47.5	47.1	47.8
Av. all years except 1906	....	..	....	..	....	..	....	..	....	..	47.9	..	52.3	..	45.2	..	56.6	..	....	..	....	..	....	..	....	....	....	....	....	....
Minn. 332 Cokato ..	1907	..	....	..	....	..	....	..	....	..	....	..	....	..	....	3	44.0	6	45.8	6	44.9	2	46.8	2	39.3	45.0	45.2	43.7	45.2	44.1
Cokato ..	1908	..	....	..	....	..	....	..	....	1	51.6	3	56.9	9	57.1	4	59.6	4	54.6	3	51.9	1	54.0	..	....	56.4	58.4	53.5	57.1	55.6
Average	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	51.8	..	50.2	..	48.4	..	50.4	..	....	50.7	51.8	48.6	51.4	49.9
Minn. 13 Cokato ..	1910	..	....	..	....	..	....	1	45.9	..	....	1	51.2	4	47.9	1	56.6	13	52.5	1	50.2	3	47.7	..	....	49.7	52.5	50.4	50.7	51.1
Cokato ..	1913	..	....	..	....	..	....	1	55.6	1	58.2	2	45.1	4	48.4	6	48.3	5	49.2	1	30.7	2	39.6	..	....	49.2	48.4	43.8	49.3	45.5
Average	....	..	....	..	....	..	....	..	50.8	..	....	..	48.2	..	48.2	..	52.5	..	50.9	..	40.5	..	43.7	..	....	49.5	50.5	47.1	50.0	48.3

The above data evidently offer no encouragement for selection emphasizing length in the hope of obtaining important increase in yield.

Relation of weight to yield.—Table V shows the advantage to be with the ears of average weight in the case of Minnesota No. 13. Not only is this true when the final averages are noted, but it is true for five of the six-year yields from which the averages are obtained. In the case of Minnesota No. 161, the advantage is with the heaviest ears, according to the final averages. But the yield of the lower third class exceeds that of the middle third class, by 0.2 bushel. The difference in favor of the upper third class over the lower third is 0.3 bushel. Obviously the advantage of the heaviest ears is of no significance. Further support for this conclusion is found when the results for each of the five years are examined. The heaviest class exceeds the lightest in only three out of the five years. When the three classes are compared, the heaviest class leads in two years, the middle in two, and the lowest in one year.

Results at the outlying stations are in substantial agreement with those for Minnesota No. 13 at University Farm (Table VI). The average ears (middle third class) lead at three out of the four stations. At the fourth, Willmar, yields of the lower and upper classes are identical and are in excess of the yield of the middle class.

The conclusion justified by these data is that any conscious selection for weight of ears should consist simply of elimination of extremes. In fact, one is probably safe in picking at random so far as weight is concerned.

Relation of shelling percentage to yield.—According to final averages for lower, middle, and upper third classes, Minnesota No. 13, University Farm (Table VII), the lower class is somewhat inferior to the other two, which are essentially identical. This would indicate no advantage in selecting seed ears of extremely high shelling percentage, but a slight advantage in eliminating those of very low shelling percentage. When the results for each of the six years are noted, however, the disadvantage of the lower class, while it still exists, is considerably reduced. The high rank of the upper class is largely due to the unusually high comparative yield for this class in 1914.

It is readily seen that the data for Minnesota No. 161 (Table VII) contradict those for Minnesota No. 13. They indicate a small advantage in favor of ears of lowest shelling percentage.

TABLE V

RELATION OF WEIGHT OF EARS TO YIELD—UNIVERSITY FARM

Year	Weight classes, grams																							
	185		200		215		230		245		260		275		290		305		320		Lower third	Middle third	Upper third	Lower half	Upper half
	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld					
		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																									
1909	..	....	4	66.0	16	65.5	12	67.5	7	65.6	2	65.0	..	....	..	....	..	....	..	....	65.6	66.6	66.1	65.9	66.3
1910	..	....	..	....	..	....	..	....	2	40.5	9	45.7	15	46.2	8	46.0	5	46.6	1	43.8	45.0	46.2	46.1	45.4	46.1
1911	..	....	3	50.3	3	51.7	9	54.7	19	58.0	5	55.6	..	....	..	....	..	....	..	....	53.0	57.5	57.2	54.5	57.3
1912	..	....	..	....	16	46.3	16	45.7	8	45.5	4	44.6	..	....	..	....	..	....	..	....	46.3	45.7	45.3	46.1	45.4
1913	..	....	2	64.5	15	68.2	8	69.2	4	63.3	3	69.9	1	70.2	..	....	..	....	..	....	67.5	68.7	67.3	67.9	67.8
1914	..	....	..	....	..	....	2	69.4	8	63.7	8	64.5	7	68.1	5	67.6	2	59.6	1	61.7	64.8	65.8	65.7	65.1	65.7
Average	..	....	..	....	..	....	..	....	..	56.1	..	57.6	..	....	..	....	..	....	..	....	57.0	58.4	57.9	57.5	58.1
Av. all years except 1910	..	....	..	....	..	....	..	61.3	..	59.2	..	59.9	..	....	..	....	..	....	..	....	....	....	....	....	....
Minn. 161																									
1909	10	66.0	22	66.6	11	67.1	4	69.9	1	72.1	..	....	..	....	1	56.2	..	....	..	....	66.2	66.6	67.4	66.3	67.1
1910	..	....	..	....	..	....	3	48.9	5	52.1	9	50.1	17	48.1	11	49.4	5	46.5	..	....	50.5	48.1	48.5	49.7	48.4
1911	..	....	1	68.3	..	....	7	63.7	8	60.7	13	63.2	5	64.6	7	64.6	1	68.7	..	....	62.7	62.8	64.8	62.7	64.1
1913	2	61.1	4	74.1	12	70.2	6	72.5	9	70.3	1	67.6	..	....	..	....	..	....	..	....	70.0	71.4	70.4	70.3	70.6
1906	..	....	..	....	19	62.0	9	62.2	3	61.4	5	60.7	1	66.8	..	....	..	....	..	....	62.0	62.1	61.8	62.0	62.0
Average	..	....	..	....	..	....	..	63.4	..	63.3	..	....	..	....	..	....	..	....	..	....	62.3	62.1	62.6	62.3	62.5

TABLE VI

RELATION OF WEIGHT OF EAR TO YIELD—WEST CONCORD, WILLMAR, AND COKATO

Variety and place	Year	Weight classes, grams																								Lower third	Middle third	Upper third	Lower half	Upper half
		125		140		155		170		185		200		215		230		245		260		275		290		305						
		Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.					
			Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13 W. Concord ...	1908	...	....	...	....	...	....	...	....	...	....	...	....	...	....	5	39.7	11	42.2	4	41.7	4	40.9	1	38.8	...	....	40.8	42.1	41.2	41.2	41.4
W. Concord ...	1909	...	....	...	....	...	....	...	....	...	....	9	36.3	7	37.6	4	34.7	...	....	...	....	...	....	...	....	...	....	36.3	36.8	35.5	36.4	36.1
W. Concord ...	1910	...	....	...	....	...	....	...	....	...	....	...	....	5	30.6	7	28.4	8	34.8	4	32.7	3	37.8	3	32.7	...	....	29.5	33.5	34.2	30.4	34.4
Average	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	35.5	37.5	37.0	36.0	37.3
Minn. 161 Willmar...	1906	...	....	...	....	...	....	...	....	...	....	...	....	1	43.2	...	....	2	39.8	7	46.0	3	44.5	7	45.8	2	44.9	44.1	45.3	45.5	44.5	45.4
Willmar...	1907	...	....	3	45.8	6	47.0	8	47.2	2	45.4	3	51.7	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	46.6	47.2	48.6	46.7	48.1
Willmar...	1908	5	66.8	1	61.7	4	62.4	1	60.0	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	65.3	61.7	61.9	64.3	61.8
Average	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	52.0	51.4	52.0	51.8	51.8
Minn. 332 Cokato ...	1907	...	....	...	....	...	....	...	....	...	....	2	41.7	9	46.4	5	45.0	2	42.0	1	39.0	...	....	...	....	...	....	44.9	46.1	43.0	45.4	44.0
Cokato ...	1908	...	....	...	....	...	....	...	....	...	....	11	54.8	7	57.8	6	56.9	1	54.0	...	....	...	....	...	....	...	....	54.8	56.8	56.7	55.2	57.1
Average	....	...	....	...	....	...	....	...	....	...	....	...	48.3	...	52.1	...	51.0	...	48.0	...	....	...	....	...	....	...	....	49.9	51.5	49.9	50.3	50.6
Minn. 13 Cokato ...	1910	...	....	...	....	...	....	...	....	...	....	1	45.9	...	....	1	49.6	3	52.6	3	48.5	10	51.7	5	52.1	1	43.8	49.9	51.7	51.0	50.4	51.2
Cokato ...	1913	...	....	...	....	...	....	...	....	...	....	...	....	2	49.5	3	39.0	6	48.8	6	49.9	1	47.9	2	53.7	2	39.9	45.0	49.4	48.6	46.3	48.6
Average	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	44.3	...	50.7	...	49.2	...	49.8	...	52.9	...	41.9	47.5	50.6	49.8	48.3	49.9

TABLE VII

RELATION OF SHELLING PERCENTAGE TO YIELD—UNIVERSITY FARM

Year	Shelling percentage classes										Lower third	Middle third	Upper third	Lower half	Upper half
	78		81		84		87		90						
	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield					
		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13															
1909	2	66.2	14	65.1	18	67.8	7	65.0	..	....	65.3	67.4	66.4	66.0	66.7
1910	..	....	8	44.3	14	46.3	16	46.7	1	46.1	45.1	46.4	46.6	45.5	46.5
1911	3	57.8	12	55.5	16	56.3	7	54.0	..	....	56.0	56.2	55.1	56.1	55.5
1912	1	47.4	9	45.3	21	46.4	10	45.0	3	45.0	45.8	46.4	45.1	46.0	45.5
1913	4	63.9	11	69.2	21	68.1	..	....	..	....	67.4	68.4	68.1	67.7	68.2
1914	2	64.8	21	63.9	11	68.3	..	....	..	....	64.1	63.9	67.9	64.1	66.6
Average	..	....	..	52.6	..	57.2	..	....	..	....	57.3	58.1	58.2	57.6	58.1
Minn. 161															
1908	6	66.3	17	68.7	19	66.8	7	63.6	..	....	67.8	67.6	65.5	67.7	66.2
1910	1	50.8	3	49.4	25	48.2	21	49.9	..	....	48.6	48.7	49.9	48.7	49.5
1911	2	66.9	13	64.0	24	63.2	3	65.7	..	....	64.4	63.2	63.7	64.0	63.5
1913	4	73.8	11	70.0	19	70.1	..	....	..	....	71.4	70.1	70.1	71.0	70.1
Average	..	64.5	..	63.0	..	62.1	..	....	..	....	63.1	62.4	62.3	62.9	62.3

At the outlying stations (Table VIII) there is a slight indication of relation. The upper third class is exceeded by both middle and lower classes in three of the four tests. The lower class exceeds the middle by small margins at two of the three stations. Possibly a very slight inverse or negative relation exists.

Relation of circumference to yield.—While there is a constant increase on passing from upper to lower third class, in the case of Minnesota No. 13, University Farm (Table IX), suggesting an inverse or negative relation, the differences are so small as to be practically negligible. This is emphasized when upper and lower half classes are compared, the difference in favor of the latter being only 0.2 bushel.

In the case of Minnesota No. 161 (Table IX), the indication of negative correlation is even less. There is only 0.2 bushel in favor of lower third as compared with upper third class, and the middle class falls below both. When upper and lower half classes are compared, a difference of only 0.1 bushel in favor of the latter is found.

At the outlying stations practically all possible arrays of yields for the three classes are shown (Table X). At West Concord the upper class leads and the middle falls below both extremes. At Willmar the lower class leads, the middle again falling below both extremes. At Cokato a progressive increase in yield from lower to upper class is shown in the case of Minnesota No. 332. With Minnesota No. 13 the upper and middle classes are essentially identical, the middle class leading slightly, and the lower class falling below them.

Relation of butts to yield.—Minnesota No. 13 data indicate no relation of butts to yield, the three classes being essentially equal. In the case of Minnesota No. 161 the advantage is with the average ears. The lower third class leads the upper third by a margin of 0.6 bushel and the difference between upper and lower half is 0.4 bushel in favor of the latter. When the results for each of the original classes, 1.0 to 4.0 inclusive, are noted, mere fluctuation is apparent.

At each of the outlying stations the poorest butts show the highest yields (Table XII). Upper and middle third classes are very close in yield. Possibly slight negative correlation existed in these tests.

Relation of tips to yield.—The better tipped ears have a slight advantage in both Minnesota No. 13 and Minnesota No. 161. In Minnesota No. 13 differences are probably insignificant. This is emphasized by the fluctuation noted when the averages for each of the original classes are compared. With Minnesota No. 161, differences are somewhat greater altho still very small. The original classes show a progressive increase from lower to higher when the six-year averages are compared. The significance of this is greatly reduced, however, when the year 1906 is excluded so as to include class 0 in the comparison.

TABLE VIII

RELATION OF SHELLING PERCENTAGE TO YIELD—WEST CONCORD, WILLMAR, AND COKATO

Variety and place	Year	Shelling percentage classes										Lower third	Middle third	Upper third	Lower half	Upper half
		77		81		84		87		90						
		Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield					
			Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																
West Concord	1908	1	44.3	7	40.6	14	41.3	3	41.6	..	....	41.1	41.3	41.4	41.1	41.4
West Concord	1909	..	....	9	38.8	10	36.5	1	46.3	..	....	38.8	37.2	38.1	38.6	37.5
West Concord	1910	4	32.7	12	33.4	10	31.8	3	30.4	..	....	33.1	32.8	31.3	33.2	31.7
Average	....	..	....	..	37.6	..	36.5	..	39.4	..	....	37.7	37.1	36.9	37.6	36.9
Minn. 161																
Willmar	1906	..	....	4	45.2	14	44.5	3	44.0	2	38.4	44.8	44.5	42.5	44.7	43.3
Willmar	1907	1	53.0	3	50.8	14	40.3	3	46.8	1	51.2	46.6	40.3	44.1	44.3	43.1
Willmar	1908	5	58.7	10	66.8	5	60.6	..	....	..	....	61.0	66.8	62.1	62.8	63.7
Willmar	1909	..	....	4	33.8	9	35.9	4	33.9	..	....	34.5	35.9	34.8	34.9	35.0
Average	....	..	....	..	49.2	..	45.3	..	....	..	....	46.7	46.9	45.8	46.7	46.3
Minn. 332																
Cokato	1907	..	....	4	47.7	10	45.2	4	43.6	..	....	46.9	45.2	44.1	46.3	44.5
Cokato	1908	5	57.1	10	58.3	10	53.4	..	....	..	....	57.6	57.7	53.4	57.8	54.4
Average	....	..	....	..	53.0	..	49.3	..	....	..	....	52.3	51.5	48.8	52.0	49.5
Minn. 13																
Cokato	1910	3	51.6	9	51.4	10	50.2	2	50.8	..	....	51.5	50.8	50.4	51.5	50.3
Cokato	1913	1	51.2	10	46.2	10	47.9	1	50.8	..	....	46.8	47.2	48.3	46.7	48.2
Average	....	..	51.4	..	48.8	..	49.1	..	50.8	..	....	49.2	48.9	49.4	49.1	49.3

TABLE IX

RELATION OF CIRCUMFERENCE TO YIELD—UNIVERSITY FARM

Year	Circumference classes, inches														Lower third	Middle third	Upper third	Lower half	Upper half
	5.50		5.75		6.00		6.25		6.50		6.75		7.00						
	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.					
		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																			
1909	3	68.8	5	65.6	20	65.0	5	67.9	..	....	..	....	..	....	66.3	65.0	66.3	65.9	66.0
1910	..	....	..	....	13	47.1	11	42.1	14	45.2	2	45.5	..	....	47.1	42.6	45.2	45.6	44.3
1911	..	....	2	53.4	11	55.6	20	56.3	4	55.9	2	56.3	..	....	55.3	56.3	56.2	55.6	56.2
1912	..	....	1	39.6	4	41.7	16	47.1	17	45.2	5	49.6	1	39.4	45.2	46.0	46.3	45.5	46.2
1913	..	....	..	....	2	66.6	4	66.6	26	68.7	3	64.9	1	65.4	67.7	68.7	67.5	68.0	67.8
1914	..	....	1	58.0	2	67.1	5	65.6	17	67.7	9	62.1	..	....	65.8	67.7	63.5	66.4	64.9
Average	..	....	..	....	..	57.2	..	57.6	..	....	..	....	..	....	57.9	57.7	57.5	57.8	57.6
Average all years except 1909	..	....	..	....	..	55.6	..	55.5	..	56.5	..	55.7	..	....	....	....	....	....	....
Minn. 161																			
1908	..	....	3	64.7	22	65.9	13	65.1	10	69.2	4	70.4	..	....	65.7	65.5	68.6	65.7	67.6
1910	..	....	..	....	9	51.0	13	49.0	15	48.6	9	47.4	4	50.9	50.1	48.7	48.5	49.7	48.6
1911	..	....	1	63.2	5	66.5	16	62.5	14	62.7	5	64.7	1	68.7	64.0	62.6	63.8	63.5	63.4
1913	..	....	..	....	4	68.4	7	73.8	14	69.7	5	69.8	4	70.3	71.8	69.7	69.9	71.1	69.9
Average	..	....	..	....	..	63.0	..	62.6	..	62.6	..	63.1	..	....	62.9	61.6	62.7	62.5	62.4

TABLE X

RELATION OF CIRCUMFERENCE OF EAR TO YIELD—WEST CONCORD, WILLMAR, AND COKATO

Variety and place	Year	Circumference classes, inches														Lower third	Middle third	Upper third	Lower half	Upper half
		5.50		5.75		6.00		6.25		6.50		6.75		7.00						
		Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield					
			Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																				
West Concord	1909	..	....	3	37.3	2	41.6	13	39.4	..	....	2	45.2	..	....	39.1	39.4	41.1	39.2	40.6
West Concord	1910	..	....	1	33.4	12	33.8	11	29.6	2	36.1	2	39.7	2	32.1	33.8	30.9	33.4	33.2	32.1
Average	....	..	....	..	35.4	..	37.7	..	34.5	..	....	..	42.5	..	....	36.5	35.2	37.2	36.2	36.4
Minn. 161																				
Willmar	1906	..	....	..	....	4	41.1	6	44.8	8	43.6	4	47.9	1	36.4	43.0	43.9	45.0	43.4	44.4
Willmar	1907	2	46.0	3	46.8	7	46.8	5	47.3	2	51.0	2	47.7	..	....	46.6	46.9	48.5	46.6	48.0
Willmar	1908	..	....	4	60.8	9	63.0	5	65.3	1	67.8	..	....	..	....	61.5	63.0	65.6	62.1	64.7
Willmar	1909	3	42.2	3	39.5	5	34.0	4	30.0	1	31.4	..	....	..	....	41.1	34.8	30.9	39.1	31.7
Average	....	..	....	..	....	..	46.2	..	46.8	..	48.5	..	....	..	....	48.1	47.2	47.5	47.8	47.2
Minn. 332																				
Cokato	1907	..	....	1	41.4	11	43.9	5	45.4	1	44.2	1	53.1	..	....	43.2	43.9	46.6	43.6	45.7
Cokato	1908	..	....	5	52.0	9	54.7	7	59.5	4	58.5	..	....	..	....	53.0	55.9	59.1	53.6	58.6
Average	....	..	....	..	46.7	..	49.3	..	52.5	..	51.4	..	....	..	....	48.1	49.9	52.9	48.6	52.1
Minn. 13																				
Cokato	1910	..	....	1	43.9	5	51.3	5	53.9	3	48.8	4	51.7	1	52.3	50.7	53.1	51.2	51.7	51.2
Cokato	1913	..	....	..	....	..	....	6	45.2	2	46.3	12	48.7	2	52.5	45.4	48.4	50.0	46.4	49.5
Average	....	..	....	..	....	..	....	..	49.6	..	47.6	..	50.2	..	52.4	48.1	50.8	50.6	49.0	50.4

TABLE XI

RELATION OF BUTTS TO YIELD—UNIVERSITY FARM

Year	Butt score classes, based on 5 as a perfect score												Lower third	Middle third	Upper third	Lower half	Upper half
	0		1.0		2.0		3.0		4.0		5.0						
	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield					
		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																	
1906	..	....	..	....	2	54.9	3	59.7	31	62.6	6	59.9	60.9	62.6	61.4	61.5	61.8
1907	..	....	..	....	..	....	24	50.6	8	50.3	1	56.7	50.6	50.6	50.9	50.6	50.8
1909	..	....	1	65.9	11	65.4	16	67.0	13	65.6	..	....	65.6	67.0	65.6	66.1	66.1
1910	..	....	1	44.0	7	48.7	26	46.0	6	43.5	..	....	47.3	46.0	44.9	46.9	45.3
1911	..	....	..	....	2	55.1	22	56.0	5	56.5	..	....	55.8	56.0	56.3	55.9	56.2
1912	..	....	2	42.9	12	47.4	21	45.0	9	46.0	..	....	46.6	45.0	45.6	46.1	45.4
1913	..	....	1	65.4	3	65.6	16	68.7	14	66.3	2	73.0	67.7	67.9	67.4	67.8	67.6
1914	..	....	..	....	..	....	3	63.2	18	65.8	12	66.2	65.1	65.8	66.2	65.3	66.1
Average	..	....	..	....	..	....	..	57.0	..	57.1	..	....	57.5	57.6	57.4	57.5	57. 4
Minn. 161																	
1906	..	....	1	66.8	7	63.8	17	61.7	12	61.0	..	....	63.3	61.7	61.0	62.8	61.3
1909	..	....	10	66.2	28	68.6	9	65.0	2	56.7	..	....	67.1	68.6	65.3	67.6	66.0
1910	..	....	6	46.1	17	49.0	24	49.9	3	47.1	..	....	48.0	49.6	49.4	48.5	49.5
1911	..	....	1	67.4	14	63.7	21	62.8	5	64.5	..	....	64.0	62.9	63.5	63.7	63.3
1913	..	....	1	58.4	8	70.0	9	74.3	14	69.6	2	66.8	69.7	72.4	69.1	70.6	70.2
1907	4	61.4	5	66.2	12	62.0	14	63.1	4	64.1	..	....	63.4	62.4	63.4	63.1	63.1
Average	..	....	..	61.9	..	62.9	..	62.8	..	60.5	..	....	62.6	62.9	62.0	62.7	62.3

TABLE XII

RELATION OF BUTTS TO YIELD—WEST CONCORD, WILLMAR, AND COKATO

Variety and place	Year	Butt score classes, based on 5 as a perfect score																		Lower third	Middle third	Upper third	Lower half	Upper half
		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5						
		Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.					
			Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																								
West Concord....	1908	..	....	3	37.0	13	28.9	9	32.2	4	31.5	..	....	..	....	..	....	..	....	31.3	30.0	31.9	30.6	31.7
West Concord....	1909	..	....	1	37.0	1	35.8	9	37.9	3	37.2	1	34.1	..	....	..	....	..	....	37.3	37.9	36.7	37.5	37.1
West Concord....	1910	..	....	..	....	..	....	7	44.3	9	39.8	6	41.8	2	38.9	1	35.2	..	....	43.7	40.0	40.1	42.3	40.2
Average.....	.....	..	....	..	....	..	....	..	38.1	..	36.2	..	....	..	....	..	....	..	....	37.4	36.0	36.2	36.8	36.3
Minn. 16.																								
Willmar	1907	..	....	..	....	..	....	..	....	..	....	2	45.4	12	47.6	8	46.9	1	51.2	47.1	47.5	47.5	47.2	47.4
Willmar	1908	..	....	..	....	..	....	..	....	..	....	..	....	9	64.7	10	62.4	..	....	64.7	63.4	62.4	64.6	62.4
Willmar	1909	1	24.3	..	....	..	....	3	35.9	7	35.4	5	36.0	3	34.4	..	....	..	....	35.7	35.6	35.2	34.4	35.4
Average.....	.....	..	....	..	....	..	....	..	....	..	.. .	..	....	..	....	..	....	..	....	49.2	48.8	48.4	48.7	48.4
Minn. 332																								
Cokato	1907	..	....	..	....	..	....	..	....	..	....	..	....	..	....	8	47.0	11	42.9	47.0	44.0	42.9	46.3	42.9
Cokato	1908	..	....	..	....	..	....	..	....	..	....	10	55.0	14	56.9	1	55.8	..	....	55.0	56.4	56.8	55.4	56.8
Average.....	.....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	51.0	50.2	49.9	50.9	49.9
Minn. 13																								
Cokato	1910	..	....	..	....	2	53.4	6	49.3	3	**54.2**	8	51.3	5	49.4	..	....	..	....	50.5	52.4	50.1	51.4	50.5
Cokato	1913	..	....	5	52.6	9	44.3	7	48.8	1	**40.2**	..	....	..	....	..	....	..	....	50.0	44.8	47.7	48.1	46.8
Average.....	.....	..	....	..	....	..	48.9	..	49.1	..	47.2	..	....	..	....	..	....	..	....	50.3	48.6	48.9	49.8	48.7

TABLE XIII

RELATION OF TIPS TO YIELD—UNIVERSITY FARM

Year	Tip score classes, based on 5 as a perfect score												Lower third	Middle third	Upper third	Lower half	Upper half
	0		1.0		2.0		3.0		4.0		5.0						
	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield					
		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																	
1906	..	....	..	....	4	61.8	11	63.0	19	62.0	8	59.1	62.7	62.1	60.3	63.4	61.0
1907	7	50.3	2	47.4	16	50.9	13	50.4	2	46.1	..	....	50.0	50.8	49.8	50.0	50.1
1909	14	65.7	..	....	16	66.3	6	66.4	4	67.0	1	63.2	65.7	66.3	66.3	65.9	66.4
1910	5	46.2	..	....	18	45.5	12	46.7	4	47.3	2	43.7	45.8	45.9	46.4	45.5	46.6
1911	5	55.4	..	....	8	55.6	15	56.7	7	55.4	3	57.6	55.5	56.7	56.3	55.6	56.1
1912	12	46.5	2	41.4	14	45.5	11	46.1	5	46.2	..	....	45.8	45.6	46.1	45.7	45.9
1913	7	68.8	2	72.0	5	67.1	9	68.2	9	66.2	4	69.0	68.9	67.9	67.1	68.5	67.3
1914	13	63.3	3	62.3	8	69.1	6	66.6	2	67.9	1	70.7	63.3	66.2	67.7	64.2	67.2
Average	..	....	..	....	..	57.7	..	58.0	..	57.3	..	....	57.2	57.7	57.5	57.4	57.6
Average all years except 1906	..	56.5	..	....	..	57.3	..	57.3	..	56.6	..	....	....	....	....	....	....
Minn. 161																	
1906	..	....	..	....	7	62.1	17	61.9	10	62.5	3	62.1	62.0	61.9	62.4	62.0	62.3
1907	9	62.2	..	....	7	63.6	18	62.8	3	63.6	1	67.0	62.6	63.0	63.4	62.7	63.3
1909	17	67.5	11	67.3	15	65.9	3	67.2	2	66.6	1	60.6	67.5	67.0	65.9	67.3	66.3
1910	10	45.2	5	47.0	19	50.9	13	49.5	3	49.8	..	....	46.4	50.9	49.6	47.9	50.1
1911	10	64.7	8	60.4	10	63.7	9	64.9	6	62.6	..	....	63.5	62.8	64.0	63.3	63.6
1913	14	71.7	..	....	4	65.9	5	67.3	5	74.8	6	69.8	71.7	68.0	72.1	70.5	70.7
Average	..	....	..	....	..	62.0	..	62.3	..	63.3	..	....	62.3	62.3	62.9	62.3	62.7
Average all years except 1906	..	62.3	..	....	..	62.0	..	62.4	..	63.4	..	....	....	....	....	....	....

TABLE XIV

RELATION OF TIPS TO YIELD—WEST CONCORD, WILLMAR, AND COKATO

Variety and place	Year	Tip score classes, based on 5 as a perfect score																				Lower third	Middle third	Upper third	Lower half	Upper half
		0		0.5		1.0		1.5		2.0		2.5		3.0		3.5		4.0		4.5		5.0						
		Ears	Yld.	Ears	Yld.	Ears	Yild.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.					
			Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																												
W. Concord..	1908	9	41.5	1	45.7	2	42.9	8	42.4	4	37.9	1	35.2	..	....	..	....	..	....	..	....	..	....	41.5	42.7	39.3	42.1	40.4
W. Concord..	1909	..	....	5	37.5	6	36.6	5	41.3	3	41.1	..	....	1	23.1	..	....	..	....	..	....	..	....	37.2	38.2	41.2	37.1	39.0
W. Concord..	1910	13	31.4	7	34.9	7	32.8	3	31.5	..	....	..	....	..	....	..	....	..	....	..	....	..	....	31.4	33.9	32.4	31.9	33.2
Average ...	....	..	....	..	39.4	..	37.4	..	38.4	..	....	..	....	..	....	..	....	..	....	..	....	..	....	36.7	38.3	37.6	37.0	37.2
Minn. 161																												
Willmar	1907	..	....	..	....	..	....	..	....	..	....	..	....	2	47.7	10	46.4	7	48.5	3	47.7	..	....	46.7	46.4	48.1	46.6	48.1
Willmar	1908	..	....	..	....	..	....	..	....	..	....	..	....	1	64.1	11	59.3	7	61.9	..	....	..	....	60.0	59.7	61.9	59.8	61.2
Willmar	1909	1	27.5	2	28.8	2	31.4	1	34.7	5	40.4	1	38.1	2	37.1	1	32.3	..	....	..	....	..	....	29.6	39.3	37.0	32.4	38.2
Average ...	....	..	....	..	....	..	....	..	....	..	....	..	....	..	49.6	..	46.0	..	....	..	....	..	....	45.4	48.5	48.8	46.3	49.2
Minn. 332																												
Cokato	1907	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	5	46.9	13	47.4	1	44.2	47.0	47.4	46.9	47.1	46.0
Cokato	1908	..	....	..	....	..	....	..	....	..	....	6	54.5	16	56.5	3	57.2	..	....	..	....	..	....	55.2	56.5	56.8	55.5	56.7
Average ...	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	....	51.1	52.0	51.9	51.3	51.4
Minn. 13																												
Cokato	1910	6	50.5	..	....	2	54.4	..	....	8	50.7	3	50.2	3	48.4	1	51.2	1	56.6	..	....	..	....	51.5	50.7	50.4	51.2	50.5
Cokato	1913	1	54.2	1	30.7	11	48.3	7	46.4	2	50.8	..	....	..	....	..	....	..	....	..	....	..	....	46.8	47.8	47.8	47.2	47.5
Average	....	..	52.4	..	....	..	51.4	..	....	..	50.8	..	....	..	....	..	....	..	....	..	....	..	....	49.2	49.3	49.1	49.2	49.0

At the outlying stations, grouping into upper, lower, and middle third classes seems to indicate some positive correlation. Yields of upper and lower third classes, which are rather close, are considerably in excess of those of the lower class at three of the four places. Upon grouping into lower and upper half classes, however, no indication of relation is found. There is a distinct difference between the two classes in only one of the four cases, when the upper half leads. In the remaining three the yields are essentially identical. There is one plus difference of 0.2 and another of 0.1 bushel. There is one minus difference of 0.2 bushel. Mere chance array of the data in the various classes is apparently operating to a large degree in bringing about the differences between the final averages.

Relation of kernel uniformity to yield.—Table XV indicates no relation between kernel uniformity and yield. Minnesota No. 13 shows upper third class leading middle and lower classes, which are essentially identical. But when results for each year are noted, the lower and upper classes each lead in three years and the middle class in two. When upper and lower half classes are compared, each leads in four out of the eight years.

In the case of Minnesota No. 161, the upper class is outyielded by the middle and lower classes, which are again essentially identical. When each year is considered separately the same tendency is shown. Possibly a slight negative relation exists altho it is rendered doubtful by the Minnesota No. 13 results.

At the outlying stations the lower third class leads in all of the four cases (Table XVI). In one, however, the difference in favor of the lower third class is only 0.2 bushel. Furthermore, in this instance the middle class is considerably below both extremes, indicating no relation. Possibly some negative relation exists.

Relation of variety character to yield.—Final averages for Minnesota No. 13 show a small progressive increase from lower to upper class. Differences between lower and upper third classes are 0.8 bushel and between lower and upper half classes 0.5 bushel in favor of upper class. When the distribution of the yearly yields of these classes is noted, it is found that positive relation is indicated in, at most, five of the eight years.

In the case of Minnesota No. 161, the averages are clearly mere fluctuations. While upper third class leads lower third, the excess is practically no greater than that of middle third class over upper third. There is no agreement between the three years in the test as regards the arrays in the final classes. Furthermore, the averages of the original classes show no definite tendency.

TABLE XV

RELATION OF KERNEL UNIFORMITY TO YIELD—UNIVERSITY FARM

Year	Kernel uniformity score classes, based on 10 as a perfect score																Lower third	Middle third	Upper third	Lower half	Upper half
	2.0		3.0		4.0		5.0		6.0		7.0		8.0		9.0						
	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield					
		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																					
1906	..	....	..	....	1	65.4	3	64.1	11	61.3	7	58.7	16	60.5	5	63.2	62.2	59.7	61.4	61.3	60.8
1907	..	....	..	....	..	....	2	52.4	8	51.6	11	48.4	18	49.9	5	51.9	50.8	49.3	50.6	50.3	50.1
1909	..	....	..	....	..	....	7	63.2	15	65.9	15	67.5	4	66.6	..	....	64.7	66.4	67.1	65.3	66.9
1910	..	....	..	....	1	44.6	12	45.8	15	45.8	7	44.7	5	45.6	..	....	45.6	45.8	45.2	45.5	45.2
1911	..	....	..	....	..	....	..	....	2	56.0	18	55.2	18	56.5	..	....	55.3	55.8	56.5	55.4	56.3
1912	..	....	..	....	..	....	6	45.7	6	44.3	19	46.9	4	46.5	..	....	45.0	46.9	46.8	45.6	46.8
1913	..	....	..	....	..	....	1	65.2	..	....	21	67.4	13	68.9	1	71.4	67.2	67.8	69.0	67.4	68.6
1914	..	....	..	....	..	....	..	....	1	61.8	11	67.1	21	65.1	..	....	66.6	65.3	65.1	66.1	65.1
Average	..	....	..	....	..	....	..	....	..	....	..	57.0	..	57.5	..	....	57.2	57.1	57.7	57.2	57.5
Minn. 161																					
1906	1	68.3	17	62.5	17	61.3	2	59.2	..	....	..	....	..	....	..	....	63.0	61.9	61.0	62.7	61.3
1907	10	63.2	22	62.4	6	64.9	..	....	..	....	..	....	..	....	..	....	63.0	62.4	63.7	62.8	63.3
1909	..	....	1	63.8	1	69.9	9	65.6	21	67.4	15	65.2	1	72.5	..	....	66.3	67.4	65.7	66.7	66.3
1911	..	....	..	....	1	70.8	4	64.5	20	63.2	15	63.3	2	62.1	..	....	64.1	63.3	63.1	63.9	63.2
1913	..	....	..	....	..	....	..	....	2	66.4	11	70.2	18	71.3	3	69.3	69.5	71.1	70.8	70.1	70.9
1910	..	....	1	49.7	5	48.8	5	48.9	21	50.4	16	47.4	2	48.7	..	....	49.4	50.0	47.6	49.6	48.4
Average	..	....	..	....	..	....	..	....	..	61.9	..	61.5	..	63.7	..	....	62.6	62.7	62.0	62.6	62.2

TABLE XVI

RELATION OF KERNEL UNIFORMITY TO YIELD—WEST CONCORD, WILLMAR, AND COKATO

Variety and place	Year	Kernel uniformity score classes, based on 10 as a perfect score																						Lower third	Middle third	Upper third	Lower half	Upper half
		2.0		2.5		3.0		3.5		4.0		4.5		5.5		6.0		6.5		7.0		7.5		8.0						
		Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.					
			Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13 W. Concord ...	1908	2	41.4	7	40.3	9	42.1	5	39.7	1	42.8	1	45.7	...	....	...	....	...	....	...	....	...	....	...	....	40.5	42.1	41.1	41.0	41.5
W. Concord ...	1909	...	....	...	....	1	35.8	9	41.3	8	40.7	3	38.4	...	....	...	....	...	....	...	....	...	....	...	....	40.5	41.0	39.7	40.7	40.1
W. Concord ...	1910	...	....	...	....	...	....	...	....	...	....	...	....	1	30.2	6	35.3	3	34.6	6	30.4	4	34.6	9	30.5	34.5	32.1	30.5	33.3	31.6
Average	....	...	....	...	....	...	39.0	...	40.5	...	41.8	...	42.1	...	....	...	....	...	....	...	....	...	....	...	....	38.5	38.4	37.1	38.3	37.8
Minn. 161 Willmar...	1907	...	....	...	....	1	53.0	4	43.2	8	46.6	9	49.3	...	....	...	....	...	....	...	....	...	....	...	....	45.7	47.4	49.3	45.9	48.8
Willmar...	1908	...	....	...	....	...	....	1	64.7	8	67.5	10	60.1	...	....	...	....	...	....	...	....	...	....	...	....	67.1	62.6	60.1	66.8	60.1
Willmar...	1909	...	....	...	....	3	32.4	7	36.2	6	33.6	...	....	...	....	...	....	...	....	...	....	...	....	...	....	34.3	35.7	33.6	34.8	34.3
Average	....	...	....	...	....	...	....	...	48.0	...	49.2	...	....	...	....	...	....	...	....	...	....	...	....	...	....	49.0	48.6	47.7	49.2	47.7
Minn. 332 Cokato ...	1907	...	....	...	....	...	....	...	....	14	45.3	5	43.1	...	....	...	....	...	....	...	....	...	....	...	....	45.3	45.3	43.5	45.3	44.1
Cokato ...	1908	...	....	...	....	...	....	4	58.1	16	55.5	5	56.6	...	....	...	....	...	....	...	....	...	....	...	....	56.7	55.5	56.2	56.3	55.9
Average	....	...	....	...	....	...	....	...	....	...	50.4	...	49.9	...	....	...	....	...	....	...	....	...	....	...	....	51.0	50.4	49.9	50.8	50.0
Minn. 13 Cokato ...	1910	...	....	...	....	...	....	...	....	...	....	...	....	...	....	3	52.3	2	51.2	7	52.6	1	49.1	11	49.5	52.1	51.0	49.5	52.3	49.5
Cokato ...	1913	...	....	...	....	...	....	...	....	...	....	...	....	...	....	5	51.2	...	....	6	40.4	...	....	11	49.5	47.2	45.6	49.5	45.3	49.5
Average	....	...	....	...	....	...	....	...	....	...	....	...	....	...	....	...	51.8	...	....	...	46.5	...	....	...	49.5	49.7	48.3	49.5	48.8	49.5

TABLE XVII

RELATION OF VARIETY CHARACTER TO YIELD—UNIVERSITY FARM

Year	Variety character score classes, based on 15 as a perfect score																				Lower third	Middle third	Upper third	Lower half	Upper half
	5.0		6.0		7.0		8.0		9.0		10.0		11.0		12.0		13.0		14.0		15.0						
	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.	Ear	Yld.	Ear:	Yld.	Ears	Yld.	Ears	Yld.	Ears	Yld.					
Minn. 13		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
1906.....	..	....	5	59.5	7	64.6	17	62.2	12	60.7	1	59.5	..	....	..	....	..	....	..	....	..	....	62.4	62.2	60.7	62.3	61.2
1907.....	..	....	1	50.7	12	49.4	23	50.5	3	49.5	1	55.4	..	....	..	....	..	....	..	....	..	....	49.5	50.5	50.6	49.8	50.5
1909.....	3	67.6	9	65.0	14	64.6	15	67.8	..	....	..	....	..	....	..	....	..	....	..	....	..	....	65.5	64.8	67.8	65.3	66.9
1910.....	..	....	..	....	..	....	..	....	1	41.2	10	47.1	1	46.1	18	45.3	2	48.6	8	46.3	..	....	46.4	45.3	46.3	46.1	46.0
1911.....	..	....	..	....	..	....	..	....	..	....	2	56.9	..	....	11	55.4	11	49.0	15	56.6	9	58.0	55.6	55.9	57.7	55.8	57.2
1912.....	..	....	..	....	..	....	..	....	3	44.3	2	42.6	7	45.6	22	46.1	7	46.5	1	44.2	..	....	45.2	46.1	46.0	45.6	46.0
1913.....	..	....	..	....	..	....	..	....	..	....	1	66.4	9	66.8	18	69.2	7	65.9	..	....	..	....	67.2	69.2	67.1	67.9	67.8
1914.....	..	....	..	....	..	....	..	....	..	....	..	....	2	62.0	5	66.3	17	65.1	9	67.4	..	....	65.1	65.1	67.0	65.1	66.4
Average	..	....	..	....	..	....	..	....	..	....	..	....	..	....	..	56.5	..	55.0	..	....	..	....	57.1	57.4	57.9	57.2	57.7
Minn. 161																											
1910.....	..	....	1	45.0	..	....	10	49.3	6	51.5	5	54.4	11	49.6	15	49.0	2	49.6	..	....	..	....	50.0	51.0	49.1	50.3	49.7
1911.....	..	....	..	....	..	....	..	....	1	70.8	3	56.6	8	63.2	12	63.2	14	63.9	4	67.8	..	....	62.3	63.4	65.0	62.7	64.5
1913.....	..	....	..	....	..	....	..	....	2	66.4	1	63.7	9	71.2	14	71.2	7	70.8	1	56.8	..	....	69.6	71.2	69.8	70.1	70.3
Average	..	....	..	....	..	....	..	....	..	62.9	..	58.2	..	61.3	..	61.1	..	61.4	..	....	..	....	60.6	61.9	61.3	61.0	61.5

TABLE XVIII

Relation of Maturity to Yield—University Farm

Year	Maturity score classes, based on 25 as a perfect score																Lower third	Middle third	Upper third	Lower half	Upper half
	18		19		20		21		22		23		24		25						
	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield					
		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																					
1910	2	48.0	..	....	9	45.6	..	....	17	46.3	..	....	8	46.1	4	43.7	46.2	46.3	45.5	46.3	45.8
1911	..	....	..	....	6	53.4	..	....	26	56.3	..	....	6	56.6	..	....	54.9	56.3	56.5	55.4	56.5
1912	..	....	..	....	..	....	..	....	6	47.2	8	46.7	1	49.4	29	45.2	47.0	45.2	45.2	46.4	45.2
1913	..	....	..	....	..	....	1	64.7	2	68.0	3	64.3	6	69.7	24	68.2	67.6	68.2	68.2	67.8	68.2
1914	..	....	..	....	2	62.2	1	69.5	4	62.8	11	66.6	3	70.9	12	64.8	64.7	67.6	64.8	65.7	65.7
Average	..	....	..	....	..	....	..	....	..	56.1	..	....	..	58.5	..	....	56.1	56.7	56.0	56.3	56.3
Minn. 161																					
1910	..	....	..	....	2	48.5	..	....	12	50.3	8	45.5	1	45.2	27	49.7	49.2	48.2	49.7	48.9	49.2
1911	2	59.6	3	57.2	4	63.7	..	....	12	63.3	7	64.4	3	68.5	10	63.8	61.4	63.8	64.8	62.2	64.5
1913	..	....	..	....	..	....	1	68.1	1	58.4	7	73.5	1	74.4	21	69.3	71.5	69.3	69.3	70.8	69.3
Average	..	....	..	....	..	....	..	....	..	57.3	..	61.1	..	62.7	..	60.9	60.7	60.4	61.3	60.6	61.0

Relation of maturity to yield.—It is apparent at once that no relation between maturity and yield is indicated. These data, however, do not constitute any real test of the question, or at least this method of analysis does not, because of the high degree of maturity of practically all of the ears. It will be noted that in only two out of the eight individual year tests do any considerable proportion of the ears used fall below the 22 class for maturity.

Another comparison which to some extent explains the lack of correlation between maturity and yield is that of the few extremely low ears with those of average maturity. In Table XIX, the ears falling below 21 are compared with those above this score.

TABLE XIX

COMPARATIVE YIELDS OF EARS OF RELATIVELY LOW AND HIGH MATURITY

Variety	Year	Yield for ears scoring 21 and lower		Yield for ears scoring above 21	
		Tests	Average yield	Tests	Average yield
			Bu.		Bu.
Minnesota 13	1910	11	46.0	19	45.9
Minnesota 13	1911	6	53.4	32	56.4
Minnesota 13	1913	1	64.7	35	68.1
Minnesota 13	1914	3	64.6	30	65.8
Minnesota 161	1910	2	48.5	48	49.1
Minnesota 161	1911	9	60.7	32	64.1
Minnesota 161	1912	1	68.1	30	70.2

While this comparison can not be regarded as entirely trustworthy, owing to the small number of ears in the lower extreme class in most cases, the fact that the ears scoring above 21 outyielded those falling below this in six out of seven cases is significant. It is indicated that the ears of lower maturity, even tho carefully cured as were these ears, will not give as high yields as those more nearly mature.

Relation of total score to yield.—The relation of total score to yield obviously is the final criterion of the validity of the score card as an index to yield, so far as the present data are concerned. Those ears which approach the perfect standard with respect to every character in the score card are compared with reference to yield with those which possess these characters in a less degree. The range between poorer and better ears is considerable, as reference to Table XX shows. The extreme range is over 28, altho most of the ears are included within the range of about 68-88. University Farm data only are available for this study.

TABLE XX

RELATION OF TOTAL SCORE TO YIELD—UNIVERSITY FARM

Year	Total score classes, based on 100 as a perfect score																		Lower third	Middle third	Upper third	Lower half	Upper half
	66.0		69.5		73.0		76.5		80.0		83.5		87.0		90.5		94.0						
	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield	Ears	Yield					
		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Minn. 13																							
1906	1	51.8	1	64.8	2	65.0	7	62.3	8	61.3	11	63.1	7	60.0	4	62.2	..	....	61.9	62.5	61.2	62.1	62.4
1907	2	50.5	8	50.7	10	49.7	8	47.7	2	53.5	5	53.5	3	50.4	1	56.2	..	....	50.4	48.8	52.1	49.9	51.0
1909	1	65.9	4	65.8	7	63.7	12	67.9	10	66.5	3	62.8	2	69.5	..	....	..	....	65.6	67.7	66.1	66.5	66.7
1910	3	46.8	3	48.1	11	45.6	10	45.9	4	45.7	8	46.1	1	43.9	..	....	..	....	46.5	45.8	45.8	46.3	45.8
1911	..	....	3	55.2	1	62.7	10	54.3	8	55.2	14	57.3	2	54.4	..	....	..	....	55.2	55.8	56.8	55.3	56.5
1912	..	....	2	44.9	3	43.6	5	45.0	13	46.3	15	46.3	3	49.0	3	42.0	..	....	45.1	46.3	46.0	45.5	46.1
1913	..	....	1	62.7	1	65.5	2	64.1	5	68.5	18	68.8	5	68.1	3	66.0	..	....	67.1	68.8	67.7	67.7	68.1
1914	..	....	..	....	..	....	..	....	3	61.7	10	64.3	14	66.4	5	67.3	1	74.0	63.6	66.0	67.5	64.4	67.0
Average	..	....	..	....	..	....	..	....	..	57.3	..	57.8	..	57.7	..	....	..	....	56.9	57.7	57.9	57.2	57.9
Average all years except 1914	..	....	..	56.0	..	56.5	..	55.3	..	56.7	..	56.9	..	56.5	..	....	..	....	....	....	....	....	....
Minn. 161																							
1911	..	....	5	64.6	5	60.1	7	62.8	6	63.6	15	62.3	3	69.2	1	63.7	..	....	62.5	63.0	63.9	62.6	63.6
1910	..	....	8	46.8	5	51.9	13	47.9	13	46.5	8	50.6	2	49.7	1	47.7	..	....	48.6	47.2	48.9	48.1	48.0
1913	..	....	2	64.2	2	67.1	3	69.7	9	70.8	4	72.5	8	73.5	5	70.6	1	56.8	68.6	71.9	70.9	69.7	71.5
Average	..	....	..	58.5	..	59.7	..	60.1	..	60.3	..	61.8	..	64.1	..	60.7	..	....	59.9	60.7	61.2	60.1	61.0

Some correlation is indicated by the data for both Minnesota No. 13 and Minnesota No. 161. The differences between the upper and lower classes, however, are small. Minnesota No. 13 shows a difference of 1 bushel in favor of the upper third over the lower third class. Between upper half and lower half classes the difference is only 0.7 bushel. Corresponding differences in the case of Minnesota No. 161 are respectively 1.3 bushels and 0.9 bushel. Examination of the results for each of the eight years reveals that in case of Minnesota No. 13 there is a regular increase from the lower to the upper class in two out of eight years. For the other six years the upper third class surpasses the lower in four years. In one of these four years the middle class falls below both extremes, indicating no correlation. To put the matter more concretely, in two out of the eight years positive correlation is definitely shown; in three years positive correlation is indicated, upper third yielding more than lower third, but both being exceeded by middle third; during the remaining three years either negative correlation or no correlation is indicated.

Comparison of the original classes, for six of which there are seven-year averages, shows a good deal of fluctuation, altho a positive tendency is indicated.

In the case of Minnesota No. 161 definite, positive correlation is shown for one year. Of the remaining two years, one shows no correlation, the middle class falling below both extremes, while the other indicates positive correlation, the upper class exceeding the lower, but the middle class exceeding both. When averages for each of the original classes are noted, positive correlation is indicated. A gradual increase is shown through the first six classes compared. The last class falls considerably below the two preceding ones.

Another comparison is afforded in this study of the relation of total score to yield which was not possible in case of any of the separate characters. Since, according to the score card, the upper third class of ears represented in Table XX includes absolutely the best ears that could be found among those tested, the yield of this group should exceed that of any other "third" group represented in any of the preceding tables. Such a comparison must obviously be made between groups in which the same years are represented. By omitting the years 1906 and 1907 in data for Minnesota No. 13, all of them are comparable for the purpose mentioned. The averages thus obtained are represented in Table XXI.

Obviously the positive correlation indicated in Table XX becomes of doubtful significance in the light of this final comparison. In the first place, the upper third class for total score is now slightly exceeded by the middle third class. Further than this, it is exceeded

by two of the other six groups, namely, "weight," and "variety character." It is equalled by three other groups, namely, "length," "tips," and "kernel uniformity." As a matter of fact, the differences among the seven groups amount to nothing.

TABLE XXI

COMPARISON OF UPPER THIRD CLASS FOR TOTAL SCORE WITH HIGHEST THIRD CLASS FOR EACH OF THE OTHER CHARACTERS

Character	Minn. No. 13	Minn. No. 161
	Bu.	Bu.
Total score (upper third class)	58.3	61.3
Total score (middle third class)	58.4	....
Length	58.3	61.7
Weight	58.4	61.2
Circumference	57.9	62.0
Shelling percentage	58.2	61.5
Butts	58.0	61.6
Kernel uniformity	58.3	61.5
Tips	58.3	61.9
Variety character	58.7	61.9

In the case of Minnesota No. 161, the highest scoring group suffers even more strikingly by this comparison, being in fact the lowest yielding of all the groups but one, namely, weight.

APPLICATION OF STATISTICAL METHOD TO DATA

Relation between any two characters or factors can be determined, when sufficient data are at hand, by assembling them into a so-called correlation table. This has been done in Table XXII with the data from University Farm for Minnesota No. 13. These alone were used because in the other cases there were too few to be treated by this method.

On the horizontal line at the top of the table appear the classes for total score. These classes have been arranged in the same manner as in other tables in Part I. On the vertical line appear the corresponding classes for yield.

These classes do not represent the actual total scores or the actual yields, as will at once be apparent. Instead of that, both yield and total score have first been reduced to terms of 100 by considering the average for each of the above two factors as 100, and referring the values for each ear to this. For instance, if the average yield of all ears in 1911 was 56 bushels, this was taken as 100. A yield of 54 bushels, then, was equivalent to 98.2; a yield of 60 bushels, 107, and so on.

The reason for expressing the values in this form is that it was necessary to include all years in one table in order to have sufficient data for this type of analysis and the different years were otherwise

not comparable. It will readily be seen that a yield of 60 bushels per acre for one year may not indicate a higher yielding capacity on the part of the ear which it represents than a yield of 40 bushels for another year. Similarly an ear which scores 85 may not be inherently different from an ear grown during another year which scores only 75, environment having affected the degree of expression of its characters.

TABLE XXII

CORRELATION BETWEEN TOTAL SCORE AND YIELD, MINNESOTA NO. 13 CORN—UNIVERSITY FARM

Yield classes	Total score classes							Total
	78	85	92	99	106	113	120	
80		1	3	2				6
85		1	1	11	5	1		19
90		1	6	17	11	2	1	38
95	1	5	13	36	6	6	1	68
100		3	13	21	19	5		61
105		3	12	27	19	3		64
110			6	14	14	2	1	37
115			1	9	2	3		15
120			1	1	3			5
125				1				1
Total	1	14	56	139	79	22	3	314

$r = +0.119 \pm 0.038$

It will readily be understood that since the classes for each of the two factors whose relation is to be studied increase from the upper left-hand corner of the table on the horizontal and vertical lines, the figures in the table, which represent the number of individuals occurring in each of the classes, would be parallel to the diagonal extending from the upper left-hand corner in case a distinct positive relation existed, and would be parallel to the diagonal extending from the upper right-hand corner if a distinct negative correlation existed.

A definite mathematical expression for the degree of relationship has been worked out, however, for data tabulated in this way. This expression is known as the "correlation coefficient." As a basis for this coefficient, perfect correlation is designated as 1. Accordingly +1 indicates perfect direct or positive correlation, and —1 represents perfect inverse or negative correlation. Amount or degree of correlation, therefore, is expressed in fractions of 1.

The correlation coefficient for total score and yield appears immediately beneath the table. It is +0.119 (r is a symbol adopted by statisticians for correlation coefficient). Immediately following the value for correlation coefficient, another value, 0.038 with the sign $\pm$

before it, appears. This value is "the probable error of the coefficient of correlation." It is designed to test the statistical significance of the correlation coefficient. By "statistical significance" is meant significance as affected by the number of individuals involved in the study. Obviously the larger the number of the data the more trustworthy are the indications which their analysis presents. That is to say, a correlation coefficient of 0.119 obtained for 100 individuals evidently will be very much less trustworthy than the same correlation coefficient obtained for 500. This is because certain values will be thrown in one direction or another by mere chance, and the larger the number of data, the greater the possibility that an equal number of these fluctuations will go in opposite directions, thus neutralizing each other. The calculated probable error increases in size, therefore, as the number of individuals decreases.

Concretely, the calculated probable error as applied to the correlation coefficient means that the chances are even that the true correlation coefficient falls within a range represented by the calculated correlation coefficient, plus and minus the calculated probable error. In other words, the chances are even that the true correlation coefficient in the present instance lies between 0.157 (0.119+0.038) and 0.081 (0.119 — 0.038).

It is evident from the above that the significance of any correlation coefficient depends upon how it compares in magnitude with its probable error. The following table illustrates this concretely:

Chances that the true correlation coefficient is within the limit established by

1 time the probable error=even
2 times the probable error= 4.5 to 1
3 times the probable error= 21 to 1
4 times the probable error=142 to 1

and so on until at nine times the probable error the chances are about one billion to one.

In Table XXIII are presented the correlation coefficients with their probable errors for each of the characters studied. The correlation tables are given in the appendix.

Out of the nine correlation coefficients appearing in the table, two (possibly three) are large enough to have possible significance. Chances are 21 to 1 that positive correlation exists in the case of total score. They are considerably greater than 21 to 1 that such correlation exists in the case of shelling percentage. This of itself is a contradiction, however, for as was noted in the discussion of the facts set forth in Table XXI, there is no group of ears so good from the score-card

standpoint as the highest scoring ears, hence none should give so great a correlation with yield.

TABLE XXIII

CORRELATION COEFFICIENTS FOR THE VARIOUS CHARACTERS AND YIELD

Character or type	Cofficient of correlation (Tables XL to XLVIII)	
Length	+0.098	±0.040
Weight	+0.047	±0.044
Circumference	−0.052	±0.041
Shelling percentage	+0.157	±0.043
Butts	+0.006	±0.037
Tips	+0.030	±0.038
Kernel uniformity	+0.048	±0.037
Variety character	+0.033	±0.037
Total score	+0.119	±0.038

Chances are more than 4.5 to 1 that positive correlation exists in the case of length. In all of the other cases, chances are either only slightly greater, slightly less, or considerably less than 1 to 1 that correlation exists.

In conclusion it must be noted that those correlation coefficients which appear to be significant are significant from a statistcial standpoint only. They are certainly not significant from a practical standpoint. Many plant breeders consider that a correlation coefficient must be not less than 0.5 to be of significance from their standpoint. However, disregarding any arbitrary limit, it is perfectly obvious that none of the present coefficients indicate sufficient increases as a result of selection of better ears to make it worth while to expend time and labor on selection. Furthermore, it should be noted again that in view of the test applied to total score in Table XXI, even the higher correlation coefficients are of doubtful statistical significance.

The above conclusion applies with equal force to all of the results from all of the analyses of the ear-to-row data.

PART II. SELECTED EAR TYPES

The investigation of selected ear types was begun in 1914. From five to ten selections representing each of the following types were made from a crib of Minnesota No. 13 corn at University Farm: Show (these were the very best ears obtainable according to the score card standard), small, thick, elongated, poor tips, good tips, poor butts, good butts, and tapering. Each of these ears (except "good tips," which were omitted through an error) was planted in a separate row. A check row was planted between the groups of five rows. The seed planted in the check rows was a composite of all of the ears represented in the test.

Half of the seed from these ears was planted at Monticello, about forty miles north of University Farm, in exactly the same way.

In 1915 a somewhat different plan was followed. A much larger number of ears representing each character or type was selected, and all of the ears of one type were shelled together and planted in a plot instead of by the ear-to-row method. Each plot consisted of four rows, the object being to use the middle two rows for the yield test in order to overcome possible unequal competition with adjacent rows of another type. It was found, however, that there was no such unequal competition. That is to say, when the outer rows of the respective plots were compared, the rank of each plot as regards yields was substantially the same as when the middle rows were compared. For this reason the yield from the entire plot was used in all of the comparisons appearing in the tables which follow. The types of ears selected for this test were as follows: Show, elongated, short thick, tapering, cylindrical, small, smooth, rough, medium smooth, high in shelling percentage, low in shelling percentage, and medium in shelling percentage. These ears were selected at random from the crop of the previous year's experiment. That is to say, the long slender ears were not selected from the progeny of the corresponding parent ears of the previous year, the short thick ears from the progeny of short thick, and so on, but were selected from any and all progeny.

The season of 1915 was extremely unfavorable for corn in Minnesota, hence the crop was very immature. In fact, that on the test plots was not far past the roasting-ear stage when harvested. No distinct difference in the degree of maturity of the different plots was observable, however, so the results are probably not materially affected by this condition of the crop.

The experiment was repeated in 1916, on the same plan as was followed in 1915. It was necessary, however, to go outside of the Station to obtain seed. Seed of Minnesota No. 13 was obtained from E. G. Enestvedt, Sacred Heart. This is substantially the same latitude as University Farm. The corn, however, averages somewhat larger than that grown at University Farm and may be somewhat later maturing. The general character of the ears selected is shown in Figures 1 to 9. The ears shown are typical of the groups. The same general character was shown by the ears selected in 1915.

RESULTS

Detailed data from the 1914 experiment, University Farm, are presented in Table XXIV. The yield for each ear row is given as well as the average yield for each type of ear. At the foot of the table is given the rank of each type in yield and the average weight of the parent ears of each type in grams.

TABLE XXIV

YIELD PER ACRE OF INDIVIDUAL EARS OF VARIOUS TYPES, MINNESOTA NO. 13 CORN—UNIVERSITY FARM, 1914

	Character of ears								
	Show	Small	Thick	Elongated	Poor tips	Good butts	Poor butts	Tapering	Check
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
	72.9	69.5	73.7	68.9	64.8	71.0	70.3	69.7	65.5
	64.0	65.8	73.5	68.7	62.5	61.2	58.1	59.6	64.4
	74.0	62.2	76.6	55.1	64.7	61.8	70.3	58.9	73.7
	72.5	....	62.6	64.8	52.2	70.0	65.8	73.7	67.6
	57.5	....	75.0	66.0	56.7	59.3	65.2	57.7	69.9
	70.6	....	65.0	....	61.2	....	74.3	63.3	64.1
	71.7	....	....	....	64.8	....	73.5	....	63.2
	70.4	....	....	....	58.6	....	56.7	....	58.2
	71.7	....	....	....	....	....	....	....	67.8
	63.2	....	....	....	....	....	....	....	69.3
	....	....	....	....	....	....	....	....	65.6
Average ..	68.8	66.7	71.1	64.7	60.7	64.7	66.8	63.5	66.3
Rank	2	4	1	5	7	5	3	6	....
Av. weight parent ears, grams....	9.25	6.75	10	8	8.75	8.75	9.25	8.25	....

It will be noted that some of the types are at a decided disadvantage owing to the small number of yield results obtained for them. This is notably true of the "small" type and to a lesser degree of "good butts" and "elongated."

TABLE XXV

RELATION OF WEIGHT OF EARS TO YIELD, MINNESOTA NO. 13 CORN—UNIVERSITY FARM, 1914

Lower third	Middle third	Upper third
Bu.	Bu.	Bu.
62.2	64.0	72.9
65.8	72.5	74.0
55.1	57.5	70.6
62.5	71.7	76.6
66.0	71.7	62.6
69.5	63.2	75.0
70.4	73.5	73.7
64.7	65.0	64.8
52.2	68.9	64.8
56.7	68.7	58.1
71.0	64.8	70.3
59.3	61.2	65.8
59.6	61.8	74.3
73.7	70.3	73.5
63.3	65.2	69.7
....	56.7	58.6
....	....	70.0
Average 63.5	66.0	69.1

Superficially the most striking figures in the table are the high yields of "thick" and "show" ears and the low yield of "poor tips." Closer examination of the table seems to indicate that in the case of

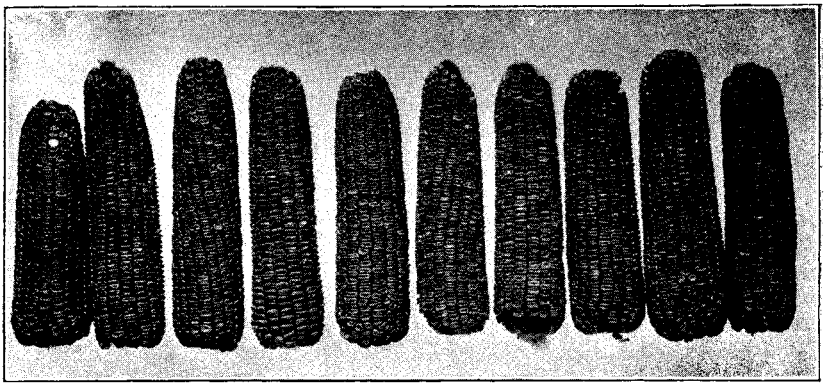

Fig. 1. Representative Rough Ears (1916 Test)

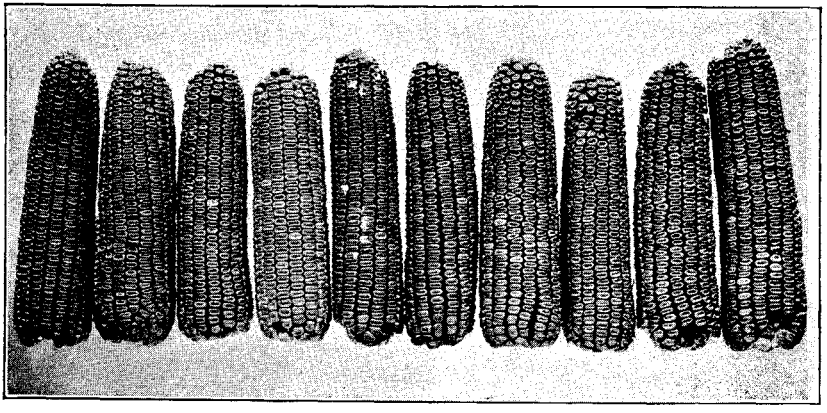

Fig. 2. Representative Medium Smooth Ears (1916 Test)

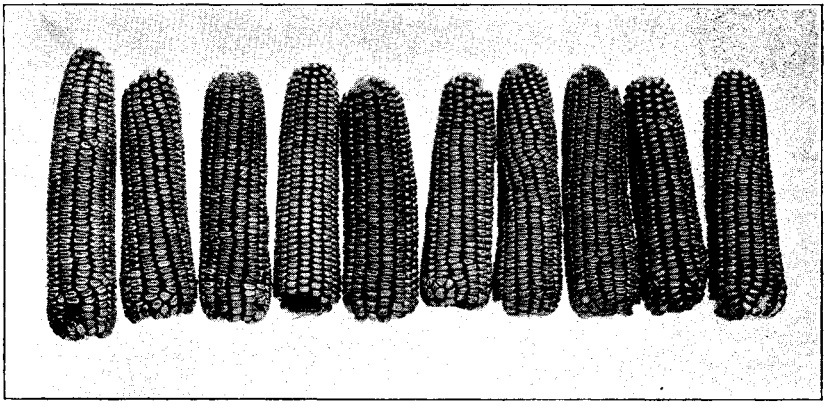

Fig. 3. Representative Smooth Ears (1916 Test)

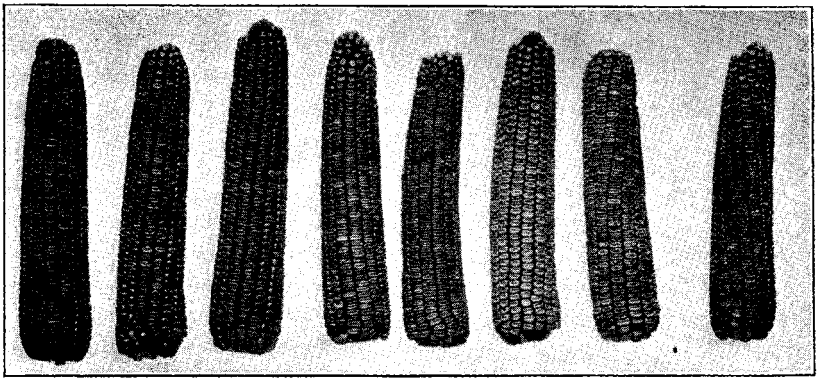

Fig. 4. Representative Long Slender Ears (1916 Test)

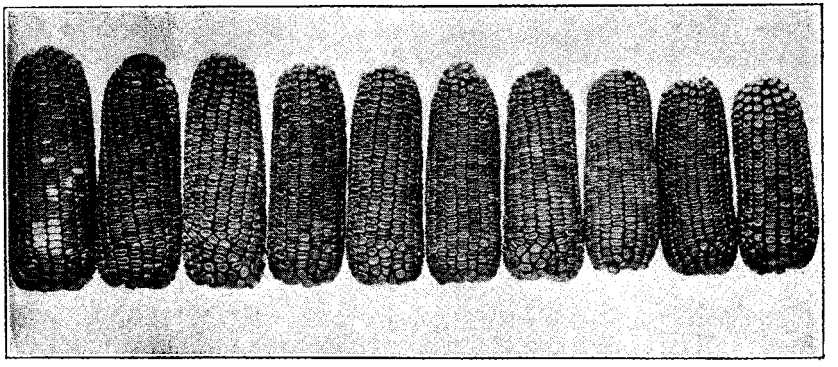

Fig. 5. Representative Thick Ears (1916 Test)

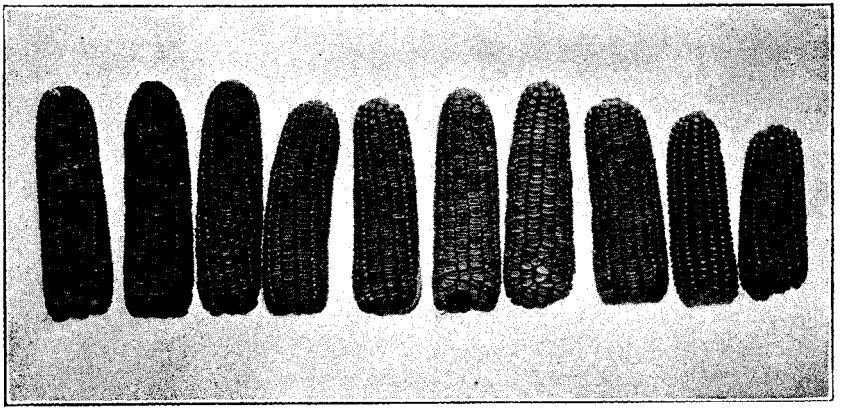

Fig. 6. Representative Small Ears (1916 Test)

the first two, these yields are associated with the weight of the ears. The relation of weight to yield is rather strikingly shown in Table XXV. The correlation coefficient for these data has been determined as 0.324 ± 0.063.

In Table XXVI are presented the corresponding data for Monticello. It must not be assumed that these figures constitute a definite check on the University Farm results. The seed used was not acclimated, a fact which might be expected to materially affect the relation of size of ear and yield, in particular. As a matter of fact, the data indicate that the relation found at University Farm was reversed at Monticello. This is most clearly shown in Table XXVII, which corresponds exactly to Table XXIV. The correlation coefficient in this case is -0.291 ± 0.066, somewhat less than that for University Farm data, but significant nevertheless.

TABLE XXVI

YIELD OF INDIVIDUAL EARS OF VARIOUS TYPES, MINNESOTA NO. 13 CORN—MONTICELLO, 1914

	Character of ears								
	Show	Small	Thick	Elongated	Poor tips	Good butts	Poor butts	Tapering	Check
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
	26.5	36.7	29.5	31.3	33.1	36.1	25.0	30.8	32.5
	28.7	35.4	31.6	32.5	30.1	24.2	18.1	33.5	36.0
	27.3	32.3	29.8	31.0	29.0	28.7	33.4	23.2	30.2
	29.2	30.2	28.8	26.1	26.4	27.7	24.0	35.0	30.3
	31.2	....	30.1	26.5	38.2	22.5	29.9	43.4	26.6
	27.6	....	....	24.4	28.7	....	32.7	28.1	27.0
	36.1	....	....	....	31.3	....	21.6	....	27.6
	27.6	....	....	....	24.3	....	30.5	....	30.1
	30.8	....	....	....	....	....	....	....	34.3
	28.7	....	....	....	....	....	....	....	35.7
Average ..	29.4	33.8	29.9	28.6	30.1	27.8	26.9	32.3	31.0
Rank	5	1	4	6	3	7	8	2	....
Av. weight parent ears, grams....	9.25	6.75	10	8	8.75	8.75	9.25	8.25	....

The above does not explain all the disagreements between University Farm and Monticello data, however. Thus "poor tips," which showed such a strikingly low yield at University Farm, yielding 4 bushels less than "good butts" which is equal to it in ear weight, exceeds the latter at Monticello. This low yield, therefore, probably has nothing to do with the character of the ears, but is purely accidental.

Since each of the ears used in this experiment was measured, it is possible to group the entire lot for a study of relation of length to yield. The result is shown in Table XXVIII. Obviously, there is no relation.

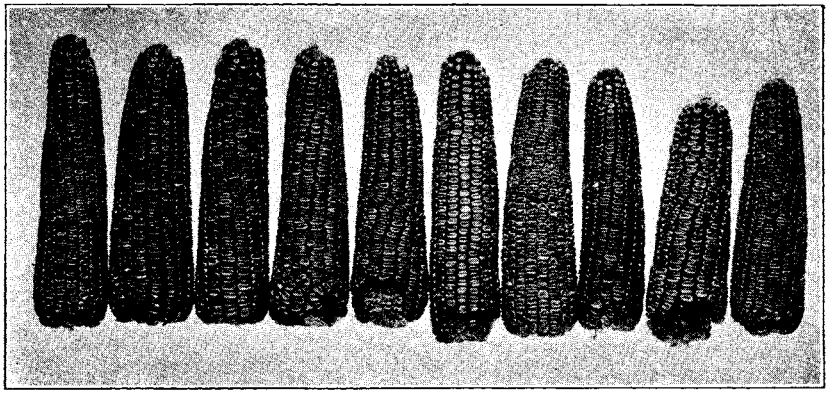

Fig. 7. Representative Tapering Ears (1916 Test)

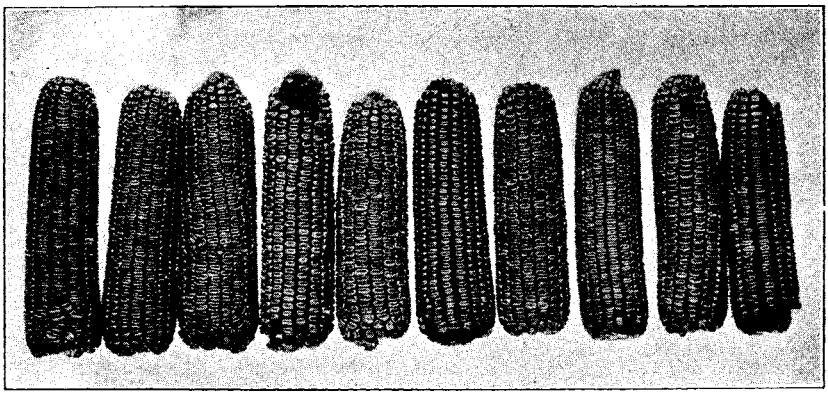

Fig. 8. Representative Cylindrical Ears (1916 Test)

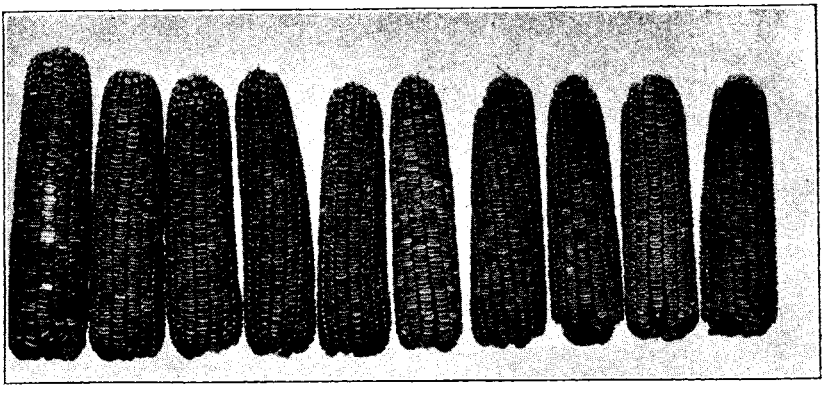

Fig. 9. Representative Show Ears (1916 Test)

TABLE XXVII

RELATION OF WEIGHT OF EAR TO YIELD, MINNESOTA NO. 13 CORN—MONTICELLO, 1914

Lower third	Middle third	Upper third
Bu.	Bu.	Bu.
20.3	28.7	26.5
35.4	29.2	27.3
21.1	31.2	27.6
30.1	36.1	29.8
24.4	30.8	28.8
32.3	28.7	30.1
36.7	31.6	29.5
27.6	31.3	26.5
29.0	32.5	31.3
26.4	31.0	18.1
38.2	33.1	33.4
36.1	28.7	24.0
22.5	28.7	32.7
43.4	25.0	21.6
33.5	29.9	30.8
35.0	30.5	24.3
28.1	....	27.7
Average 31.5	30.4	27.6

TABLE XXVIII

RELATION OF LENGTH OF EAR TO YIELD, MINNESOTA NO. 13 CORN—UNIVERSITY FARM, 1914

Lower third	Middle third	Upper third
Bu.	Bu.	Bu.
63.2	64.0	74.0
71.7	70.6	72.5
69.5	71.7	68.9
65.8	70.4	68.7
62.2	64.8	55.1
76.6	71.0	64.8
62.6	65.2	66.0
75.0	70.3	61.2
65.0	61.2	58.6
62.5	72.9	58.1
64.7	64.8	65.8
61.8	52.2	74.3
70.0	69.7	73.5
59.3	56.7	64.1
58.9	56.7	57.5
57.7	73.5	66.0
73.7	....	70.3
....	....	59.6
Average 65.9	65.9	65.5

In Table XXIX the data are similarly arranged for the study of the relation of number of rows per ear to yield. It is apparent, when averages for upper, lower, and middle third classes are compared, that there is a decided positive relation. Roughly, the number of rows is simply another measure of the weight of the ears, as reference to Table XXX will show.

TABLE XXIX

RELATION OF NUMBER OF ROWS TO YIELD, MINNESOTA NO. 13 CORN—UNIVERSITY FARM, 1914

	Number of rows					Lower third	Middle third	Upper third
	12	14	16	18	20			
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
	55.1	64.8	73.7	73.7	76.6	....	....	....
	....	66.0	69.7	73.5	75.0	....	....	....
	....	61.2	56.7	62.6	61.2	....	....	....
	....	70.3	72.9	65.0	....	....	....	....
	....	58.1	64.0	64.8	....	....	....	....
	....	65.2	74.0	74.3	....	....	....	....
	....	59.6	72.5	73.5	....	....	....	....
	....	57.7	57.5	58.9	....	....	....	....
	....	63.3	70.6	....	....	....	....	....
	....	....	71.7	....	....	....	....	....
	....	....	70.4	....	....	....	....	....
	....	....	71.7	....	....	....	....	....
	....	....	63.2	....	....	....	....	....
	....	....	68.9	....	....	....	....	....
	....	....	68.7	....	....	....	....	....
	....	....	64.8	....	....	....	....	....
	....	....	62.5	....	....	....	....	....
	....	....	64.7	....	....	....	....	....
	....	....	52.2	....	....	....	....	....
	....	....	56.7	....	....	....	....	....
	....	....	58.6	....	....	....	....	....
	....	....	71.0	....	....	....	....	....
	....	....	61.8	....	....	....	....	....
	....	....	70.0	....	....	....	....	....
	....	....	59.3	....	....	....	....	....
	....	....	70.3	....	....	....	....	....
	....	....	65.8	....	....	....	....	....
Average	55.1	62.9	66.1	68.3	67.6	63.8	66.1	67.4

TABLE XXX

RELATION OF WEIGHT OF EARS TO YIELD AND TO NUMBER OF ROWS PER EAR—UNIVERSITY FARM, 1914

Type	Average yield per acre	Average weight parent ears	Average number of rows
	Bu.	Oz.	
Good	68.8	9.25	16.0
Small	66.7	6.75	15.6
Short thick.....	72.3	10.0	18.7
Elongated slender.....	64.7	8.0	14.8
Poor tips.....	60.7	8.75	16.0
Good butts.....	64.7	8.75	16.8
Poor butts.....	66.8	9.50	15.8
Tapering	63.5	8.25	15.4

In Table XXXI is given the summary for 1915. In the left-hand columns are given the yields for each of the duplicate plots, and in the right-hand columns the rank in yield of each type. The only types for which there is any indication of relation to yield are "show" and

"small," both of which appear to be low yielders. Evidently it made no difference in this test whether ears had a high or low shelling percentage. Both of these types are high yielders, according to these data. The shelling percentages were respectively, 87.5 and 79.5.

TABLE XXXI

RELATION OF EAR TYPES TO YIELD, MINNESOTA NO. 13 CORN—UNIVERSITY FARM, 1915

Character of ears	Yield per acre		Rank as regards yield		No. of ears in test
	Plots Series I	Plots Series II	Plots Series I	Plots Series II	
	Bu.	Bu.			
Show	20.4	17.7	10	10	30
Elongated	23.2	22.2	7	4	44
Short thick	23.9	20.1	5	7	50
Tapering	24.2	19.8	4	9	35
Cylindrical	23.4	16.2	6	11	29
Small	20.6	15.7	9	12	40
Smooth	22.3	20.4	8	6	60
Rough	19.9	21.2	11	5	50
Medium smooth	19.8	23.0	12	3	48
High shelling percentage	24.4	24.4	3	1	17
Low shelling percentage	24.9	24.1	1	2	17
Medium shelling percentage	24.6	19.4	2	8	17

TABLE XXXII

RELATION OF EAR TYPES TO YIELD, MINNESOTA NO. 13 CORN—UNIVERSITY FARM, 1916

Character of ears	Yield per acre		Rank as regards yield		No. of ears in test
	Plots Series I	Plots Series II	Plots Series I	Plots Series II	
	Bu.	Bu.			
Show	42.7	49.5	8	3	29
Elongated	41.8	39.9	9	8	27
Short thick	44.0	39.5	5	9	42
Tapering	44.7	49.9	4	2	37
Cylindrical	46.9	34.2	3	12	10
Small	50.5	45.6	1	4	40
Rough	41.6	41.4	10	7	29
Medium smooth	50.0	38.4	2	10	25
Crooked rows	43.4	42.1	6	5	11
High shelling percentage	38.1	41.6	12	6	17
Low shelling percentage	40.8	50.0	11	1	17
Medium shelling percentage	43.2	37.4	7	11	18

Table XXXII presents corresponding data for 1916. Elongated and rough ears appear to be rather low yielders, while tapering and small ears appear to be high yielders.

The data analyzed for relation of weight to yield are presented in Tables XXXIII and XXXIV, for 1915, and Table XXXV, for 1916. Table XXXIV indicates a slight relation; so slight, however, as to be practically insignificant. Table XXXV, for 1916, indicates a nega-

tive relation altho the yield of ears of average size is practically equal to that of ears of largest size.

TABLE XXXIII

RELATION OF WEIGHT OF EARS TO YIELD—UNIVERSITY FARM, 1915

Type of ears	Average weight parent ears	Rank as regards yield
	Grams	
Show	199	8
Elongated slender	193	1
Short thick	175	2 and 3
Tapering	188	2 and 3
Cylindrical	180	7
Small	108	9
Smooth	155	5
Rough	175	6
Medium smooth	177	4

TABLE XXXIV

RELATION OF WEIGHT OF EARS TO YIELD—UNIVERSITY FARM, 1915

	Lower third	Middle third	Upper third
	Bu.	Bu.	Bu.
	22.0	22.0	19.1
	18.2	19.8	22.7
	21.4	21.4	22.0
	20.6	20.6	....
Average	20.5	20.9	21.3

TABLE XXXV

RELATION OF WEIGHT OF EARS TO YIELD, MINNESOTA NO. 13 CORN—UNIVERSITY FARM, 1916

	Lower third	Middle third	Upper third
	Bu.	Bu.	Bu.
	50.5	44.0	41.8
	45.6	39.5	39.9
	46.9	38.1	43.4
	34.2	41.6	42.1
	41.6	40.8	43.2
	41.4	50.0	37.4
	44.7	50.0	42.7
	49.9	38.4	49.5
Average	44.5	44.1	42.5

MAINE DATA ON RELATION OF WEIGHT OF EARS TO YIELD

Reference has been made to certain data gathered by Pearl and Surface, of the Maine Agricultural Experiment Station, in their experiments in breeding sweet corn. The writers have compiled such of these data as bear upon the relation of weight of ears to yield and the results are presented in summarized form in Table XXXVI.

TABLE XXXVI

RELATION OF WEIGHT OF EAR TO YIELD*

"Type" Corn

	Yield	Average weight of parent ears	Weight of lightest parent ear in class	Weight of heaviest parent ear in class	Number of ears in class
	Bu.	Grams	Grams	Grams	
1908					
Total weight per ear					
Lower third	18.4	81.3	71.5	88.0	33
Middle third	16.9	94.5	88.4	99.5	34
Upper third	17.4	111.0	100.0	125.0	33
Weight per ear of shelled corn					
Lower third	18.1	63.4	56.7	68.0	33
Middle third	17.4	74.9	68.6	79.9	34
Upper third	17.4	87.4	80.0	112.3	33
1909					
Total weight per ear					
Lower third	10.3	77.0	62.0	96.5	15
Middle third	9.5	118.0	98.0	131.5	16
Upper third	10.0	141.5	132.0	157.0	16
Weight per ear of shelled corn					
Upper third	10.2	65.2	49.5	77.5	15
Lower third	9.6	94.9	78.0	107.0	16
Middle third	9.8	114.6	108.5	126.5	16

* Data by Pearl and Surface, Maine Agr. Exp. Sta.

Data from a two years' investigation are included in the table. The study has been made on the basis of both total weight of ear and weight of shelled corn per ear. In the second, third, and fourth columns are given, respectively, the average weight of ears in each of the three classes and the weight of the lightest and heaviest ears in each class. A slight negative correlation is indicated. When analyzed by the statistical method for the determination of correlation coefficient this is found to be -0.033 ± 0.067 and -0.023 ± 0.067 for total weight of parent ear with subsequent yield and shelled corn weight per parent ear and subsequent yield, respectively, in 1908. Obviously these coefficients indicate no correlation, since in both cases the probable error exceeds the coefficient. Because of the smaller number of ears used, this latter analysis was not made for the 1909 data. By comparison it is readily seen, however, that the relation amounts to nothing.

PART III. SELECTION FOR YIELD AND EAR TYPE VS. SELECTION FOR EAR TYPE ALONE

Simultaneously with the ear-to-row work which has already been discussed, a plot was maintained in which ears were selected annually on the basis of the character of the ear only. While this selection was not based on the detailed scoring which formed a part of the ear-to-

row work, a conscious effort was made each year to adhere to a standard type of ear. Minnesota No. 161 was the variety used. A comparison with the ear-to-row results for this variety is shown in Table XXXVII.

TABLE XXXVII

SELECTION FOR YIELD AND TYPE VS. SELECTION FOR TYPE ALONE

Year	Selection	Field cured weight	Difference
		Bu.	Bu.
1904	Yield and ear type	51.4	+1.3
	Ear type	50.1	
1905	Yield and ear type	75.8	+21.1
	Ear type	54.7	
1906	Yield and ear type	57.3	
	Ear type	57.6	—0.3
1907	Yield and ear type	64.1	+7.8
	Ear type	56.3	
1908	Yield and ear type	56.3	
	Ear type	56.5	—0.2
1909	Yield and ear type	62.5	
	Ear type	62.6	—0.1
1910	Yield and ear type	44.6	+11.3
	Ear type	33.3	
1911	Yield and ear type	62.5	+4.1
	Ear type	58.4	
	Average of yield and ear type	59.3	+5.6
	Average of ear type	53.7	

As an average of the eight years in the test there is a difference of 5.6 bushels in favor of the ear-to-row selection. The latter, moreover, had the advantage in five of the eight years. During the other three there was an insignificant difference in favor of the ear type alone.

The investigation does not afford any direct evidence on the question of the comparative effect of selection for yield alone with selection for yield and type. Since type of ear does not, according to the preceding data, bear any important relation to yield, it is fair to assume that the entire difference of 5.6 bushels may be credited to yield selection.

SUMMARY OF EXPERIMENTAL RESULTS

I. EAR-TO-ROW TESTS

In the ear-to-row tests carried on at University Farm and at three outlying stations, West Concord, Willmar, and Cokato, a large number of ears selected each year from the highest yielding rows were carefully scored in the laboratory on the basis of the customary corn score card. Several of the highest scoring ears (thirty-six or more in most cases) were used for each succeeding year's ear-to-row planting. The value of this intensive selection was studied by grouping the ears in classes according to the size of their score for each of

various characters and noting the comparative average yields of these groups. A summary of the results according to the final groupings is given in Table XXXVIII. The figures for University Farm represent a much larger volume of data than those for the outlying stations and are regarded as more trustworthy.

TABLE XXXVIII

SUMMARY OF YIELDS FOR LOWER, MIDDLE, AND UPPER THIRD CLASSES

Ear character	University Farm					
	Minnesota No. 13			Minnesota No. 161		
	Lower	Middle	Upper	Lower	Middle	Upper
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Length	57.5	58.0	58.3	62.1	62.0	63.3
Weight	57.0	58.4	57.9	62.3	62.1	62.6
Shelling percentage	57.3	58.1	58.2	63.1	62.4	62.3
Circumference	57.9	57.7	57.5	62.9	61.6	62.7
Butts	57.5	57.6	57.4	62.6	62.9	62.0
Tips	57.2	57.7	57.5	62.3	62.3	62.9
Kernel uniformity	57.2	57.1	57.7	62.6	62.7	62.0
Variety character	57.1	57.4	57.9	60.6	61.9	61.3
Total score	56.9	57.7	57.9	59.9	60.7	61.3

Ear character	Outlying Stations					
	West Concord			Willmar		
	Minnesota No. 13			Minnesota No. 161		
	Lower	Middle	Upper	Lower	Middle	Upper
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Length	33.8	36.9	35.3	47.1	47.5	47.5
Weight	35.5	37.5	37.0	52.0	51.4	52.0
Shelling percentage	37.7	37.1	36.9	46.7	46.9	45.8
Circumference	36.5	35.2	37.2	48.1	47.2	47.5
Butts	37.4	36.0	36.2	49.2	48.8	48.4
Tips	36.7	38.3	37.6	45.4	48.5	48.8
Kernel uniformity	38.5	38.4	37.1	49.0	48.6	47.7

Ear character	Cokato			Cokato		
	Minnesota No. 332			Minnesota No. 13		
	Lower	Middle	Upper	Lower	Middle	Upper
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Length	50.7	51.8	48.6	49.5	50.5	47.1
Weight	49.9	51.5	49.9	47.5	50.6	49.8
Shelling percentage	52.3	51.5	48.8	49.2	48.9	49.4
Circumference	48.1	49.9	52.9	48.1	50.8	50.6
Butts	51.0	50.2	49.9	50.3	48.6	48.9
Tips	51.1	52.0	51.9	49.2	49.3	49.1
Kernel uniformity	51.0	50.4	49.9	49.7	48.3	49.5

An additional test of correlation has been made with Minnesota No. 13, University Farm, the correlation coefficient having been worked out for each of the characters. By this test even statistical significance can be attached to indication of correlation in only two or possibly three cases. The correlation coefficients for total score, shelling percentage, and length are respectively three, three and a half, and two and a half times their probable errors. (See Table XXIII.)

The validity of total score as an index to yield has been further tested by comparing the yield of the "upper third" group of total score ears with the highest yielding third group for each of the other characters. By this comparison the highest scoring ears become only average. In the case of Minnesota No. 13 they exceed three groups, are surpassed by two, and are equalled by three. In the case of Minnesota No. 161 they are surpassed by all but one group. As a matter of fact the yields are very close in both cases. (See Table XXI.)

In view of this final analysis it is very doubtful if any of the indications of correlation found in any of the analyses of all the data are even of statistical significance. It is, of course, clear that they are not of practical significance as the differences in any case are very small.

2. SELECTED EAR TYPES

Definite types of ears, as show ears, elongated ears, short thick ears, tapering ears, etc., were selected from a lot of corn, and each type planted in a separate plot. This method was continued three years. The selection was not continuous. The various types were not selected respectively from the crop produced the preceeding year from a corresponding type. The results in brief are as follows:

1914. Show ears and thick ears were outstanding in yield. A significant relation existed between weight and yield (Table XXV). The correlation coefficient for weight and yield was $+0.324 \pm 0.063$. No relation between length and yield was shown.

1915. Show ears and small ears appeared to be low yielders. No relation to yield was indicated in case of any of the other types. A very slight indication of relation between weight and yield was shown. (Tables XXXI, XXXIII, and XXXIV.)

1916. Some positive relation was indicated in the case of tapering and small ears and some negative relation appeared to exist in the case of long slender and rough ears. (Table XXXII.) Thus no consistent relation is shown when results for different years are compared.

3. SELECTION FOR YIELD AND EAR TYPE VERSUS SELECTION FOR EAR TYPE ALONE

Simultaneously with the carrying on of the ear-to-row work described under I, a plot of Minnesota No. 161 was maintained in which ears were selected continuously on the basis of the character of the ear only. As an average of eight years, the ear-to-row method outyielded the exclusive ear selection method by 5.6 bushels.

GENERAL DISCUSSION OF RESULTS

With reference to their method of fertilization, field crops are of two kinds, namely, those which are generally self-fertilized, and those which are often cross-fertilized. Familiar examples of the former are wheat, oats, and barley; of the latter, corn and rye.

If all the kernels produced by a single wheat plant were planted, a very high degree of similarity among all of the resulting plants would be seen. In fact, the only differences would be fluctuations in size due to inequalities of soil or other environmental conditions. If, on the other hand, all of the kernels from an ear of average corn were planted, considerable differences among the resulting plants would be seen, differences in shape of kernels, shape of ears, number of rows per ear, in many cases in color of kernels, and many others which could not be ascribed to differences in environmental conditions. The wheat plant is pure for all of its transmissible or heritable characters. This obviously must, under normal conditions, always be true of the wheat plant, for the pollen, containing the male reproductive elements, and the egg cell, or female reproductive cell, which unite to form the new individual are produced from generation to generation by the same plant. The male and female cells are identical with reference to the qualities or potential characters which they contribute to the new individual. In the case of corn, however, the situation is quite different. The potential characters possessed by any ear have been contributed by a large number of plants. Male and female reproductive elements are quite unlike in the majority of cases. Necessarily unlike progeny must be the result.

But the degree of variability in corn may be reduced by artificial means. By close and long-continued selection a similarity of type may be obtained. Such similarity is due to the fact that the selection tends toward the production of a variety in which the inheritance for the selected characters approaches the condition in self-fertilized plants. That is to say, for these characters the male and female reproductive cells tend to become of like nature.

It is now generally recognized that inbreeding in cross-fertilized plants tends to reduce vigor. Self-fertilization in corn, for example, causes an immediate reduction in yield. After continuous self-fertilization a state is reached in which a purity of type is obtained. Such self-fertilized strains are very inferior from the standpoint of yield. After this purity of type is reached, however, continued self-fertilization does not further decrease yield. (Shull 1910.) (East and Hayes 1912.)

Reduced yields accompanying inbreeding are, according to the best genetic evidence, a direct result of increased gametic purity. That is, as the gametes or reproductive bodies which meet to form the new individual become more and more alike, the stimulus to growth resulting from the union decreases. Continued selection to a type, therefore, may be expected to tend toward the same reduction in yield. The reduction will take place much less rapidly than under artificial self-fertilization, because the approach to purity will be much less rapid.

A rather attractive interpretation of this well-known stimulus which very frequently accompanies heterozygosis, has recently been offered by Jones (1917). His hypothesis attributes this stimulus to an increased number of growth factors entering into the heterozygous individual as compared with the number contained in either of the parents. As factors are frequently linked in inheritance, it is considered impossible for a homozygous individual to contain as many growth factors as can be obtained in a heterozygous form.

The results presented in this paper show conclusively that close selection for high-scoring ears is of no practical value in increasing yield. The selection of high-yielding ears as determined by the ear-to-row method proved to be of considerable value as a means of increasing yield. Whether selection for yield plus selection for type will give as high a yield as selection for yield alone is not known. Close selection for any particular set of characters, we believe, tends to reduce yield if such selection succeeds in producing a uniform type. As evidence of results having been obtained, the Illinois selection for high and low protein and high and low oil may be given (Smith 1908). The figures in Table XXXIX are taken from Illinois Bulletin 128.

These results show that the standard variety gave an average yield for the four-year period of 4.4 bushels per acre more than the close-selected strain of low protein, and 15.9 bushels more than the average obtained for the high protein selection.

Similar results were obtained for high and low oil selections as compared with the standard. In selecting for a valuable character, as high protein, some sacrifice of yield may be worth while. This is clearly pointed out by Smith (1908). From the standpoint of a close

approach to a score card type the breeder must determine the particular value of such approach for himself. The results of all experiments would surely tend to show that such score card selection might tend to a reduction in yield if long continued and if no new blood were introduced.

TABLE XXXIX

YIELDS OBTAINED IN VARIETAL TEST PLOTS

Year	High protein	Low protein	High oil	Low oil	Standard variety
1903	27.3	37.7	32.7	41.3	40.9 (Boone Co. White)
1904	32.1	55.5	41.9	40.5	53.7 (Boone Co. White)
1905	56.6	60.7	58.4	58.1	68.4 (Silver Mine)
1906	65.1	73.2	66.3	83.2	{ 75.7 (Silver Mine) { 87.9 (Leaming)
Average	45.3	56.8	49.8	55.8	61.2

A broad system of breeding for corn would seem, therefore, to be the correct procedure. Such a method is here given.

RECOMMENDED METHOD OF BREEDING

If the breeder is willing to use the ear-to-row method, the following plan is recommended. It is taken from the work of Montgomery (1909).

1. Select from 100 to 200 ears of the variety to be grown. If possible, select these ears in the field from those stalks which under competition give a good yield.

2. Make an ear-to-row test of these selected ears, saving half of the seed from each ear planted. From this ear-to-row test the 3 to 5 high-yielding ears may be determined.

3. Mix the remnants of the 3 to 5 high-yielding ears and plant the following year in a seed plot. Select all ears obtained which are fairly desirable, eliminating the very undesirable types.

4. Use the selected seed for field planting.

5. Give special attention to a part of the field so that a uniform stand may be obtained. Select enough seed from this part of the field for the entire acreage. Select seed in the fall from those stalks which under competition show ability to produce one or more good ears. Eliminate only the very undesirable types.

6. Continue the method outlined under 5 for a period of four or five years and then use the ear-to-row method as outlined under paragraphs 1 and 2.

For the grower who does not have time for accurate ear-to-row breeding the following plan is suggested:

1. Give special attention to a part of the field with regard to planting and cultivation. Select each fall before frost from those stalks which under competition show yielding ability. Do not select from stalks which clearly have unusual environmental advantages, such as more room for development, as these environmental variations are not inherited. Discard the very undesirable types but do not practice a close laboratory selection to type.

2. Continue the above plan each crop season.

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APPENDIX

TABLE XL

CORRELATION BETWEEN TOTAL SCORE AND YIELD

Yield classes	Total score classes							Total
	78	85	92	99	106	113	120	
80	..	1	3	2	..	..	..	6
85	..	1	1	11	5	1	..	19
90	..	1	6	17	11	2	1	38
95	1	5	13	36	16	6	1	68
100	..	3	13	21	19	5	..	61
105	..	3	12	27	19	3	..	64
110	..	..	6	14	14	2	1	37
115	..	..	1	9	2	3	..	15
120	..	..	1	1	3	..	..	5
125	..	..	..	1	..	..	..	1
Total	1	14	56	139	79	22	3	314

$r = + 0.119 \pm 0.038$

TABLE XLI

CORRELATION BETWEEN SCORE FOR TIPS AND YIELD

Yield classes	Tip score classes										Total
	17	52	87	122	157	192	227	262	297	332	
80	2	..	2	..	1	1	..	..	..	..	6
85	5	2	1	5	4	1	1	..	..	..	19
90	7	2	9	5	4	3	4	..	..	4	38
95	16	4	19	13	10	5	..	1	..	..	68
100	13	4	16	14	5	6	3	..	..	..	61
105	7	5	15	17	7	6	5	2	..	..	64
110	5	2	9	10	6	3	..	..	2	..	37
115	6	..	3	1	3	..	1	..	1	..	15
120	..	..	1	1	..	2	1	..	..	..	5
125	1	..	..	..	..	..	..	..	..	..	1
Total	62	19	75	66	40	27	15	3	3	4	314

$r = + 0.030 \pm 0.038$

TABLE XLII

CORRELATION BETWEEN SCORE FOR BUTTS AND YIELD

Yield classes	Butt score classes									Total
	30	45	60	75	90	105	120	135	150	
80	..	..	..	3	1	1	1	..	..	6
85	1	..	1	4	3	4	4	1	1	19
90	..	..	1	4	8	13	7	2	3	38
95	2	..	4	8	16	26	7	5	..	68
100	2	..	..	12	12	17	8	3	7	61
105	..	..	2	10	17	24	7	2	2	64
110	..	..	1	6	7	14	7	1	1	37
115	..	..	..	3	3	5	3	..	1	15
120	..	..	1	2	1	..	..	1	..	5
125	..	..	..	..	..	1	..	..	..	1
Total	5	..	10	52	68	105	44	15	15	314

$r = + 0.006 \pm 0.037$

TABLE XLIII

CORRELATION BETWEEN SCORE FOR KERNEL UNIFORMITY AND YIELD

Yield classes	Kernel uniformity classes										Total
	56	65	74	83	92	101	110	119	128	137	
80	..	..	..	..	4	..	2	..	..	..	6
85	..	..	..	2	5	3	8	1	..	..	19
90	..	..	..	4	15	4	13	1	..	1	38
95	..	3	3	11	18	13	12	5	2	1	68
100	..	2	1	10	16	3	20	4	4	1	61
105	1	1	1	9	17	12	19	2	2	..	64
110	..	..	2	2	9	6	14	3	1	..	37
115	..	1	..	..	6	3	3	1	..	1	15
120	..	..	..	1	..	1	2	1	..	..	5
125	..	..	..	..	..	..	1	..	..	..	1
Total	1	7	7	39	90	45	94	18	9	4	314

$r = + 0.048 \pm 0.037$

TABLE XLIV

CORRELATION BETWEEN VARIETY CHARACTER AND YIELD

Yield classes	Variety character classes									Total
	71	78	85	92	99	106	113	120	127	
80	..	1	..	4	..	1	..	..	..	6
85	..	1	1	2	7	6	2	..	..	19
90	..	1	2	3	13	16	3	..	..	38
95	1	2	9	13	16	12	5	10	..	68
100	2	3	6	7	14	14	11	4	..	61
105	..	3	6	14	16	18	6	..	1	64
110	2	1	1	5	8	10	6	4	..	37
115	..	..	1	1	5	6	1	1	..	15
120	..	..	..	1	..	3	1	..	..	5
125	..	..	..	..	..	1	..	..	..	1
Total	5	12	26	50	79	87	35	19	1	314

$r = + 0.033 \pm 0.037$

TABLE XLV

CORRELATION BETWEEN LENGTH OF EAR AND YIELD

Yield classes	Length of ear classes							Total
	85	90	95	100	105	110	115	
80	1	1	..	1	1	..	..	4
85	..	2	6	4	5	1	..	18
90	1	2	9	7	7	2	1	29
95	2	2	20	18	18	3	..	63
100	1	2	19	6	24	3	..	55
105	1	3	18	16	15	2	..	55
110	..	1	5	9	16	..	2	33
115	..	..	6	3	3	1	..	13
120	1	..	1	..	1	..	..	3
125	..	..	..	..	1	..	..	1
Total	7	13	84	64	91	12	3	274

$r = + 0.098 \pm 0.040$

TABLE XLVI

CORRELATION BETWEEN CIRCUMFERENCE OF EAR AND YIELD

Yield classes	Circumference of ear classes									Total
	60	90	93	96	99	102	105	108	111	
80	..	..	1	..	..	3	..	..	..	4
85	..	1	1	3	3	6	3	..	1	18
90	..	1	1	4	10	5	8	..	..	29
95	..	..	4	6	17	19	14	3	..	63
100	..	1	..	13	14	18	5	4	..	55
105	1	2	3	9	15	16	7	2	..	55
110	..	..	..	4	13	12	4	..	..	33
115	..	..	..	2	6	5	..	..	..	13
120	..	..	..	1	..	..	2	..	..	3
125	..	..	..	..	1	..	..	..	..	1
Total	1	5	10	42	79	84	43	9	1	274

$r = -0.052 \pm 0.041$

TABLE XLVII

CORRELATION BETWEEN WEIGHT OF EAR AND YIELD

Yield classes	Weight of ear classes												Total
	84	87	90	93	96	99	102	105	108	111	114	120	
80	1	..	..	1	1	..	..	..	..	..	..	..	3
85	..	..	2	3	1	4	..	3	3	..	..	..	16
90	..	..	1	4	6	5	4	..	6	..	1	..	27
95	2	..	4	5	8	9	5	8	1	7	4	..	53
100	1	1	5	5	8	6	10	5	3	1	..	..	45
105	2	..	1	3	12	10	6	5	3	2	..	1	45
110	..	..	..	2	9	3	5	5	3	..	..	..	27
115	..	..	..	3	2	2	1	2	..	..	2	..	12
120	..	..	..	1	..	..	..	1	1	..	..	..	3
125	..	..	..	..	..	1	..	..	..	..	..	..	1
Total	6	1	13	27	47	40	31	29	20	10	7	1	232

$r = +0.047 \pm 0.044$

TABLE XLVIII

CORRELATION BETWEEN SHELLING PERCENTAGE AND YIELD

Yield classes	Shelling percentage classes							Total
	93.5	95.5	97.5	99.5	101.5	103.5	105.5	
80	1	..	1	..	..	1	..	3
85	..	1	6	2	2	5	..	16
90	1	5	5	4	5	5	2	27
95	1	10	11	14	12	4	1	53
100	..	3	11	11	10	9	1	45
105	1	1	8	13	12	8	2	45
110	..	2	2	12	7	2	..	27
115	..	..	..	5	4	2	1	12
120	..	..	..	..	2	1	..	3
125	..	..	..	..	1	..	..	1
Total	4	22	46	61	55	37	7	232

$r = +0.157 \pm 0.043$