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A STUDY OF THE PHENOMENON OF BARRENNESS
IN CORN.

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A THESIS SUBMITTED

BY

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FOREWORD.

Barrenness in corn is one of the most commonly observed phenomena exhibited by this prominent cereal, and one of the least understood. Why various, seemingly growthy and hardy stalks of corn fail to produce grain has been a source of wonder and comment to both practical farmers and agricultural investigators as well.

Strange as it may seem, however, there has been practically no work done to discover why the maize plant, or any other grain normally bisexual, should be sterile. Many theories have been advanced to explain the phenomenon such as lack of food, lack of constitutional vigor, thickness of planting, and inbreeding. It has also been suggested that the condition might be hereditary, but this has in the main been generally rejected as unsound, thinking that since a barren stalk produces no seed it must surely breed itself out. Whether or not any or all of these theories will stand the test of accurate experimentation remains to be seen. On the other hand it is an undoubted fact that the barren tendency still persists in all sub-species and varieties of corn. Farmers realize their detrimental effect and are continually asking for a method whereby they may be eliminated from their fields.

Nearly all attempts to eliminate them have failed so far because it is very hard to say a stalk will be barren at tasseling time and once past that time the damage is done and any interference is more than useless.

Seeing then that the subject has an economic bearing as well as a purely scientific interest, what are the factors that influence barrenness in corn?

OBJECT OF THE EXPERIMENT.

The object of this work was to make a study of barren stalks of corn to discover the causes of barrenness, if possible, and to find out the factors which influence barrenness in any way. There seems to be some difference in the barren quality of stalks which are naturally barren and those which are barren due to environmental conditions. The causes of permanent barrenness would then refer to the first condition and the factors influencing induced barrenness to the latter condition.

Once in a while a perfectly barren stalk will be found in the field of corn where no possible explanation can be given outside of the question of heredity, as to why this stalk should not have borne an ear. All conditions may be favorable for growth and development and yet that particular stalk has seemingly made no effort to produce an ear or a rudiment of an ear.

On the other hand many stalks may be found in a field where some external condition may account in a measure for their inability to produce grain. The factors which will be discussed

in this experiment are those which ^{was} it/presumed might have an influence in producing sterility as thickness of planting, inbreeding, lack of proper food supply, and an inherent hereditary characteristic.

PLAN OF THE EXPERIMENT.

The plan upon which this experiment was conducted was to find as many totally barren stalks as possible, cross them upon the good shoots by hand and afterwards make a detailed study of the stalks themselves.

The following year the grain so produced was to be planted in rows in which the stand was varied. Good ears having the least possible known hereditary ^{barren} tendency were to be planted in the same plot and in the same manner as the ears having barren stalks as their sire.

All those produced from seed not possessing barren blood were to be detasseled thus allowing only pollen from those stalks having the barren tendency to fertilize the whole plot. In this way it was hoped that some data could be obtained on the ability of barren pollen to fertilize ears of corn in the open field and by planting those ears, to find out whether or not the barren tendency was transmitted in the same manner as from hand pollinated ears.

WORK IN 1908.

In August of 1908 the writer began work on this

experiment. In a plot of corn on the Experiment Station field of the University of Missouri a number of shoots were bagged with paper bags before any silks had appeared. The same time careful search was made of the plot and many stalks which seemed that they would not produce an ear were tagged to serve as sources of barren pollen.

It is very difficult to say what will be a barren stalk at tasseling time for some stalks are very slow in putting out their shoots so that a large number of ears so marked and pollinated from individual stalks afterward had to be discarded owing to the fact that the male stalk used produced an ear. Before the pollinating period was over the number of ears being fertilized was reduced to nine in this manner. All of the nine stalks used as sources of pollen did not show a sign of a shoot during the pollinating period.

As soon as the silks were dry the strings on the bags were loosened in order to allow the ear better development and each stalk, both mother and pollen bearer was also accurately tagged. After the corn had ripened the stalk bearing the ears and those which had produced pollen were taken from the field. Upon examination at that time it was found that six of the nine so-thought "barren" stalks had thrown a shoot and formed some grain. The other three were perfectly barren. This left then, only the three ears which could be used the following spring to produce pollen for the entire plot to be planted. All nine of the ears however, were saved on account of the fact that they

were hand fertilized and had one stalk as their male parent. Since the chances are good that every ear of corn is fertilized from several other stalks rather than one, it was thought that these ears would serve better to represent corn without a barren tendency than good ears taken from the open field where the chances were good that some barren stalks had fertilized a part of them.

None of the ears so produced were at all good in shape; all the kernels however, were matured and fairly well developed so that good results were expected from them. Every ear was carefully labelled with the number of its mother stalk and pollen stalk and laid away until the following spring.

THE WORK IN 1909.

In the spring of 1909 the nine ears of corn produced by hand pollination and another good ear which was chosen from the breeding corn work were planted in an isolated plot. The nine ears of corn were numbers 29-129, 43-114, 41-104, 30-103, 27-119, 26'-108, 36-110, 32-102, and 25-101. The ear from the breeding plot was simply called a good ear. The first number refers to the mother stalk and the last refers to the pollen bearing stalk. Of these nine only the first three proved to be the product of fertilization from barren stalks. Table I (1909) shows the order in ^{the} which/ various ears were planted. Four rows were planted from each ear, the first

TABLE I. (09)

ORDER OF PLANTING OF CORN USED IN BARREN WORK SHOWING ROWS, EARS USED FOR
 POLLEN AND DETASSELING, AND NUMBER OF STALKS
 PER HILL.

Row-Bar	Function-	Stalks per Hill.	Row-Bar	Function-	Stalks per Hill.
1 29-129	Pollen	2 stalks	2 29-129	Pollen	3 stalks.
3 29-129	Pollen	4 stalks	4 29-129	Pollen	5 stalks
5 30-103	Detassel	2 stalks	6 30-103	Detassel	3 stalks
7 30-103	Detassel	4 stalks	8 30-103	Detassel	5 stalks
9 27-119	Detassel	2 stalks	10 27-119	Detassel	3 stalks
11 27-119	Detassel	4 stalks	12 27-119	Detassel	5 stalks
13 43-114	Pollen	2 stalks	14 43-114	Pollen-	3 stalks
15 43-114	Pollen	4 stalks	16 43-114	Pollen	5 stalks
17 26-108	Detassel	2 stalks	18 26-108	Detassel	3 stalks
19 26-108	Detassel	4 stalks	20 26-108	Detassel	5 stalks
21 36-110	Detassel	2 stalks	22 36-110	Detassel	3 stalks
23 36-110	Detassel	4 stalks	24 36-110	Detassel	5 stalks
25 41-104	Pollen	2 stalks	26 41-104	Pollen	3 stalks
27 41-104	Pollen	4 stalks	28 41-104	Pollen	5 stalks
29 32-102	Detassel	2 stalks	30 32-102	Detassel	3 stalks
31 32-102	Detassel	4 stalks	32 32-102	Detassel	5 stalks
33 25-101	Detassel	2 stalks	34 25-101	Detassel	3 stalks
35 25-101	Detassel	4 stalks	36 25-101	Detassel	5 stalks
37 43-114	Pollen	2 stalks	38 43-114	Pollen	3 stalks
39 43-114	Pollen	4 stalks	40 43-114	Pollen	5 stalks
41 Good Ear	Detassel	2 stalks	42 Good Ear	Detassel	3 stalks
43 Good Ear	Detassel	4 stalks	44 Good Ear	Detassel	5 stalks

Planted May, 18, 1909.

Thinned to above stands, July 9.

Rows 15 hills long.

Hills 3 feet, 14 inches apart each way.

one to have two stalks per hill, second three, third four, and the fourth five stalks. More grains than necessary to produce this stand were planted in order that they might be thinned later and exactly such a stand produced if possible.

Since the number of ears fertilized from a barren stalk was so few, two good ears were inserted between each poor one thus making two rows to produce pollen and four to be detasseled followed by two for pollen. The rows were only fifteen hills long with those planted two and three stalks per hill and those to be four and five stalks respectively from end to end. The whole plot was laid out in diagram as shown by Table I.

The corn was thinned to the proper stand on July 9th, then cultivated until it was too high to use a two-horse cultivator. Care was taken not to break down any more stalks than was absolutely necessary.

After this corn was mature a count was made of the number of stalks which had come to maturity in each hill of each row. Table II shows the total number of stalks for each row which was to have two and four stalks per hill respectively. Table III shows the actual number of stalks per hill and the total for each row which was to have three and five stalks per hill respectively.

A count was also made of the number of barren stalks which occurred in each row under the varying changes of stand. Table IV shows the total number barren stalks and the percent of

TABLE II. (09)

SHOWING ACTUAL NUMBER OF STALKS PER HILL AT HARVEST TIME AND TOTAL
 PER ROW. ROWS ODD NUMBERS AND PLANTED TO HAVE STAND OF
 2 & 4 STALKS PER HILL RESPECTIVELY.

Row	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43
Hill	Showing actual number stalks per hill.																					
1	1	2	1	4	2	2	2	4	2	2	2	3	0	4	2	1	2	4	2	3	2	4
2	2	4	1	4	2	2	1	4	2	4	2	0	1	0	1	2	2	3	2	3	2	4
3	1	0	0	4	2	3	2	4	2	3	2	0	2	2	2	2	2	4	1	4	2	4
4	0	2	2	4	2	3	1	4	1	4	2	2	1	3	1	1	2	4	2	4	2	3
5	2	4	2	1	1	4	2	4	1	4	2	4	2	4	2	2	1	4	2	4	2	4
6	2	4	2	1	2	3	1	4	2	4	2	4	1	3	0	2	2	4	2	4	2	4
7	1	4	2	4	1	4	2	4	1	4	2	4	1	4	1	3	2	4	2	2	2	4
8	1	2	2	3	1	4	2	2	2	4	0	3	2	4	2	2	2	4	2	3	2	4
9	2	3	2	4	0	4	2	4	2	3	0	3	2	2	1	2	2	4	2	3	2	4
10	2	3	2	4	2	4	0	2	2	3	2	4	2	4	1	2	2	4	2	3	2	4
11	2	4	2	1	2	3	2	4	2	3	2	3	2	4	2	2	2	3	2	2	2	4
12	2	4	0	0	2	1	0	4	0	3	2	4	1	4	2	2	0	4	2	2	2	4
13	2	4	0	3	1	0	1	0	2	2	2	2	1	4	0	1	2	0	2	3	2	4
14	1	3	0	1	0	0	2	4	2	4	0	2	2	2	1	1	2	3	2	0	2	3
15	2	3	2	4	1	3	1	4	1	3	3	2	2	2	2	1	2	4	2	1	1	1
Tot al.	23	46	20	42	21	40	21	52	24	50	25	40	22	46	20	26	27	53	29	41	29	55

TABLE III. (09).

SHOWING ACTUAL NUMBER OF STALKS PER HILL AT HARVEST TIME AND TOTAL
 PER ROW. ROWS EVEN NUMBERS AND PLANTED TO HAVE STAND
 OF 3 & 5 STALKS PER HILL RESPECTIVELY.

Row	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44
Hill	showing			actual			number			stalks			per			hill.						
1	3	3	3	0	3	5	3	4	3	3	3	4	0	2	3	2	0	4	3	2	3	4
2	2	2	3	5	3	5	3	3	3	3	3	3	3	3	3	1	3	6	3	2	3	5
3	3	3	3	4	1	5	2	4	1	4	3	5	3	5	3	0	3	4	3	3	3	4
4	0	3	2	3	2	4	0	4	2	4	1	4	2	4	1	4	2	5	2	4	3	4
5	3	3	3	5	3	1	0	5	3	3	3	4	3	5	3	2	3	6	3	4	3	4
6	0	3	3	0	3	5	0	5	3	4	3	4	3	3	0	2	3	5	2	4	3	4
7	2	0	3	1	0	2	1	5	3	5	3	5	2	5	0	1	3	5	3	5	2	5
8	0	0	3	4	3	3	2	2	3	3	3	3	3	3	2	2	3	4	1	5	3	5
9	1	4	3	5	3	4	2	3	3	3	2	4	3	4	1	1	3	5	3	5	3	5
10	3	4	3	5	3	5	3	4	2	4	3	4	2	4	2	2	3	2	3	4	1	4
11	0	0	3	5	2	3	3	4	2	3	2	1	3	4	2	1	3	5	3	5	3	5
12	1	0	2	5	2	3	2	4	3	3	3	5	2	3	2	0	2	5	2	2	3	4
13	2	4	2	5	1	3	1	5	2	4	1	4	3	1	2	2	3	5	2	3	3	3
14	3	0	3	5	2	0	3	2	2	1	3	2	0	3	2	1	1	5	3	5	3	5
15	0	5	2	4	1	5	2	3	1	3	0	2	2	5	2	1	2	4	2	4	3	2
Total	23	34	41	56	32	53	27	57	36	50	36	54	34	55	29	20	38	68	38	57	42	65

barrenness thrown by each row. It is well to note in this connection that nothing was called a barren stalks which had produced as much as one grain of corn. Those stalks which had produced rudimentary shoots without grain were included as barren.

Other data taken on the stalk characters of each row is shown in Table V. The height of stalk and its circumference give us a good idea of the constitutional vigor of the plants produced. The size and droop of the ears are also good indications of the productive ability of the stalks in question.

DISCUSSION OF RESULTS FOR 1909.

Hereditary Barrenness.

The actual number of barren stalks produced by each row is shown in Table IV.(09). Rows 1,2,3, and 4 were from ear 29-129, 13,14,15 and 16 from ear 43-114, 25,26,27, and 28 from ear 41-104 and 37,38,39, and 40 from ear 43-114. It will be noticed that these ears produced a large number of barren stalks, the average being much higher than the remaining rows although ear 25-101 threw a very large number of barren stalks especially in the row planted to four stalks per hill. In no case do the good ears exhibit the same uniform tendency to a high percent of barrenness as shown by the barren bred ears.

Turning to Table VII (09) there is shown the total number of barren stalks produced both by barren bred seed and

TABLE IV. (09).

SHOWING TOTAL NUMBER OF BARREN STALKS AND PERCENT
OF BARRENNESS FOR EACH ROW.

Row. No.	No. barren stalks.	% barren stalks.	Row. No.	No. barren stalks.	% barren stalks.
1	23	2	2	23	1
3	46	10	4	34	5
5	20	0	6	41	2
7	42	2	8	56	8
9	21	0	10	32	2
11	40	9	12	53	11
13	21	5	14	27	5
15	52	22	16	57	26
17	24	3	18	36	7
19	50	27	20	50	23
21	25	2	22	36	0
23	40	5	24	54	7
25	22	11	26	34	10
27	46	31	28	55	24
29	20	1	30	29	1
31	26	2	32	20	2
33	27	9	34	38	1
35	53	31	36	68	26
37	29	9	38	38	10
39	41	20	40	57	20
41	29	0	42	42	1
43	55	8	44	65	5

good seed when planted in the various thicknesses named. The rows planted to two stalks and four stalks per hill were side by side as were also those rows planted to three stalks and five stalks per hill respectively. There is considerable, and very constant differences in the amount of barrenness produced on each side of the plot showing a difference in soil. But seed of both barren bred and good ears were planted on the same soil at the same rate of planting. There is also a great difference in the percentage of barrenness produced from each class of seed. Table IX shows the actual percentage of barrenness in each case. Since then the barren bred and good ears were planted on the same soil and at the same rate the difference in barrenness must be due to the seed used. As shown by the table there was a difference of 19.39% with two stalks per hill, 15.80% with three stalks per hill, 17.41% with four stalks per hill and 14.54% with five stalks per hill.

Now since the portion of the plot planted to three and five stalks per hill respectively seemed to ^{be} richer than the other side we would expect the amount of barrenness to decrease, which it did. Furthermore if the barren bred ears had any definite hereditary tendency we would not expect the number of barren stalks produced to keep up in exact percent with the increase in stand. In view of these facts the difference in percentage of barrenness which is so much greater in the case of barren bred seed can only be ascribed to the seed.

Whether or not this tendency is strictly an inherited

TABLE V. (09).

SHOWING STALK CHARACTERS OF EACH ROW.

Row.	Ht. of stalk.	Circ. stalk.	Size ears.	Drop ears.	No. broken.	% broken.	Row.	Ht. of stalk.	Circ. stalk.	Size ears.	Drop ears.	No. broken.	% broken.
1	m	g	m	g	7	30.4	2	m	m	m	g	3	13.04
3	m	p	p	m	9	19.56	4	m	p	p	m	9	26.5
5	mg	g	m	g	3	15.0	6	g	m	g	g	6	14.6
7	m	p	p	m	7	16.6	8	mg	p	p	m	10	17.8
9	m	g	g	g	0	0.0	10	g	g	m	g	3	9.4
11	mp	p	p	m	0	0.0	12	g	p	p	m	3	5.7
13	vg	m	vp	p	0	0.0	14	g	m	p	p	5	18.5
15	vg	vp	vp	vp	6	11.5	16	g	vp	vp	vp	10	17.5
17	p	m	p	g	5	20.8	18	m	mp	m	m	3	8.3
19	vp	vp	vp	p	6	12.0	20	m	vp	p	m	4	8.0
21	g	mp	p	g	1	4.0	22	g	g	m	g	5	13.9
23	g	p	p	m	3	7.5	24	g	p	p	m	3	5.5
25	m	p	vp	p	4	18.18	26	g	m	p	m	9	26.5
27	m	vp	vp	vp	3	6.5	28	g	vp	vp	p	11	20.0
29	g	g	g	g	1	5.0	30	g	g	mg	g	7	24.1
31	g	g	m	g	3	11.5	32	g	g	mg	g	0	0
33	g	m	m	g	2	7.4	34	mg	g	m	g	11	28.9
35	p	vp	vp	vp	5	9.4	36	mg	p	p	m	23	33.8
37	m	vp	vp	vp	5	17.2	38	g	m	vp	vp	11	28.9
39	m	vp	vp	vp	4	9.8	40	g	vp	vp	vp	15	26.3
41	m	mg	m	g	1	3.4	42	m	g	g	g	3	7.1
43	p	p	p	m	2	3.6	44	m	m	m	g	1	1.5

vg = very good
g = good
mg = medium good
m = medium
vp = very poor
p = poor
mp = medium poor

TABLE VI.(1909)

SHOWING YIELD OF GRAIN INCLUDING NUMBER OF GOOD
EARS, NUBBINS, AND AVERAGE WEIGHT
PER EAR FROM EACH ROW.

Row.	Yld.No.	No.	Tot.	Av.wt.	Row.	Yld.No.	No.	Tot.	Av.wt.		
	lbs.good	ears.nubbins.	ears.	ear.oz.		lbs.good	ears.nubbins.	ears.	ear.oz.		
	7	4	17	21	5.3	2	5	5	14	19	4.2
	9	4	28	32	4.5	4	8	6	16	22	5.8
	1	0	4	4	4.0	6	15	15	20	35	6.8
	5	2	5	7	11.4	8	10	4	36	40	4
	7	5	6	21	10.2	10	11	12	15	27	6.5
1	5	3	7	10	8	12	13	9	29	38	5.4
3	4	3	5	8	8	14	5	4	16	20	4
5	6	2	13	15	6.4	16	8	4	25	29	4.4
7	6	5	16	21	4.6	18	8	6	20	26	4.9
9	4	3	21	24	2.7	20	9	4	25	29	5
11	6	7	12	19	5	22	12	10	23	33	5.9
13	8	5	31	36	3.3	24	12	6	34	40	4.8
15	3	1	7	8	6	26	6	3	10	13	7.4
17	4	2	13	15	4.2	28	7	4	22	26	4.3
19	8	7	14	21	6.1	30	11	9	17	26	6.8
21	7	7	15	22	5.1	32	10	8	13	21	7.6
23	4	5	13	18	3.5	34	13	12	16	28	7.4
25	5	2	19	21	3.8	36	13	9	28	37	5.6
27	4	2	17	19	3.4	38	6	1	21	22	4.4
29	5	2	20	22	3.6	40	9	2	29	31	4.6
31	8	5	24	29	4.4	42	15	10	29	39	6.1
33	14	8	36	44	5.1	44	19	7	50	57	5.3

* Some ears eaten by cow. Data worthless.

TABLE VII. (09).

SUMMARY OF DATA ON BARREN VS. GOOD ROWS ALL

FIGURES AVERAGES.

Stand.	Average of Barren Stalks.				Average of Good Rows.			
	2 stalks.	3 stalks.	4 stalks.	5 stalks.	2 stalks.	3 stalks.	4 stalks.	5 stalks.
Total stalks.	95	122	185	203	166	254	306	366
Total Barren	27	26	83	75	15	14	84	82
Percent barren	28.42	21.31	44.86	36.94	9.03	5.51	27.45	22.4
Total broken	16	28	22	45	13	38	26	44
percent broken	16.84	22.95	11.89	22.16	7.83	14.96	8.49	12.02
av. yld. pounds:	4.5	5.5	6	8	6.5	12.1	7.6	12.3
av. wt. per ear. ounces.	5.14	4.75	4.17	4.74	5.25	6.32	4.14	5.26

one is more the work this year has proven. It may be that fertilization from barren stalks weakens the vitality of the seed and the general virility of the plant thus causing barrenness. Since however, the whole plot was composed of good thrifty stalks and since no difficulty was encountered in getting the pollen grain to fertilize the silks the writer is strongly of the opinion that the results show that barrenness is an inherited and transmissible character.

BARRENNESS DUE TO POOR SOIL & INCREASED STAND.

As mentioned above there is a very constant difference in the percentage of barrenness between rows planted to two and four stalks per hill respectively and three and five stalks respectively. In the case of the barren bred ears (Table VII) the average percent of barren stalks for rows two stalks per hill was 28.42, for four stalks 44.86, difference 16.44%. For all rows planted to three stalks per hill the average percent of barrenness was 21.31 and for five stalks was 36.94, difference 15.63%. In case of the good ears the differences as above were 18.42% and 16.89% respectively. Now, since the two and four stalk plantings were always on one side of the plot and the three and five stalk plantings on the other, it is obvious that some soil condition on the two and four stalk side must have been responsible for the increase in barrenness.

The supposition that the soil on the side of the

plot planted with rows having two stalks and four stalks per hill was poorer than the other side is supported by the record of the yield of corn. As seen in Table VII the yield of corn in all good rows averaged 6.5 pounds with two stalks per hill, 12.1 pounds with three stalks per hill, 7.6 pounds with four stalks per hill, and 12.3 pounds with five stalks per hill. Instead of the yield increasing steadily with the stand or increasing to a certain point and then falling it is uniformly greater on the side of the plot planted three stalks and five stalks per hill respectively. This shows that the soil must have been richer there.

Since the increase in barrenness on the same soil was so uniform with the increase in stand it seems that the percent of barrenness increases directly with the increase in stand. Taking the increase in total number of stalks and total number of barren stalks from rows planted to two stalks per hill to four stalks per hill and from three to five stalks in both barren bred and good rows the rates of increase in barren stalks to one stalk increase in the stand is 1:.62, 1:.49, 1:.605, and 1:.607. The average is 1:.58. That is increasing the stand one stalk adds .58 of one barren stalk.

With this proportion the number of barren stalks can be corrected to both the good and poor soil found in this plot. Table VIII shows this correction for both barren bred and good ears to each soil. With the correction made it is seen that the fertility of the soil must play a very important part in producing or reducing the number of barren stalks in a

TABLE VIII. (1909).

SHOWING CORRECTIONS TO SAME SOIL CONDITIONS OF BOTH BARREN
AND GOOD EARS WITH DIFFERENCE IN % OF BARRENNESS
DUE TO SOIL.

Rate of Planting.	Total stalks.	Total no. barren stalks.	Barren				Diff. in % Barren due to soil.
			Barren stalks cor't. to poor soil.	% Barren on poor soil	Barren stalks cor't. to poor soil.	% Barren stalks on good soil.	
2 stalks	95	27	27	28.42	11.34	11.93	16.49
3 stalks	122	26	42.66	34.96	27	22.13	12.83
4 stalks	185	83	79.2	42.81	63.54	34.34	8.47
5 stalks	203	75	89.64	44.15	73.98	36.44	7.71
Good.							
2 stalks	166	15	15	9.03			
3 stalks	254	14	66.04	26.0	15	5.9	20.1
4 stalks	306	84	96.2	31.43	45.16	14.75	16.68
5 stalks	366	82	131	35.79	79.96	21.84	13.95

field of corn. The differences in percent of barrenness due to poor soil for barren bred ears were 16.49% rows planted two stalks per hill, 12.83%, rows planted three stalks per hill, 8.47% rows planted four stalks per hill, and 7.71% rows planted five stalks per hill. In the good rows it was found that the correction reduced the number of barren stalks to a minus quantity for the good soil showing that on a fertile soil a stand of two stalks per hill would not have produced any barren stalks. This also showed that the barrenness observed in these rows was due to increasing the stand and the soil condition. The effect of poor soil was even more noticeable ranging from 20.1% barrenness due to poor soil with a stand of three stalks per hill, 16.68% stand four stalks per hill, to 13.95% stand five stalks per hill. It is also to be noticed that in the case of both barren bred and good ears on both good and poor soil that the number and percent of barren stalks increased with the stand but that the percent due to soil declined with an increase in stand. This showed that the influence of the poor soil was a fairly constant thing and did not increase with the increase in stand.

THE EFFECT OF STAND ON STALK CHARACTERS.

Table V shows the characteristics of the stalks in each row of the plot. It will be noticed that in every case the general vigor of both barren bred and good rows decreases as the stand increases. This is shown by lack of height,

TABLE IX. (09).

SHOWING THE DIFFERENCE IN PERCENT OF BARRENNESS OF ROWS PRODUCED FROM SEED HAVING KNOWN BARREN PARENTAGE AND GOOD SEED HAVING NONE SO FAR AS KNOWN. DIFFERENCE IS DUE TO SEED AS THE STAND IS EVEN GREATER AND ON SAME SOIL.

Rate of Planting	Tot. stalks bar.rows.	Tot. stalks good rows.	Bar. stalks in Bar. rows.	Bar. stalks in good rows.	% Barren stalks bar.rows.	% barren stalks good rows.	Diff.in barrenness due to seed.
2 stalks	95	166	27	15	28.42	9.03	19.39
3 stalks	122	254	26	14	21.31	5.51	15.80
4 stalks	185	306	83	84	44.86	27.45	17.41
5 stalks.	203	366	75	82	36.94	22.4	14.54

smaller circumference of stalk, less size and droop of ear, and an increase in the number of broken stalks which indicated smaller weaker joints and internodes. The weakening of the vitality and vigor of the plants must then be the cause of barrenness induced by thickening the stand.

OTHER WORK DONE IN 1909.

Further hand pollination was done this season.

A wider range in numbers and types of barren stalks was available and much better ears were secured.

A New Pollinator.

Such poor ears were secured with the paper bags that the writer decided that they must present some mechanical obstruction to the growth of the ears. It was thought that they had two objectionable features, one that they became very hot inside and that a large percent of pollen applied to the silks was devitalized by the heat, and second that after the ear had been fertilized no scheme could be devised for holding the bags in place other than tying them around the ear. This caused a constriction and a poorly developed ear.

In making a new pollinator the writer decided on cloth because of ease of handling and tying. A quantity of corn pollen was secured and placed on various pieces of cloth and put under a microscope. An attempt was then made to force the pollen grains through the meshes of the cloth. Two kinds a very fine silk, and a good grade of canton flannel with the

nap turned out would not allow pollen to go through. Bags about a foot long and six inches in diameter were made from each of these materials. They had a draw string in the large end to regulate the size of the opening and to tie around the stalk. At the small end a glass tube was inserted which had been reamed out at one end to prevent its slipping out. (The accompanying photograph shows a cotton flannel pollinator).

These bags were slipped over good shoots before the silks appeared and tied to the stalk. As soon as the silks began to come pollen was gathered from a barren stalk previously selected and carried in a flat covered pan to the ear to be fertilized. The pollen was poured into the tube and a puff of breath down the tube sent it flying over the silks. By this plan the bags once in place are never removed and all danger of wild pollen is eliminated. Care was taken to loosen the draw string each day as the ear was forming in order not to constrict the ear around the butt. Good ears of corn were secured this season as shown by the photograph. Those ears not well formed are probably so because of a lack of pollen to finish them out. Most of the stalks used as sires finished shedding their pollen before all the silks were out.

It is well to note here that the cotton flannel bags proved to be the best as the silk ones rot and the grass hoppers eat them badly.

BEGINNING THE WORK ON INBREEDING.

In order to determine the effect of inbreeding on barrenness a plot of line bred corn was used for the purpose. In the Boone County White breeding work of this Station, two exceptionally good strains were found which we will call 10 and 67. The object was to cross these and inbreed 10 at the same time then pile up the blood of 10 in the outcross by line breeding methods. In the season of 1909 only one ear of the cross and one of the inbred 10 were secured.

Inbreeding was also done in the plot devoted to the barren work. Care was taken to fertilize some ears from a barren stalk having the same parentage as the ears. Thus ears 12-25 and 17-17 of 1910 were inbred coming from mother ears 41-104 and 32-102 of 1909 respectively. A report of results secured by inbreeding appears under the work done in 1910.

WORK DONE IN 1910.

Five ears barren bred were secured in 1909 which were made to furnish pollen for the 1910 plot. (See photograph of ears). One good ear number 9-6 of the corn breeding work which had not thrown a single barren stalk was used as a check. Also three ears open fertilized in the plot of 1909 were used but detasseled.

In the plot of 1910 there were then strictly barren bred ears, ears open fertilized from pollen produced by stalks which had been previously barren bred, and a tested ear from the breeding work which had not thrown any barren stalks.

TABLE I. (1910)

ORDER OF PLANTING OF CORN USED IN BARREN WORK SECOND YEAR, SHOWING
 ROWS, EARS USED FOR POLLEN AND DETASSELING, AND NUMBER OF
 STALKS PER HILL.

Row-Ear	Function	Stalks, per hill	Row-Ear	Function	Stalks, per hill
1 9-7	Pollen	2 stalks	2 9-7	Pollen	3 stalks
3 9-7	Pollen	4 stalks	4 9-7	Pollen	5 stalks
5 (1)32-102(09)	Detassel	2 stalks	6 (1)32-102(09)	Detassel	3 stalks
7 (1)32-102(09)	Detassel	4 stalks	8 (1)32-102(09)	Detassel	5 stalks
9 7-3	Pollen	2 stalks	10 7-3	Pollen	3 stalks
11 7-3	Pollen	4 stalks	12 7-3	Pollen	5 stalks
13 (2)32-102(09)	Detassel	2 stalks	14 (2)32-102(09)	Detassel	3 stalks
15 (2)32-102(09)	Detassel	4 stalks	16 (2)32-102(09)	Detassel	5 stalks
17 15-15	Pollen	2 stalks	18 15-15	Pollen	3 stalks
19 15-15	Pollen	4 stalks	20 15-15	Pollen	5 stalks
21 (1)29-129(09)	Detassel	2 stalks	22 (1)29-129(09)	Detassel	3 stalks
23 (1)29-129(09)	Detassel	4 stalks	24 (1)29-129(09)	Detassel	5 stalks
25 12-25	Pollen	2 stalks	26 12-25	Pollen	3 stalks
27 12-25	Pollen	4 stalks	28 12-25	Pollen	5 stalks
29 9-6(09)B	Detassel	2 stalks	30 9-6(09)B	Detassel	3 stalks
31 9-6(09)B	Detassel	4 stalks	32 9-6(09)B	Detassel	5 stalks
33 17-17	Pollen	2 stalks	34 17-17	Pollen	3 stalks
35 17-17	Pollen	4 stalks	36 17-17	Pollen	5 stalks

Planted May 31, 1910.

Thinned to above stands, July 8.

Rows 18 hills long.

Hills 3 feet, 4 inches apart each way.

SHOWING ACTUAL NUMBER OF STALKS PER HILL AT HARVEST AND TOTAL PER ROW.

ROWS PLANTED TO HAVE STAND OF 2 & 4 STALKS PER HILL RESPECTIVELY.

Row	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
Hill	Showing actual number stalks per hill.																	
1	1	4	1	4	2	4	2	3	2	4	1	3	1	0	2	3	2	4
2	2	4	1	4	2	4	2	2	0	2	3	3	0	0	1	0	0	5
3	2	4	2	4	0	2	3	4	2	2	2	0	0	0	2	0	0	2
4	2	4	2	4	2	3	3	3	2	2	3	4	0	1	2	0	1	0
5	2	3	2	4	2	3	1	3	2	4	1	4	1	0	2	0	2	3
6	2	2	2	3	2	4	2	3	1	4	2	4	1	0	0	0	2	4
7	2	4	2	4	2	2	0	3	2	4	1	5	2	3	2	1	2	1
8	1	3	2	4	2	4	2	3	2	4	2	2	1	0	2	0	2	4
9	2	4	2	4	2	4	2	3	2	3	2	3	2	1	2	4	3	4
10	2	4	2	4	2	3	2	4	2	3	2	3	2	0	2	1	2	4
11	2	4	2	4	2	3	1	1	2	4	1	4	2	4	1	1	2	5
12	2	4	1	3	2	3	1	1	2	4	1	4	2	4	1	4	2	4
13	2	2	2	3	2	5	1	3	2	3	2	4	2	1	2	4	2	4
14	2	3	2	4	2	4	2	3	2	5	1	4	1	1	1	3	2	4
15	1	2	2	3	2	4	1	2	2	4	2	4	1	1	2	2	2	4
16	2	2	1	2	2	5	2	3	1	4	1	4	2	2	2	1	2	4
17	2	3	2	3	2	4	1	2	2	3	2	4	2	3	2	3	2	4
18	2	3	2	2	2	3	1	4	2	4	2	4	2	2	3	3	2	4
Tot.	33	58	32	63	34	64	30	53	32	62	30	62	24	23	32	27	32	64

TABLE III (1910):

SHOWING ACTUAL NUMBER OF STALKS PER HILL AT HARVEST AND TOTAL PER ROW.

ROWS PLANTED TO HAVE STAND OF 3 & 5 STALKS PER HILL RESPECTIVELY.

Row	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
Hill	Showing actual number stalks per hill.																	
1	3	4	3	6	3	4	3	4	3	3	3	3	3	4	3	5	3	4
2	3	5	3	4	3	4	4	5	3	3	3	6	2	2	3	4	3	4
3	3	5	0	3	3	4	3	4	3	3	3	3	3	4	3	5	3	5
4	3	4	3	2	3	5	3	4	5	3	0	4	2	3	2	2	3	5
5	3	5	3	4	3	4	2	3	3	5	3	3	3	2	2	3	3	4
6	3	3	2	6	2	4	1	3	4	4	3	5	3	0	2	3	2	3
7	2	4	2	5	3	7	2	4	3	3	3	3	3	1	2	7	3	5
8	3	3	3	3	3	4	2	4	3	4	3	4	3	0	1	4	3	5
9	4	5	3	4	2	5	3	5	3	4	2	5	1	0	1	1	3	5
10	3	3	3	5	3	4	3	4	3	3	2	4	1	0	2	2	4	5
11	3	5	3	5	2	4	2	3	3	2	3	3	0	0	1	2	4	5
12	3	4	3	5	3	5	2	4	4	4	2	5	3	0	1	4	0	5
13	3	4	3	3	3	2	3	5	3	3	1	2	3	0	2	0	2	5
14	3	5	3	5	1	4	3	3	3	4	3	4	0	0	2	1	0	4
15	3	4	3	5	3	6	3	2	4	2	2	2	0	0	2	0	2	0
16	2	4	3	5	2	4	3	4	3	3	4	5	1	0	2	0	4	5
17	2	3	2	5	0	3	0	4	3	4	3	2	0	0	2	3	3	2
18	3	3	3	5	3	6	3	4	3	5	2	3	1	0	1	1	3	3
Tot.	53	73	48	80	45	79	45	69	60	64	45	67	32	16	34	45	48	74

The order of planting, Table I (1910), and ranges in stand ~~were~~ exactly the same as for 1909. The soil was all good though sloping considerably to the north. The slope afterward caused considerable damage by ^{rains} washing out some of the rows and burying some kernels so deep that they never came up.

Tables II and III (1910) show the actual number of stalks per hill per row which came to maturity in each row of the whole plot. The totals are used throughout the following tables.

DISCUSSION OF RESULTS FOR 1910.

Hereditary Barrenness.

A count was made of all barren stalks in each row exactly as in 1909. The number and percent of barren stalks appear in Table IV (1910). A glance will show that the barren bred, and naturally crossed ears are exceedingly high in percent of barrenness, with very little difference between them. They both threw a much larger percent of barren stalks than the good ear.

Table VII (1910) shows a summary of the average results secured from the three classes of ears. The differences in percent of barrenness is more clearly shown in Table VIII(1910). It is seen that the percent of barren stalks from barren bred ears run 31.61, 51.68, 50.92 and 63.72 as the stand increases from two to five stalks per hill. The naturally crossed ears from a barren bred ancestry threw 44.56, 50.72,

TABLE IV. (1910).

SHOWING TOTAL NUMBER OF BARREN STALKS AND PERCENT OF BARRENNESS
FOR EACH ROW.

Row.	No.	No.	%	Row.	No.	No.	%
	stalks.	barren.	barren.		stalks.	barren.	barren
1	33	5	15.15	2	53	11	20.75
3	58	25	43.1	4	73	35	47.95
5	32	16	50.0	6	48	19	39.59
7	62	27	43.55	8	80	43	53.75
9	34	13	38.24	10	45	18	40.0
11	64	40	62.5	12	79	44	55.7
13	30	10	33.3	14	45	21	46.68
15	52	28	53.85	16	69	39	56.52
17	32	16	50.0	18	60	37	61.67
19	62	28	45.16	20	64	41	64.06
21	30	15	50.0	22	45	30	66.66
23	62	35	56.45	24	67	53	79.1
25	24	9	37.5	26	32	25	78.12
27	23	12	52.17	28	16	13	81.27
29	32	6	17.7	30	34	9	26.47
31	27	5	18.5	32	45	17	37.78
33	32	6	17.7	34	48	32	66.67
35	64	33	51.56	36	74	62	83.78

TABLE V. (1910).

SHOWING STALK CHARACTERS OF EACH ROW.

Row.	Vigor.	Size	Droop	No.	%	Row.	Vigor.	Size	Droop	No.	%
		ears.	ears.	broken	broken			ears.	ears.	broken	broken
				stalks	stalks					stalks	stalks
1	m	mp	p	3	9.09	2	p	p	vp	6	11.32
3	mp	p	vp	11	18.96	4	vp	vp	vp	4	5.48
5	vp	p	vp	1	3.1	6	vp	p	vp	1	2.08
7	vp	vp	vp	4	6.45	8	vp	p	vp	2	2.5
9	m	mp	p	3	8.82	10	mp	mp	vp	0	0.0
11	mp	vp	vp	6	9.37	12	mp	p	vp	5	6.33
13	mp	m	mp	1	3.33	14	vp	vp	vp	3	6.66
15	mp	mp	mp	4	7.69	16	vp	vp	vp	4	5.8
17	mg	mp	p	1	3.12	18	p	vp	vp	6	10.0
19	m	p	vp	2	3.22	20	p	vp	vp	7	10.97
21	mp	vp	vp	7	23.33	22	vp	vp	vp	6	13.33
23	p	vp	vp	4	6.45	24	vp	vp	vp	9	13.43
25	mp	p	vp	1	4.16	26	vp	vp	vp	0	0.0
27	mp	vp	vp	1	4.35	28	vp	vp	vp	1	6.25
29	mg	mg	g	8	25.0	30	p	vp	vp	3	8.18
31	mp	mp	m	4	14.81	32	p	vp	vp	9	20.0
33	mg	mp	p	1	3.12	34	p	vp	vp	0	0.0
35	mg	p	vp	3	4.69	36	p	vp	vp	2	2.7

TABLE VI. (1910)

SHOWING YIELD OF GRAIN INCLUDING NUMBER OF GOOD EARS,NUBBINS, WEIGHT FODDER,
AND AVERAGE WEIGHT PER EAR FROM EACH ROW.

Row	Yld.No.	No.	Total	Wt.	Av.wt.	Row	Yld.No.	No.	Total	Wt.	Av.wt.	
	lbs.good	nubs.	ears.	fod-ear	oz.		lbs.good	nubs,	ears.	fod- ear	oz.	
	ears.			der.			ears.			der.		
14	5	24	29	12	7.7	2	17	6	30	36	17	7.6
10	2	32	34	18	4.7	4	11	2	33	35	19	5.0
8	4	19	23	9	5.5	6	10	4	26	30	10	5.3
11	3	35	38	11	4.6	8	9	5	32	37	12	3.9
8	0	22	22	14	5.8	10	10	6	21	27	18	5.9
7	0	32	32	23	3.5	12	11	5	31	36	20	4.9
6	7	13	20	10	4.8	14	7	2	22	24	9	4.6
9	3	23	26	12	5.5	16	10	8	23	31	13	5.1
6	2	15	17	16	5.6	18	6	3	21	24	21	4.0
7	3	24	27	23	4.1	20	5	2	19	21	21	3.8
4	2	15	17	9	3.8	22	4	1	17	18	9	3.5
7	4	22	26	12	4.3	24	3	0	16	16	8	3.0
5	2	13	15	7	5.3	26	1	0	8	8	11	2.0
3	4	6	10	6	4.8	28	1	0	3	3	6	5.3
10	9	20	29	9	5.5	30	12	9	17	26	7	7.4
6	4	14	18	6	5.3	32	7	2	24	26	9	4.3
8	5	19	24	17	5.3	34	5	2	12	14	17	5.7
8	3	18	21	27	6.1	36	2	0	9	9	22	3.5

Note. The number of ears plus the number of barren stalks produced by each row may be the same, greater or less than the total number of stalks per row. If greater some stalks have produced twin ears. Where less those nubbins producing a grain or two have been overlooked at husking time.

TABLE VII. (1910).

SUMMARY OF DATA ON BARREN, PART BARREN, AND GOOD ROWS.

ALL FIGURE AVERAGE.

Stand.	Total stalks.	Total barren.	% barren.	Total broken.	% broken.	Av.yld.lbs.	Av.wt. ear.	Increase in barrenness per 1 stalk in stand.
2 stalks	155	49	31.61	9	5.8	8.2	6.1	
3 stalks	238	123	51.68	12	5.04	7.8	6	1:.99
4 stalks	271	138	50.92	23	8.49	7	4.5	1:.76
5 stalks	306	195	63.72	19	6.21	6	4.6	1:.96
2 stalks	92	41	44.56	9	9.78	6.0	4.8	
3 stalks	138	70	50.72	10	7.25	7.0	4.7	1:.63
4 stalks	176	90	51.13	12	6.82	9.0	4.8	1:.58
5 stalks	216	135	62.6	15	6.94	7.3	4.2	1:.75
2 stalks	32	6	18.75	8	25.0	10	5.5	
3 stalks	34	9	26.47	3	8.8	12	7.4	1:.15
4 stalks	27	5	18.51	4	14.8	6	5.3	1:.2
5 stalks	45	17	37.77	9	20.0	7	4.3	1:.84

TABLE VIII. (1910).

SHOWING THE DIFFERENCE IN PERCENT OF BARRENNESS OF ROWS PRODUCED FROM SEED HAVING KNOWN BARREN PARENTAGE, SEED NATURALLY CROSSED FROM A PREVIOUS BARREN CROSS, AND GOOD SEED.

Rate of Planting	2 stalks.	3 stalks.	4 stalks.	5 stalks.
Total stalks barren rows.	155	238	271	306
Total pt. barren rows	92	138	176	216
Total stalks good rows	32	34	27	45
No. Barren stalks in barren rows	49	123	138	195
No. Barren stalks in pt. barren rows.	41	70	90	135
No. Barren stalks in good rows.	6	9	5	17
% Barren stalks in barren rows.	31.61	51.68	50.92	63.72
% Barren stalks in pt. barren rows	44.56	50.72	51.13	62.6
% Barren stalks in good rows.	18.75	26.47	18.51	37.77
% Diff. favor barren. Barren vs. pt. barren.	-12.95	+ 0.96	+ 0.21	+ 1.12
% Diff. favor barren. Barren vs. good.	+12.86	+25.21	+32.41	+31.95

51.13, and 62.6 percent barrenness as the stand increased from two to five stalks per hill. While the good ear only threw 18.75, 26.47, 18.51 and 37.77 percent of barren stalks as the stand increased from two to five stalks per hill. As shown by the table there is a difference of 12.95% and 0.21% barrenness in favor of the naturally crossed ears over barren bred ones having a stand of two stalks and four stalks respectively. In case of three and five stalk stand the barren bred ears showed an increase of 0.96 and 1.12% respectively. Comparing the good ear with the barren bred ones the differences in barrenness are all greater in case of the barren bred seed ranging 12.86%, 25.21%, 32.41% and 31.95% as the stand ranged from two to five stalks per hill respectively. The last three differences are very constant and must be due to seed as the stand and soil were the same in each case. The differences also give a good idea of the percentage of barrenness inherited. No explanation can be offered as to why the first difference fell so low other than the stand in this case was nearly as large as in rows where it should have been greater thus making this row appear to have thrown a much greater percent of barren stalks than the thickness of the stand would warrant.

BARRENNESS DUE TO INCREASE OF STAND.

From Tables VII and VIII it will be seen that the number and percent of barren stalks for each class of seed increased directly with the stand. Since the increase was so

uniform it shows that there was no difference in the fertility of the soil over the whole plot. A very slight decrease occurred in the percent of barrenness of barren bred ears planted to four stalks per hill over three stalks and a considerable decrease in the same place in case of the good ear. This latter case is accounted for by the fact that this row was badly washed and the number of stalks reaching maturity was only 27 as compared to 34 planted to three stalks per hill. The first case is unaccounted for.

The last column in Table VII shows the ratio of increase in barrenness per stalk increase in stand. This ratio is very constant for the barren bred and naturally crossed ears, but exceedingly variable for the good ear. Since, however, these rows were badly damaged by the rains and washing and since it did not come to a proper development the number of barren stalks produced may be considered too high and erratic. The average ratio of increase in barrenness per stalk increase in stand is 1:.76. In 1909 the average ratio of increase was 1:.58. These figures are constant each year and close enough to say that barrenness increases in direct ratio with the increase of stand and in ratio near 1:.58-.76. These figures may vary with another season.

**UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
COOPERATING WITH
MISSOURI AGRICULTURAL EXPERIMENT STATION.**

SEED LABORATORY,
MISSOURI BRANCH.

Columbia, Mo., May 9, 1910.

Mr. F. H. Demaree,
City.

FINAL REPORT OF GERMINATION TEST OF SEED RECEIVED May 2, 1910,-----

TEST NUMBER.	SENDER'S MARK.	NAME OF SEED.	DURATION OF TEST IN DAYS.	GERMINATION PER CENT.
1184	9-7		7	95
1185	7-3		7	100
1186	15-15		7	95
1188	(1)29-129		7	90
1196	(1)32-102		7	100
1197	(2)32-102		7	95
1224	17-17		7	100
1226	12-125		7	100

REMARKS Ears us^{ad.} in Barren work season 1910.

F. H. Demaree

Collaborator in Charge.

The names of the United States Department of Agriculture and of the Missouri Agricultural Experiment Station must not be used for advertising purposes in connection with this report.

INCREASES IN STAND AS AFFECTING STALK CHARACTERISTICS.

Practically the same notes with the same results were secured on stalk characteristics due to changing the stand. Thickness of planting invariably decreases the vigor of the stalk, the size and droop of the ear and increases the number and percent of broken stalks. It is well to note in this connection that the stalks from the barren bred ears were equally as vigorous as the others. Furthermore the power of germination of the seed before planting was equally as good as shown by the report on germination here presented. It does not seem then that barren pollen has any tendency to lessen the stalk vigor of the plants produced but a constitutional inability to produce an ear seems to be transmitted.

INBREEDING AS AFFECTING BARRENNESS.

Table IX shows the total percent of barren stalks thrown by each barren bred ear of 1910. It will be noted that the two inbred ears 12-25 and 17-17 threw a larger percent of barren stalks in every case except 7-3 and 15-15 planted to two stalks per hill and 7-3 planted to four stalks per hill. The average difference between the two classes for two stalks per hill is -6.86%, for three stalks 24.92%, for four stalks 14.61%, for five stalks 26.52%. This seems to show that inbreeding decreases the ear producing power of the stalks although the table (V) on stalk character# does not show these rows to be poorer than the others.

Table X shows the results secured from the cross between

TABLE IX.(1910).

SHOWING THE INFLUENCE OF INBREEDING. ALL EARS WERE HAND
 POLLINATED FROM BARREN STALKS. EARS 12-25 AND
 17-17 WERE INBRED.

Stand	Ear 9-7 % barren	Ear 7-3 % barren	Ear 15-15 % barren	Ear 12-25 Inbred % barren	Ear 17-17 Inbred % barren
2 Stalks	15.15	38.24	50.0	37.5	17.7
3 Stalks	20.75	40.0	61.67	78.12	66.67
4 Stalks	43.1	62.5	45.16	52.17	51.56
5 Stalks	47.95	55.7	64.06	81.27	83.78
Aver- age.	31.74	49.11	55.22	62.26	54.92

Stand.	Barren cross bred.	Barren inbred.	Difference favor inbred.
2 stalks.	34.46	27.6	- 6.86
3 "	47.47	72.39	24.92
4 "	50.25	51.86	1.61
5 "	55.9	82.52	26.62

10 X 67 and the inbred 10. Five rows were planted to the cross and five to the inbred seed. The cross was detasseled and the inbred furnished the pollen. During the season the inbred rows seemed the more growthy but at harvesting time the yields with the number of **barren** stalks produced did not show up. The averages for the two show 25.0% more barren stalks in the inbred rows. While the cross produced 15 more good ears, 16 more nubbins, 15 more pounds of corn on the average and an average of 1.6 pounds more fodder per row. The stand in each case started the same. At the end however, more of the cross bred stalks came to maturity thus indicating superior vitality of stalk in this case. It is decidedly evident however, that the inbred plants did not ear as well nor produce as large ears as the cross bred ones.

DESCRIPTIONS OF BARREN STALKS.

In the fall of 1908 while doing some work on individual stalks, the writer found one of the few absolutely barren stalks which occur even under favorable conditions in most fields of corn.

This stalk (No. 148) was nine feet high, seemingly very vigorous and had fifteen leaves. The leaves were long, medium in width, and light green in color. The stalk was practically mature at the time it was found but the upper nine leaves were standing almost straight out. The leaves and sheathes were very fleshy and heavy.

The stalk upon dissection proved to be practically round, at the second node above ground were some rudimentary brace roots and on the third and fourth nodes appeared small rudimentary shoots. These were less than one inch in length and $1/16$ of an inch in width and as thin as tissue paper. From the fourth node the stalk became perfectly round with no sign of a shoot. The color of the leaf, sheathes and stalk was a reddish-yellow. The nodes were strong but not pronounced and the whole stalk tapered from the base to the tassel.

The tassel was large, branches thick and outstanding.

This stalk was found growing in the hill with another stalk on good soil. The stalk by which it was growing was of about the same height, vigorous, flatter than the barren stalk having a groove running between nodes on alternate sides of the stalk as is characteristic of corn. It produced a good ear.

During the same season the writer found a barren stalk in the variety test of Johnson County White and one of Boone County White. The leaves of the Johnson County White stalk were rather narrow and long having fleshy sheathes. They had the same peculiar outstanding posture of stalk 148.

The stalk itself was $7\frac{1}{2}$ feet high, slender and nearly round but with nodes fairly well pronounced. It had four rudimentary shoots but no kernels were formed.

The tassel was heavy, thick, each branch being heavily laden with empty pollen cases. There was a long main

spike also densely covered with cases.

The Boone County White stalk was 7 1/2 feet high, larger and flatter than the Johnson County White sheath. The nodes were thirteen in number but not so well pronounced as in the other. The leaves were much the same in shape and posture as has been described.

There was no sign of a shoot from the outside but upon examination nine small shoots were found ranging from the first node up. The last one had some husks over a rudimentary cob but no embryos nor silks were formed.

DESCRIPTIONS OF BARREN STALKS.
(Plot of 1909).

Barren Stalk No. 3. This stalk was 8 feet 6 inches high and 2 1/2 inches in circumference at the second node. The stalk was very slender and the internodes long. It possessed thirteen nodes, fairly well pronounced. The leaf sheathes and leaves were vairy fleshy and had a great deal of red color in them. There was a well developed shoot on the stalk but no grain was formed. The tassel was small and sparsely branched.

Stalk No. 7 .

This stalk was 9 feet tall 2 3/4 inches in circumference at the second node. The internodes were fairly long with nodes not well pronounced. The nodes were fourteen in number. The leaves were fairly fleshy and outstanding. The sheathes were also fleshy and there was considerable red color in stalk, sheathes, and leaves. This stalk also had put out several small shoots but no grain was formed. The tassel was

large with a long main spike.

Stalk No. 8.

This stalk was 8 feet, 2 inches tall and 2 1/2 inches in circumference at the second node. The internodes were fairly long and the nodes well pronounced. The nodes were twelve in number. The leaves were thin and the sheathes fleshy with red color in both sheathes and stalk. The tassel was heavy and compact with a large main sipke.

Stalk No. 10.

This stalk was 9 feet, 6 inches high, 2 1/2 inches in circumference at the second node. It possessed thirteen nodes, medium in size with long internodes. The leaves and sheathes were fleshy and showed a red color. There was a very small shoot but no grain had formed. The tassel was medium in size with a long main spike.

Stalk No. 11.

and 6 inches high,
This stalk was 10 feet, 2 7/8 inches in circumference at the second node. The nodes were fourteen in number and well pronounced. The internodes were fairly long. The leaves were thin but the sheathes were fairly fleshy. The red color was shown in the stalk. There was a well developed shoot and embryonic cob but no grain. The tassel was very heavy and thick.

Stalk No. 15.

This stalk was 11 feet 6 inches high and 2 3/4 inches in circumference at the second node. It had fourteen nodes which were not pronounced. The internodes were very long. The

leaves and sheathes were fleshy and the stalk showed considerable red color. Several shoots were produced but no grain.

The tassel was medium in size and very compact and had a large main spike.

Stalk No. 16.

This stalk was 11 feet high and 3 inches in circumference at the second node. The nodes were sixteen in number and only fairly pronounced. The internodes were medium long and the leaves and sheathes were fleshy. Some red color was shown in the stalk, leaves, and sheathes. Small shoots were produced but no grain. The tassel was very small but very compact.

Stalk No. 17.

This stalk was 11 feet 6 inches high and 3 inches in circumference at the second node. The nodes were fifteen in number and not pronounced. The internodes were only fairly long. The leaves and sheathes were still green in color turning to a reddish-yellow. They were also very fleshy. This stalk had fairly well developed shoots but no grain. The tassel was large and branching with a large main spike.

Stalk No. 20.

This stalk was 11 feet tall and $3 \frac{1}{3}$ inches in circumference at the second node. It had sixteen nodes which were well pronounced. The internodes were long. The leaves were fairly thin and the sheathes were fleshy. The red color was shown in stalk, sheathes and leaves. There were four

well developed shoots on this stalk but not a kernel had formed. The tassel was large and branching.

Stalk No. 22.

This stalk was 8 feet 6 inches high, 2 1/4 inches in circumference at the second node. It had thirteen nodes, which were fairly well pronounced. The internodes were long. The leaves were thin but the sheathes were fleshy. The red color was shown in both sheathes and stalk. The stalk produced two small shoots but no grain. The tassel was small but had a large main spike.

Stalk No. 23.

This stalk was 10 feet high 2 3/4 inches in circumference at the second node. It had fifteen nodes and the nodes were of medium size. The internodes were of medium length. The leaves and sheathes were fleshy and had a great deal of red color in both. There were several shoots one of which produced ^{an} embryonic cob but no grain. The tassel was medium in size and widely branching.

Stalk No. 25.

This stalk was 10 feet 3 inches high, 2 3/4 inches in circumference at the second node. There were thirteen nodes which were not well pronounced. The internodes were long and slender. The leaves and sheathes were fleshy and the leaves upstanding. The sheathes possessed a great deal of red color. The tassel was large and branching with a heavy main spike.

From the foregoing description of barren stalks it

seems that we can rightly infer that a typical barren stalk is rather round, the nodes not pronounced, generally long and slender with leaves and sheathes fleshy causing the leaves to have a peculiar upstanding appearance. When mature the leaves and sheathes and sometimes the stalk, possess a peculiar red color. It is well to add that in every case the stalk is much heavier than a good stalk of corn and is full of sugar.

The appearance of good stalks of corn is much different from the above description. A productive stalk is generally flat instead of round. It is also grooved deeply on alternate sides between nodes. In these grooves the shoots come. The leaves and sheathes are also generally thin and generally turn a whitish yellow upon ripening rather than reddish. The stalk also becomes pithy and does not remain solid as did the barren stalks. This is probably due to the fact that the food found in the various parts of good stalks is transferred to the ear while in the case of barren stalks this remained deposited in the various parts of the stalk. The following table shows the weight of stalk, leaves, sheathes and grain of various barren and good stalks of corn.

TABLE XI.
 SHOWING WEIGHT OF LEAVES, SHEATHES, STALK OF BARREN
 AND PRODUCTIVE STALKS OF CORN.

Barren or productive.	Weight leaves.	Weight sheathes.	Weight stalks.	weight ear.	Total
C.W. Barren	34.5 g	35.0 g	94.5 g		164.0 g
C.W. Barren	39.0 g	32.0 g	170.0 g		241.0 g
Productive	139.1 g	49.6 g	174.0 g	276.7g	639.4 g
Productive	82.8 g	30.5 g	121.0 g	154.0g	388.3 g
Productive	36.5 g	18.8 g	79.9 g	38.3 g	173.5 g
Barren (shoots)	140.0 g	52.4 g	243.4 g		435.8 g
Barren (shoots)	63.1 g	39.3 g	237.0 g		339.4 g
Barren (shoots)	55.5 g	44.3 g	127.2 g		227.0 g
Barren	34.3 g	22.0 g	74.8 g		131.1 g
Barren	39.3 g	26.0 g	95.3 g		160.6 g
Average Barren	57.9 g	35.8 g	148.9g		242.7 g
Average Productive	81.6 g	32.9 g	124.9 g	156.3g	400.4 g
Diff.favor barren.		2.9 g	24.0 g		
Diff.favor Productive	23.7 g			156.3 g	157.7 g

From the table it will be seen that the average weight of the barren stalks studied never equalled the total weight including the ear of fertile stalks. The differences in weight of ear then, is always in favor of productive stalks. There was a difference of 24 grams in weight of stalk in favor of the barren stalks and also 2.9 grams in weight of leaf sheathes in favor of the barren stalks. The actual weight of the leaves themselves however, was greater in the case of the productive stalks there being on the average 23.7 grams more weight in the favor of the leaves from the fertile stalks.

The question now naturally arises, what becomes of the plant food elaborated by the barren stalks since they produce no grain. Those stalks numbered from 1 to 8 inclusively were analyzed in order to determine the percentage of various plant foods found in each division of the stalks noted. The ears of the productive stalks were not analyzed because there was no corresponding part to compare them with in case of the barren stalks. The following table shows the results of this analysis.

TABLE XII

ANALYSIS OF CORN STALKS--BARREN AND PRODUCTIVE.

Stalk	Kind	Part	Moisture	Protein	Fat	Ash	Crude Fibre	Nitrogen Free Extract
1	Prod.	Stalk	6.58	3.04	2.83	5.82	36.81	44.93
1	"	Sheaths	7.59	2.29	0.82	9.29	31.98	48.04
1	"	Leaves	6.99	4.91	1.34	13.47	31.25	42.05
2	"	Stalk	6.62	1.74	2.49	6.51	40.57	42.07
2	"	Sheaths	7.94	2.37	0.50	10.21	31.31	47.68
2	"	Leaves	7.29	5.51	1.50	12.90	28.98	43.82
3	"	Stalk	6.38	1.72	1.46	5.83	38.20	46.43
3	"	Sheaths	8.49	2.83	0.08	9.06	34.14	45.42
3	"	Leaves	8.31	4.71	0.94	14.48	27.30	44.26
4	Barren	Stalk	5.42	4.22	3.94	4.18	30.83	51.41
4	"	Sheaths	6.33	3.38	1.37	10.42	27.83	50.68
4	"	Leaves	7.66	5.99	1.34	12.36	28.15	44.50
5	"	Stalk	5.95	2.28	4.91	5.90	31.41	49.55
5	"	Sheaths	7.28	2.33	1.09	8.69	32.44	48.18
5	"	Leaves	7.49	6.62	1.91	10.39	28.25	45.27
6	"	Stalk	6.91	4.55	1.51	4.41	35.31	47.32
6	"	Sheaths	6.95	3.45	0.78	7.69	27.68	53.47
6	"	Leaves	7.61	11.11	1.90	13.26	26.66	39.47
7	"	Stalk	6.19	2.84	2.24	6.05	32.65	50.03
7	"	Sheaths	7.80	2.71	0.87	9.05	30.69	48.89
7	"	Leaves	7.55	8.58	1.84	14.27	28.47	39.30
8	"	Stalk	5.86	2.19	6.27	4.73	26.95	54.00
8	"	Sheaths	7.20	1.76	1.06	9.25	32.97	47.76
8	"	Leaves	7.23	4.34	1.77	13.82	29.34	43.50

TABLE XIII

Showing Average Analysis of Barren and Productive Stalks of
Corn with the Location of Plant Food.

Character	Part	Moisture	Protein	Fat	Ash	Crude Fibre	Nitrogen Free Extract
Prod't	Stalk	6.53	2.17	2.26	6.05	38.53	44.48
Barren	"	6.07	3.22	3.77	5.05	31.23	50.26
Diff.Prod. or Barren		0.46	1.05	1.51	1.00	7.30	5.78
Prod't	Sheaths	8.07	2.50	0.47	9.52	32.48	47.05
Barren	"	7.11	2.73	1.03	9.02	30.32	49.80
Diff.Prod. or Barren		0.96	0.23	0.56	0.50	2.16	2.75
Prod't	Leaves	7.53	5.04	1.26	13.62	29.18	43.38
Barren	"	7.51	7.34	1.75	12.82	28.17	42.41
Diff.Prod. or Barren		0.02	2.30	0.49	0.80	1.01	0.97

Table XIII is a summary of the previous one. It shows the average composition of the three parts of productive and barren stalks analyzed.

The differences in composition of the various parts are interesting. The productive stalks, sheaths, and leaves contained more moisture, ash, and crude fibre than did the barren stalks. On the other hand the stalks, sheaths, and leaves of barren stalks contained more protein, fat, and nitrogen free extract than did those of productive stalks.

This analysis bears out the observation made that barren stalks seem to be full of sugar, and leaves and sheaths fleshier than productive ones. The difference in composition is not enough however to say that all of the food which would go into the ear is lodged in some part of the plant. It would seem then that barren stalks do not manufacture food much beyond their own needs. Since then this function of the plant largely ceases upon maturity of the plant it is another evidence that true barrenness is an inherent tendency and not a condition induced by circumstance.

DATA ON BARRENNESS FROM OTHER SOURCES.

Barrenness in Corn Varieties.

Table **XIV** shows the total number of stalks, the number of barren stalks, percent of barren stalks, and yield per acre of the varieties of corn grown on the Experiment Station field at the University of Missouri in the season of 1910. It will be noted that the percent of barrenness varies from 1.01 to 9.2. The 1.01% was a check which was Boone County White and the 9.2% was St. Charles White. Owing to the fact that our soil is rather ununiform all our varieties of grain are planted with a check of some good variety introduced every third plot. In case of these corn varieties every variety was planted in a long row each row being 3 feet, 4 inches apart and the hills 3 feet, 4 inches in the row. The stand was thinned to two stalks per hill when the corn was about 6 inches high. By following the percentage of barrenness in the two checks which include each set of two varieties it can be seen whether or not the barrenness was due to poor soil or was a varietal characteristic. If due to poorer soil the percentage of barrenness in the checks should be large as well as the percentage of barrenness of the varieties. Special instances are noted as in the case of St. Charles White which produced 9.2% of barren stalks and Commercial White growing by the side of it produced 11.11% of barren stalks while the two checks of Boone County White on each side of these rows produced 5.78% and 5.93% of barren stalks. Another instance is in the case of the Cartner which produced only 2.03% of barren stalks as compared

with 7.47% of barren stalks produced by the check which grew in the row beside it. Such tendencies to throw a number or very few barren stalks since they vary so far above in the one case or below the check in the other, must be due to an inherent characteristic of the variety rather than an external influence. This seems especially reasonable when we consider that the rows were side by side, the stand was the same, the season, cultivation and any other factors which would have entered were also the same.

The average yield of the five varieties producing the highest percent of barren stalks was 58.5 bushels per acre. The average yield of the five varieties throwing the lowest percent of barren stalks was 65.1 bushels per acre. This leaves 6.6 bushels per acre in favor of those varieties producing a low number of barren stalks. The difference in percentage of barrenness between the two was 5.74%.

It must be remembered in this connection that there is a great deal of difference between the yields of various varieties of corn due to adaptability and yielding power, so that there is a chance that this difference in yield is due as much to the variety characteristics as to the barren tendency. However, since the two points under discussion are in such close correlation that it is a very important piece of evidence that barrenness may be a variety characteristic and tends to decrease the yield of those varieties.

TABLE XIV.
 SHOWING BARRENNESS OF VARIETIES OF CORN UNDER TEST AT
 THE MISSOURI EXPERIMENT STATION. SEASON 1910.

Variety	Total stalks	No. Barren stalks	% Barren stalks	Yield Bu. per Acre.
Check	414	9	2.17	47.43
Hogues Yel. Dent	382	20	5.23	63.86
Reids Yel. Dent	372	9	2.41	78.43
Check	374	14	3.74	68.68
Leaming	386	12	3.10	61.57
Cartner	393	8	2.03	62.77
Check	360	27	7.47	72.99
St. Chas. Yel.	374	13	3.47	62.05
Hildreths Y. D.	469	27	5.75	91.23
Check	437			78.23
Eclipse	392	17	4.33	52.51
Pride of North	260	21	8.07	28.19
Check	430	17	3.95	88.08
Pride of Nishua	377			47.57
Queen of Nishua	388	13	3.35	40.13
Check	377	10	2.65	81.00
Farmers Reliance	316	18	5.69	30.93
Boone Co. White	421	29	6.88	66.02
Check	380	22	5.78	68.68
St. Chas. White	384	35	9.20	65.75
Commercial White	447	50	11.11	82.30
Check	421	24	5.93	68.37
Johnson Co. W.	360	17	4.72	55.48
Clay Co. White	389	33	8.48	62.80
Check	418	17	4.06	72.69
Diamond Joe.	367	19	5.17	52.36
Champion W. P.	364	18	4.94	63.75
Check	373	18	4.82	67.75
Silvermine (Ia.)	358	19	5.30	56.45
Silvermine (Ill)	379	22	5.80	53.61
Check	356	14	3.93	67.76
Cob Pipe	342	9	2.62	82.24
Strain 4	338	19	5.62	58.75
Check	423	38	8.98	
Lenochers Hm'std	344	18	5.23	51.02
Calico	343	14	4.08	65.46
Bloody Butcher	414	37	8.93	64.25
Check	316	32	11.01	60.98

TABLE XV. I.

SHOWING BARRENNESS IN BOONE COUNTY WHITE BREEDING

EARS OF CORN. SEASONS OF 1910 AND 1911.

Ear No.	Total stalks	No. Barren	%- Barren	Yield.	Ear No.	Total stalks	No. Barren	%- Barren	Yield.
Check					Check	127	1	0.787	62.37
Check					Check	127	1	0.787	62.37
10-1	112	4	3.57	54.6	33-1	141	1	0.71	89.20
10-2	117	7	5.98	54.6	33-2	146	9	6.16	91.36
Check					Check	125	3	2.40	54.75
10-3	114	3	2.63	47.8	33-3	140	5	3.57	80.16
10-4	116	12	10.35	45.5	45-4	137	7	5.11	75.02
Check					Check	137	4	2.92	67.97
10-5	108	5	4.63	46.9	31-2	149	2	1.34	92.84
10-6	108	1	0.92	60.6	31-3	140	6	4.29	108.85
Check					Check	116	4	3.45	50.03
10-7	110	4	3.63	52.9	31-4	139	4	2.88	102.10
10-8	109	3	2.75	52.9	31-5	136	0	0.0	96.30
Check					Check	125	10	8.0	58.53
10-9	104	4	3.84	63.9	31-6	143	5	3.5	93.50
10-10	107	1	0.93	65.8	31-7	137	3	2.19	101.65
Check					Check	128	13	10.2	61.67
10	101	1	0.99	39.9	45-3	138	10	7.24	92.42
67	115	1	0.87	58.0	28-3	131	1	0.76	106.16
Check					Check	126	5	3.97	65.30
67-2	114	2	1.75	55.5	54-2	141	5	3.55	84.44
67-3	118	1	0.848	58.0	69-1	138	2	1.45	83.49
Check					Check	113	8	7.08	60.77
67-6	118	2	1.69	50.8	7-2	135	3	2.22	73.61
70-1	118	4	3.39	60.1	10-6	139	4	2.88	106.00
Check					Check	122	6	4.92	63.49
70-3	118	3	2.54	53.3	10-2	136	9	6.62	85.98
70-4	114	2	1.75	48.1	4-1	146	5	3.42	94.87
Check					Check	105	3	2.86	58.95
70-5	110	1	0.909	53.5	4-2	113	3	2.65	71.83
45-3	116	1	0.86	67.4	19-2	128	6	4.69	68.10
Check					Check	128	7	5.47	70.74
45-4	116	11	0.86	69.2	13-1	114	7	6.14	61.70
61-2	112	0	0.0	59.9	13-2	143	1	0.7	96.60
Check					Check	124	6	4.84	74.37
61-4	116	2	1.72	61.6	13-3	141	4	2.84	85.69
61-5	109	2	1.83	51.0	10-8	139	1	0.72	81.64
Check					Check	135	1	0.74	75.28
61-6	91	2	2.2	50.5	16-1	129	1	0.77	71.45
48-1	109	1	0.917	56.8	16-2	111	2	1.8	64.90
Check					Check	130	6	4.61	78.91
48-2	94	4	4.25	47.9	16-3	144	7	5.35	76.70
48-4	100	1	1.0	60.1	10-10	126	4	3.17	59.74
Check					Check	131	3	2.29	79.81
58-2	60	1	1.67	30.4	21-1	122	4	3.28	56.95
58-4	112	2	1.79	63.5	21-2	132	5	3.79	71.21

Barrenness in Breeding Corn.

Data has been secured on the various ears of the breeding corn plot of this institution for the past two years. The corn in question is of Boone County White variety and has been bred along the ear-to-row method since 1904. At that time a bushel of this corn was secured and the ears planted, an ear to a row. Several ears were selected every succeeding year from the highest producing rows and these in turn planted, each an ear to a row. At the present time all of the ears being bred came from three original ears - numbers 17, 22 and 30.

The first thing to note is that there is a wide range in the number of barren stalks produced by individual ears. In 1909 ears 61-2, 58-6, 49-1 and 9-6 did not produce a barren stalk while ear 10-4 produced twelve. In 1910 ear 31-5 did not produce a barren stalk while 453 produced ten. No data on the check rows was secured in 1909 but was taken in 1910. This check was unimproved Boone County White and it is to be noted that in many cases the number of barren stalks is comparatively high. Take the case of ear 31-7 and it will be seen that it produced only three barren stalks while the checks on each side produced ten and thirteen respectively. Now, since the checks were of the same corn it is probable that this high number of barren stalks is due to a strip of poor soil in that portion of the field. However, since 31-7 only produced three barren stalks this ear certainly had very little barren tendency.

The one thing which is striking in this study of individual ears is the fact that they varied so widely in number

and percent of barren stalks produced. Unless this tendency was inherited from previous fertilization, why should not the number of barren stalks produced in the individual cases vary with the check rows which indicated the fertility of the soil over the whole plot?

CONTEMPORARY DATA.

No such experiment as the one dealt with in this thesis has ever been reported to the knowledge of the writer. Furthermore, there is very little said about barrenness with the exception that barren stalks are obviously a nuisance in a field and should be eliminated. In bulletin 107 of the University of Minnesota the following statement is made concerning barrenness: "Barren stalks are those which bear no ears. They may be discovered by the absence of the enlarged leaf sheath just above the joint where the ear should appear. In average fields of corn in the state there are often 10% barren stalks - such features as physical weakness and barrenness tend toward deterioration and must be avoided. If left to ripen the pollen from these stalks fertilize the strong ones which may possibly be selected". The author evidently believes that barrenness is an hereditary and transmissible character.

In bulletin 91 of the Nebraska Experiment Station the following paragraph appears: "A study of the results noted from the differences in rates of planting discovered that the percent of barren stalks is directly affected by the rate of

planting. Thus in 1904 6% of the stalks planted at the rate of one to the hill were barren while the rate ranged as high as 27% in the corn planted at the rate of five stalks per hill. Crowding is thus seen to result in a degree of barrenness higher than would otherwise be natural".

In bulletin 112 page 30 of the Nebraska Station appears the results of an experiment on the rates of planting corn. The column devoted to barrenness shows three barren stalks per hundred when planted one stalk per hill and the number increases directly to 10.8 barren stalks per hundred when the stand was increased to five stalks per hill. This experiment is in agreement with the one previously noted and both of them are in perfect accord with the results on varied rates of planting shown in this thesis.

In bulletin 141 Bureau of Plant Industry, U.S. Department of Agriculture, is found the paper on "The Importance of Broad Breeding in Corn". In discussing the question of the removal of barren stalks the writer is of the opinion that the tendency to barrenness is but an adaptation to prevent inbreeding. He says in part, "This persistent tendency to proterandry can be thought of as a natural reaction of the species against the danger of extinction from inbreeding. Even the true barren stalks might represent a tendency on the part of the plant to become dioecious." This may give us another theory as to the true cause of barrenness. It may be an adaptation to prevent inbreeding and the truly barren stalks may be males which have been produced exclusively for the purpose of producing pollen. Even though this be the case it

is of economic importance to prevent barrenness because of the decrease in the yield of corn which will result from breeding them.

Bulletin 165 of the Virginia Experiment Station, also contains a short summary on barrenness. The general conclusion presented here is as follows: "Our work here seems to reveal the fact that these barren stalks come chiefly from two sources; first, from stalks that have become distorted or injured in any way as from a fungus growth which may weaken a plant and cause it to silk too late to receive the pollen, or it may be injured from cultivation and the same result will follow. Second, weak germination is apparently the cause of more barren stalks than anything else, preventing as it does the development of the stalk in time to become properly pollinated. Vigorous growing varieties that mature late or are not well suited to the section of the country in which they are grown are likely to show a large percent of barren stalks."

BARRENNESS AND MENDELISM.

Since the foregoing results prove conclusively that barrenness in corn is hereditary, the question which logically arises is in what way is this character transmitted. Since a barren stalk produces no seed, going on the old theories of heredity we would naturally think that barrenness would breed itself out. In view of the fact that it does not, but on the contrary the number of barren stalks is made to increase, then we are forced to admit that either our old ideas of heredity are wrong or that our conclusions are not justified. That the conclusions are justifiable is evident from the number of barren stalks produced from barren bred stalks as compared with good.

In order to explain the phenomenon let us consider the Mendelian theory. A kernel of corn planted produces a stalk which in turn produces an ear. Suppose the embryo which formed this kernel had been fertilized by barren pollen. According to the law of segregation this kernel when planted would have produced a shoot bearing approximately 1000 embryos and half of these embryos would have been good and the other half barren. If barren pollen had been applied by hand it is obvious that the 500 embryos which contain in themselves the barren tendency would have been fertilized by pollen grains which also contain barren tendency. Consequently, this set of kernels would have produced stalks the next year which were totally barren. The other 500 would be cross bred and in turn would act as the original kernel. From this it can be seen that taking barrenness as a Mendelian character, barren

stalks can be produced and increased in number as well without the production of seed on the barren stalk. This explanation will nicely explain the differences in the number of barren stalks produced by various ears of corn.

POSSIBILITIES IN CORN BREEDING.

Once proven that barrenness follows Mendelian principles the fact would lead to a much more exact study of the science of breeding corn. If the various characteristics noted in ears and stalks of corn will but follow the laws of segregation and recombination as set forth by Mendel, we can do away with continual selection and bred corn for the various types which we want.

Take for instance the composition of corn; should it follow the above laws in breeding for starchy or horny endosperm all that we need to do will be to plant very hard or soft kernels and inbreed a large number of ears then plant the product in an isolated plot and those which produce type to one type are homozygous to that character. In this way, the one stroke, and in not more than three years time we should be able to produce altogether horny or starchy strains of corn. Other characters should be set in the same way as soon as their importance is discovered by an exact study of the character itself or correlation with other characters.

CONCLUSION.

In the light of the preceeding data the following conclusions seem to be justified:

1. There are two forms of barrenness exhibited by the corn family. Certain stalks may be found which are absolutely barren and yet are growing under very favorable conditions. Barrenness may be induced by crowding, by lack of plant food on a poor soil and by weakening the vitality of the seed as in the case of inbreeding. The first form is hereditary but there is no reason to suppose that that the latter can be inherited.

2. Fertilization of good ears from pollen of the first type of barren stalks produces seed which under all conditions throws a much higher percent of barrenness than does seed with no known barren tendency.

3. Increasing the stand under similar conditions increases the number of barren stalks produced in direct proportion to the increase in stand. This is evidently due to the effect of crowding bringing out any weakness which may exist in the individual stalks.

4. Inbreeding according to work done here seems to decrease the vitality and vigor of corn causing a greater percent of barren stalks to appear.

5. Poor soil in which available plant food is badly lacking is one of the most fertile causes of barrenness.

6. A typical barren stalks is round, tapers from the

base to the tassel, the leaves and sheathes are thick and fleshy and the stalk is full of sugar upon ripening. There is generally a good deal of red color exhibited in all parts of the plant at maturity. Seemingly on account of the fleshy leaves and sheathes the leaves assume a peculiar upstanding posture which is quite characteristic of the stalk.

7. There is a wide range in the percent of barrenness produced in the different varieties of corn which is probably one of the most fertile causes of the inability of those varieties to yield large amounts of grain.

8. Individual ears of any variety show a wide range in the number of barren stalks produced. This is another evidence that some of the kernels on those ears were fertilized by a barren stalk and the tendency to barrenness was transmitted to the progeny.

9. Chemical analysis of barren and good stalks shows that barren ones contain more protein, fat, and nitrogen free extract than the productive. The difference is not great enough however to say that the food which would normally have gone into the ear is lodged in the stalk.

BIBLIOGRAPHY.

As previously mentioned no complete report on barrenness of corn has ever been published. The references to bulletin 107 of the University of Minnesota, and bulletins 91 and 112 of the University of Nebraska, bulletin 141 of the Bureau of Plant Industry, U.S. Dept. of Agriculture, and bulletin 165 of the Virginia Experiment Station were the only articles dealing with the subject which could be found in our agricultural literature.

Finding that literature on the subject was not to be had the writer wrote to all the Experiment Stations in the corn belt asking if they knew of any additional data on the subject. The replies from the men addressed constitute the main bibliography of this thesis and follow verbatim.

MINNIE NELSON, AGRONOMIST
W. H. ZEK, ASSISTANT
J. H. CASSETTER, ASSISTANT
W. H. HAY, FARM FOREMAN

UNIVERSITY OF ARKANSAS
Agricultural Experiment Station
DEPARTMENT OF AGRONOMY
FIELD CROPS AND SOILS

SUB-STATIONS
DANVILLE, LA TOUR,
LONOKE, IMBODEN,
HOPE, MENA.

FAYETTEVILLE, ARKANSAS, Mar. 4, 1911.

Mr. F. H. Demaree,
Acting Agronomist,
Columbia, Mo.

Dear Sir:

Replying to your enquiry regarding the heredity of barrenness in corn will say that we have no literature on the subject because our work like that of most other stations has taken a trend along the line of working entirely with the most practical problems discarding barrenness as far as possible without investigating it any further.

Very truly yours,

Martin Nelson
Agronomist.

MIN-CW

DEPARTMENT OF
EXPERIMENTAL PLANT-BREEDING

HERBERT J. WEBBER, PROFESSOR
ARTHUR W. GILBERT, ASSISTANT PROFESSOR
HARRY H. LOVE, ASSISTANT PROFESSOR
CLYDE E. LEIGHTY, ASSISTANT
MAXWELL J. DORSEY, JR., ASSISTANT
ANNA M. ATWATER, LABORATORY ASSISTANT
HERBERT W. TEETER, SUPT. OF GARDEN.

CORNELL UNIVERSITY
COLLEGE OF AGRICULTURE
AND AGRICULTURAL EXPERIMENT STATION

L. H. BAILEY, DIRECTOR

ITHACA, N. Y., February 28, 1911

Professor F. H. Demaree,
University of Missouri,
Columbia, Missouri

Dear Sir:

I am in receipt of your communication of February 24 in regard to the heredity of barrenness. So far as I am aware no literature has been published on this subject by our Station. In the study of the heredity of barrenness, I should think you would want to clearly distinguish between the delimitation of sex to different individuals, which might occur and still not indicate barrenness particularly. The literature which has come out recently on the heredity of sex would be interesting for you to look up in this connection.

Very truly yours,



IOWA STATE COLLEGE

College of Agriculture

AND

Agricultural Experiment Station

CHARLES F. CURTISS, DEAN AND DIRECTOR

DEPARTMENT OF AGRONOMY
W. H. STEVENSON, PROFESSOR

SOILS

J. F. BARKER, ASS'T PROFESSOR
R. E. BROWN, BACTERIOLOGIST
ROY E. SMITH, INSTRUCTOR
S. L. JODIDI, EXPERIMENTALIST
A. A. WELLS, ASS'T. EXPERIMENTALIST
A. H. SNYDER, EXTENSION

FARM CROPS

HUGHES, PROFESSOR
POTTER, ASS'T. PROFESSOR
CALDWELL, INSTRUCTOR
BURNETT, PLANT BREEDING
MOSHER, EXTENSION
FORMAN, FIELD SUPERINTENDENT

AMES, IOWA March , 9, 1911.

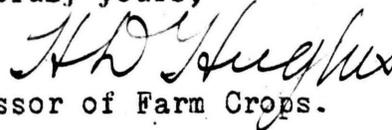
Professor F. H. Demaree,
University of Missouri,
Columbia, Mo.

My Dear Sir:

I am in receipt of your letter of some few days ago regarding the subject, "barrenness in corn". I think that there has been very little work done on this subject and I am certainly glad to know that you have some results which will be worth recording. I would suggest that you get in touch with the Illinois Experiment Station as they have made some observations on this subject. The Minnesota Experiment Station has made some observations but has I think published very little or none of this information.

I thank you for your letter of a few days ago and also for the information regarding the boxing gloves. I am certainly very glad to have had the boys make use of them and know that they went towards a good cause.

Very truly yours,



Professor of Farm Crops.

HDH-MMB

DEPARTMENT OF AGRONOMY.

L. JARDINE,
PROFESSOR OF AGRONOMY
AND SUPERINTENDENT OF FARM.
W. C. CALL,
ASSISTANT PROFESSOR IN SOILS.
W. C. SCHAFER,
ASSISTANT PROFESSOR IN CROPS.
W. C. SCHAFFER,
ASSISTANT IN CROPS.
J. NASH,
ASSISTANT IN CROPS.
W. C. CHASE,
ASSISTANT IN FARM MECHANICS.
W. C. LILL,
ASSISTANT IN SOILS.
J. WILSON, FARM FOREMAN.
H. E. JONES, CLERK.

KANSAS STATE AGRICULTURAL COLLEGE
AND
EXPERIMENT STATION.

MANHATTAN, KAN., Mar. 10, 1911.

Mr. F. H. Demaree,

Columbia, Missouri.

Dear Sir:--

Your letter to Professor TenEyck, concerning barren stalks, at hand. So far as I know, this Station has never worked out anything in connection with hereditary qualities on "Barrenness in Corn". I do not know of anyone else who has contributed anything on this subject by way of experimental work.

I am sorry that we cannot be of assistance to you in this matter.

Yours truly,



Assistant in Crops.

ECS-GMC.

State University of Kentucky

HENRY S. BARKER, PRESIDENT

College of Agriculture
M. A. SCOVELL, DIRECTOR

DEPARTMENT OF AGRONOMY
GEO. ROBERTS, PROFESSOR
E. J. KINNEY, ASS'T PROFESSOR

Lexington, Ky., March 1, 1911.

Professor F.H. Demaree,
College of Agriculture,
Columbia, Mo.

Dear Sir:

I have received your letter of February 24th. We have no literature on the subject of barrenness in corn and do not know of any that has been published. Dr. Louie H. Smith of the Illinois College of Agriculture has done some very interesting work on this subject but I do not think he has published his results.

Yours very truly,

Geo Roberts

The University of Minnesota

Department of Agriculture Experiment Station

A. F. WOODS, DEAN AND DIRECTOR

DIVISION OF
AGRONOMY AND FARM MANAGEMENT
NEW BOSS CHIEF
BULL AGRONOMY
COOPER FARM MANAGEMENT

A. C. ARMY AGRONOMY
G. J. BAKER FARM MANAGEMENT
JOHN HOFFMAN ASST. FARM SUPT.
LEE ALEXANDER CROP NURSERY FOREMAN

SUBJECT Corn.

UNIVERSITY FARM, ST. PAUL, MINN. Mar. 4, 1911.

Professor P. E. Demaree,
Columbia, Missouri

Mr. T. H. Demaree,
Columbia, Mo.

Dear Sir;-

I regret that I do not have anything published which treats specifically upon the subject of barrenness in corn. The only thing we have, you will find in my bulletin from this Station, No.107.

Very truly yours,

C. P. Bull
Associate Professor.

CPB-J

THE UNIVERSITY OF NEBRASKA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
LINCOLN

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W. MARSHALL, EXECUTIVE CLERK

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F. J. PHILLIPS, FORESTRY
R. A. EMERSON, HORTICULTURE
G. A. LOVELAND, METEOROLOGY
SAMUEL AVERY, CHANCELLOR
J. S. DALES, FINANCIAL SECRETARY

March 15, 1911.

Professor F. H. Damaree,
Columbia, Missouri.

Dear Prof. Damaree-

Your letter of February 24 at hand asking for information influencing barrenness in corn. The only publications I have on this matter are found in Bulletin ¹¹² 91 of this Experiment Station, a copy of which you probably have, but I am sending another, under separate cover.

Very truly yours,



EGM/o

J. H. WORST, LL.D.,
PRESIDENT.

W. A. YODER,
SECRETARY.

**NORTH DAKOTA AGRICULTURAL COLLEGE
AND
GOVERNMENT EXPERIMENT STATION**

AGRICULTURAL COLLEGE, NORTH DAKOTA.

DEPARTMENT OF AGRICULTURE
J. H. SHEPPERD,
DEAN AND VICE DIRECTOR.

February 28, 1911.

Mr. F. H. Demaree,

Columbia, Mo.

Dear Sir:

This Station has no publication on the
heredity of bareness in corn breeding.

Yours truly,

J. H. Shepperd

OHIO AGRICULTURAL EXPERIMENT STATION

Chas. E. Thorne, *Director*
WOOSTER, OHIO

DEPARTMENT OF AGRONOMY

C. G. Williams, *Chief*
F. A. Welton, *Assistant*
C. A. Patton, *Field Assistant*
William Holmes, *Farm Foreman*
E. C. Morr, *Clerk*

Feb. 27, 1911.

Prof. F. H. Dwmaree,
Columbia, Mo.

Dear Sir:

Replying to your letter of Feb. 24, I regret to say that we have no publications regarding barrenness in corn. We have made some observations and may possibly have given something in addresses, but have nothing we can send out.

Cordially yours,


Agronomist.

M

Address All Communications to the Experiment Station, Stillwater, Okla.

Oklahoma Agricultural Experiment Station

JAMES A. WILSON, DIRECTOR
STILLWATER

B. C. PITTMAN
Assistant Director
L. L. LEWIS
Veterinarian
V. A. LINKLATER
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A. L. LOVETT
Assistant Entomologist
J. L. MCKEOWN
Financial Secretary
W. W. EVANS
Farm Superintendent
LULA TOURTELLOTTE
Clerk

Feb. 28, 1911.

Mr. F. H. Demaree,
University of Missouri,
Columbia, Mo.

Dear Sir:

This Station has no publication on the subject which you inquire about in your recent letter. I am sorry we can be of no benefit to you but we have made no investigation along this line.

Yours truly,



CCC-IM

THE PENNSYLVANIA STATE COLLEGE
SCHOOL OF AGRICULTURE AND EXPERIMENT STATION

PARTMENT OF AGRONOMY

STATE COLLEGE, PA.

March 7, 1911.

Mr. F. H. Demaree,
Dept. of Agronomy,
Columbia, Mo.

Dear Sir:

I am unable to supply you with any literature on the "Heredity of Barrenness in Corn". You will find a number of Experiment Station Bulletins that give results of the determinations of the extent of barrenness in different varieties and under different conditions.

I presume that Mr. L. H. Smith of the Illinois Experiment Station is better qualified to advise you concerning the securing of literature along this line than any other man in the United States.

Yours very truly,

Franz D. Gardner,

Professor of Agronomy.

FDG-G

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A. CRAIG, Veterinary Science
F. HUNZIKER, Dairy Husbandry
J. JONES, JR., State Chemist (Fertilizer
and Feeding Stuff Control)
E. SKINNER, Animal Husbandry
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PURDUE UNIVERSITY

AGRICULTURAL EXPERIMENT STATION

ARTHUR GOSS, DIRECTOR

SOILS AND CROPS

A. T. WIANCKO, Chief
S. D. CONNER, Chemist
M. L. FISHER, Associate in Crops
J. B. ABBOTT, Associate in Soils
C. O. CROMER, Assistant in Crops

LAFAYETTE, IND. Mar. 3, 1911

Prof. F. H. Demaree,
College of Agriculture,
Columbia, Mo.

My dear Demaree:-

In reply to yours of the 24th ult. I beg to say that we have not published anything concerning barrenness in corn, although we have a great deal of data in the records of our various corn breeding plots. This has not even been summarized so I am unable to state the results and just now, I have not time to look the matter up. If, however, you can use it a little later, I shall be glad to look it up and give you the principal results.

Very truly yours,



Chief in Soils and Crops.

W. WILSON, M. S. A., DIRECTOR
ANIMAL HUSBANDRY

HANSEN, M. S., VICE-DIRECTOR
HORTICULTURE AND FORESTRY

JAMES H. SHEPARD, B. S.
CHEMISTRY

L. MOORE, B. S., D. V. S.
VETERINARY

South Dakota
Agricultural Experiment Station
BROOKINGS, S. D.

ROBERT L. SLAGLE, A. M., PH. D.
PRESIDENT OF COLLEGE
CLIFFORD WILLIS, M. S.
AGRONOMY AND SUPT. OF SUB-STATION
EDGAR W. OLIVE, A. M., PH. D.
BOTANY
CHRISTIAN LARSEN, M. S. A.
DAIRY HUSBANDMAN
R. A. LARSON, SECRETARY

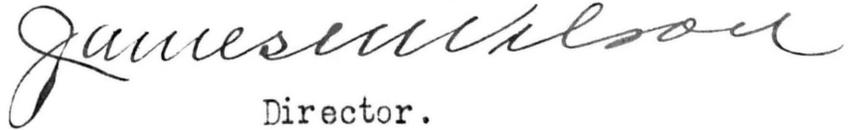
March 1, 1911.

Mr. F. H. Demaree,
Acting Agronomist,
University of Mo., Columbia, Mo.

Dear Sir:

In reply to yours of Feb. 24th for literature on the subject of barrenness in corn, I am sorry to state that we have none here at this institution.

Yours truly,


Director.

JWW-J

HEADS OF DEPARTMENTS

BURRILL, Botany
 CINTOSH, Veterinary Science
 HOPKINS, Agronomy and Chemistry
 DAVENPORT, Thremmatology
 BLAIR, Horticulture
 MUMFORD, Animal Husbandry
 FRASER, Dairy Husbandry
 BEVIER, Household Science
 RANKIN, Agricultural Extension

UNIVERSITY OF ILLINOIS
 COLLEGE OF AGRICULTURE
 AND
 AGRICULTURAL EXPERIMENT STATION

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 J. H. PETTIT, Soil Fertility
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 H. C. WHEELER, Soil Physics
 J. E. WHITCHURCH, Soil Fertility
 E. E. HOSKINS, Soil Fertility
 FRANCES D. ABBOTT, Chemistry
 W. H. SACHS, Chemistry and Soils
 F. C. GRANNIS, Soil Fertility
 E. M. McDONALD, Crop Production
 W. R. LEIGHTY, Chemistry

Urbana, Illinois, February 27, 1911

Professor F.H.Demaree

University of Missouri
 Columbia, Missouri

My dear Professor Demaree:

Your inquiry concerning barrenness of corn is at hand. In reply I may say that we have as yet issued no formal publication concerning this matter, altho the matter may have been mentioned incidentally in some general address on corn breeding. This is an interesting topic and it seems strange that there is such a dearth of literature. But I think that you are right in the fact that scarcely any does exist upon this particular subject. I shall be interested in your thesis when it appears. In case I happen to run across anything bearing upon the topic, I shall be very glad to let you know concerning it.

With kind regards, I am,

Very truly yours,

L. H. Smith

LHS/AT

A. HENRY, EMERITUS PROF. OF AGR.

- S. ALEXANDER, VET. SCIENCE;
STALLION LICENSING.
- J. COLE, EXPERIMENTAL BREEDING.
- H. FARRINGTON, DAIRY HUSBANDRY.
- G. HALPIN, POULTRY HUSBANDRY.
- B. HART, Agr. CHEMISTRY.
- G. HASTINGS, Agr. BACTERIOLOGY.
- L. HATCH, Agr. EDUCATION;
SECRETARY OF Agr. EXTENSION.
- C. HUMPHREY, ANIMAL HUSBANDRY.
- R. JONES, PLANT PATHOLOGY.
- L. MARLATT, HOME ECONOMICS.
- C. MARQUIS, Agr. JOURNALISM;
Agr. EDITOR.
- G. MOORE, HORTICULTURE.
- A. MOORE, AGRONOMY.
- A. COCK, Agr. ENGINEERING.
- S. SANDERS, ECONOMIC ENTOMOLOGY;
NURSERY INSPECTION.
- C. TAYLOR, Agr. ECONOMICS.
- R. WHITSON, SOILS.
- W. WOLL, FEED AND FERTILIZER
INSPECTION; DAIRY TESTS.
- S. HEAN, Agr. LIBRARY.

THE UNIVERSITY OF WISCONSIN

 COLLEGE OF AGRICULTURE
 AND
 AGRICULTURAL EXPERIMENT STATION

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- C. P. NORGORD
- A. L. STONE
- E. J. DELWICHE
- L. F. GRABER
- B. D. LEITH

CHARLES R. VAN HISE, PRESIDENT OF THE UNIVERSITY.

H. L. RUSSELL, DEAN AND DIRECTOR. D. H. OTIS, ASST. TO THE DEAN.

S. M. BABCOCK, ASST. DIR. IDA HERFURTH, EXECUTIVE SECY.

MADISON, WIS. March 3, 1911.

Prof. F. H. Demaree,
 Columbia, Missouri.

My dear Sir:

Yours of recent date in regard to the
 heredity of barrenness in corn came duly to hand.
 I regret exceedingly we have not carried on any
 experimental work along the line you are working.

Regretting I am unable to assist you at
 this time, I am

Sincerely yours,

R. A. Moore

RAM--NWL.

PHOTOGRAPHS.

THE FOLLOWING PHOTOGRAPHS SHOW MORE CLEARLY THAN
WORDS THE FIELD CONDITION OF THE CORN FURNISHING THE DATA
HEREIN CONTAINED, EARS OF CORN USED, TYPICAL
BARREN STALKS AND PRODUCTIVE ONES.

PHOTO. I

HAND FERTILIZED EARS USED IN 1909.

EARS DEFORMED ,KERNELS GOOD.



PHOTO. II

END VIEW OF PLOT OF 1909.
NOTE VARYING HEIGHTS OF ROWS.

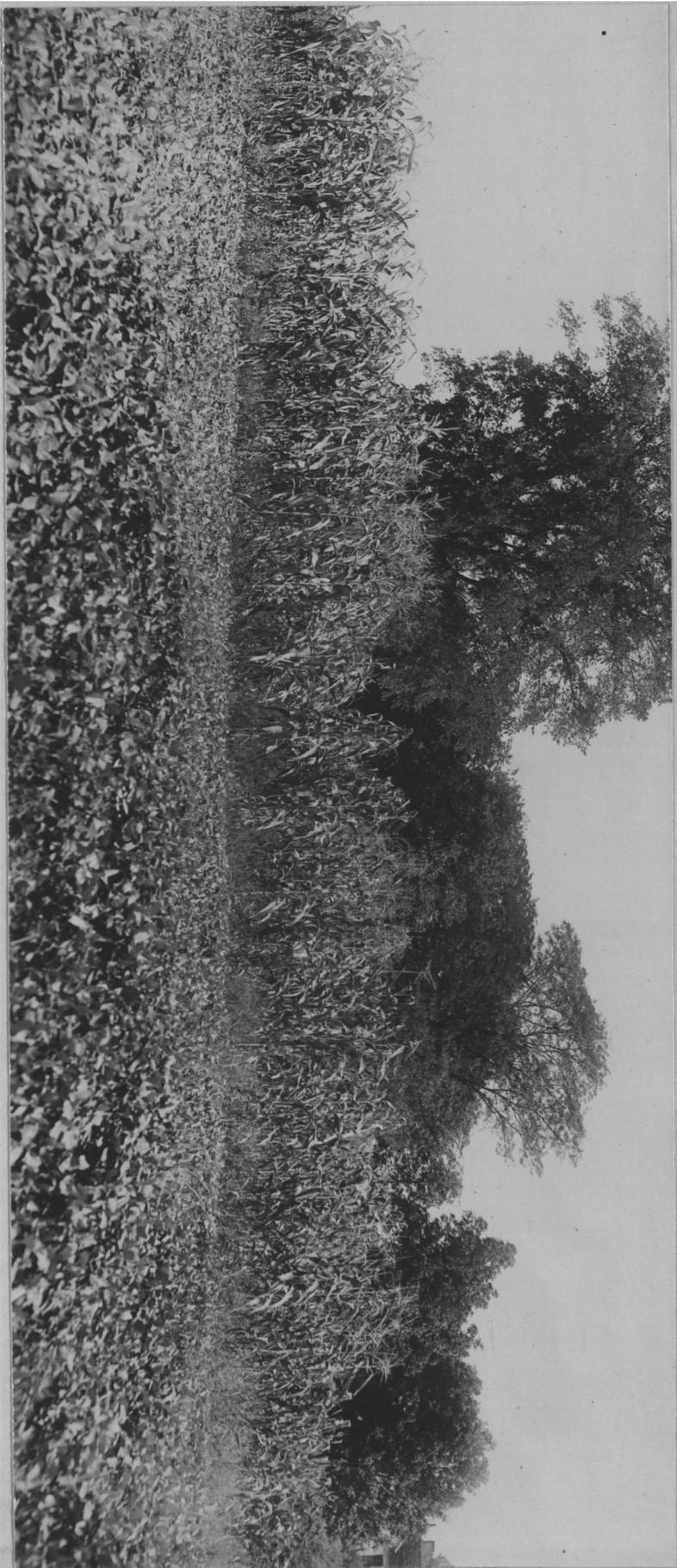


PHOTO. III

SIDE VIEW OF PLOT OF 1909, SHOWING DIVISION
BETWEEN ROWS. THIS CORN DOES NOT SEEM
TO LACK VIGOR.



PHOTO. IV

EARS OF CORN USED IN 1910.

BARREN STALK PLOT.

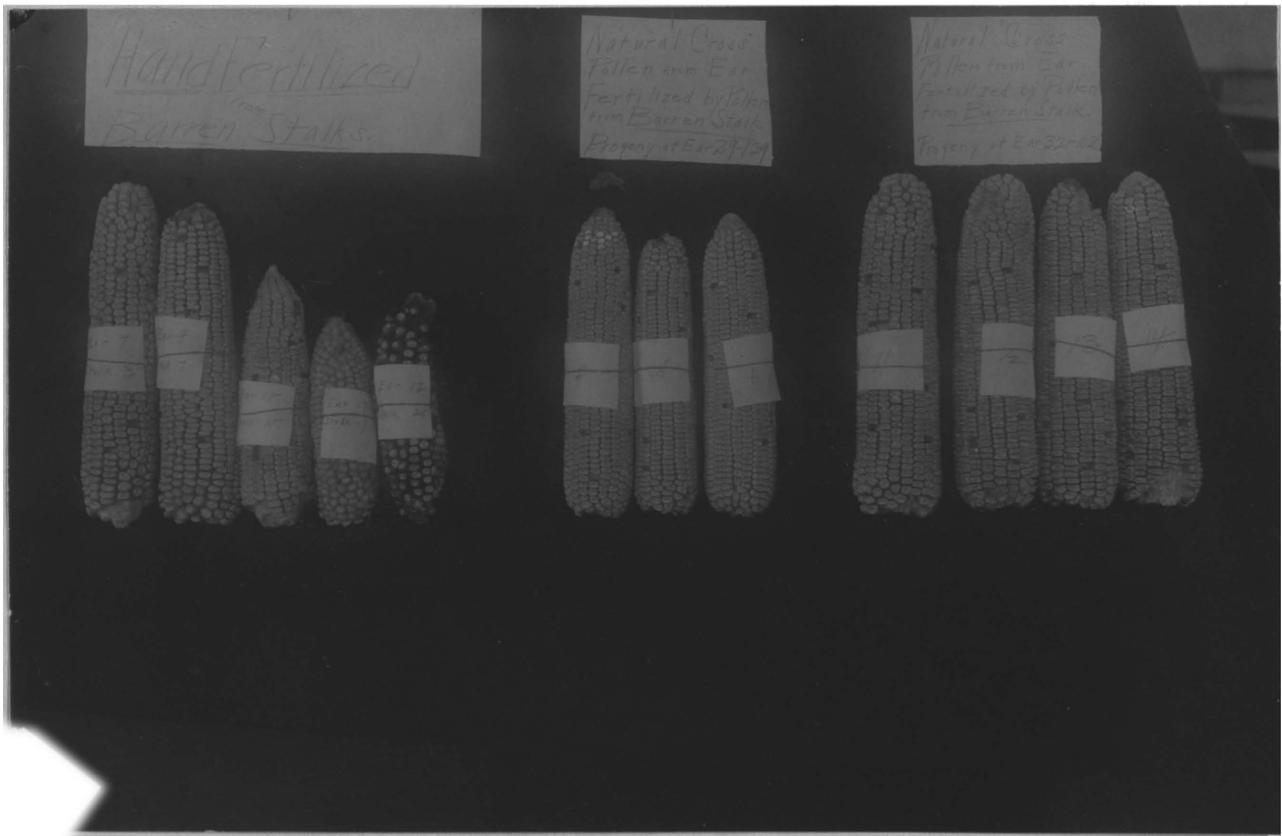


PHOTO. V

SHOWING DETAILS OF THE HAND POLLENATOR.



USING THE HAND POLLENATOR IN THE FIELD.

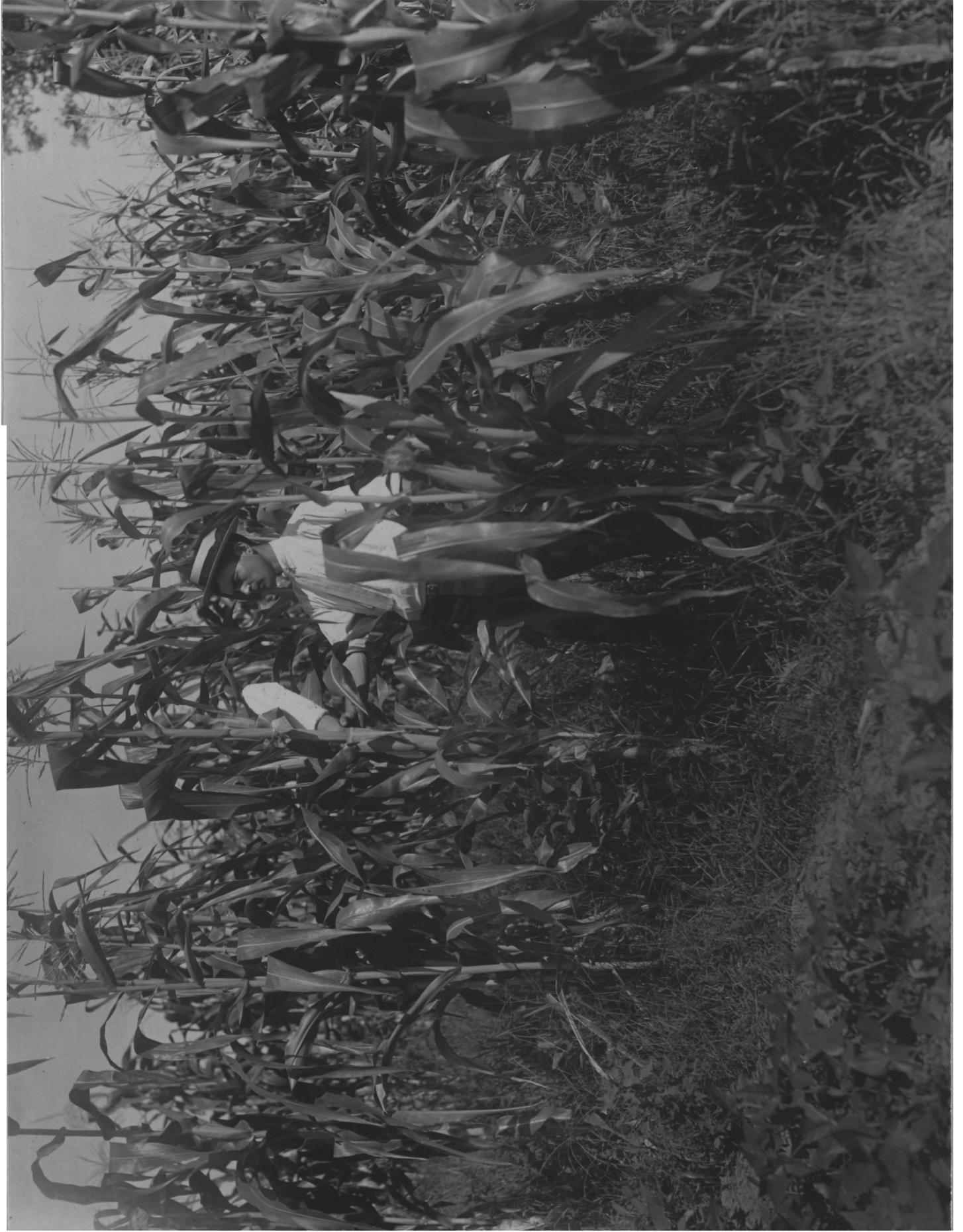


PHOTO. VII

EAR 9, SIRE STALK 7, HAND POLLENATED
SEASON 1909.



PHOTO. VIII

EAR 7, SIRE STALK 3, HAND POLLENATED
SEASON 1909.



PHOTO. IX

INBRED 10 ON THE RIGHT. CROSS
10 x 67 ON THE LEFT.



PHOTO. X

BARREN STALKS 7 AND 8. NOTE TYPICAL POSE.



PHOTO. XI

THREE BARREN STALKS DISSECTED---6,7, AND 8.

NOTE RUDIMENTARY SHOOTS.



PHOTO. XII

BARREN STALK 6, SHOWING A PECULIAR
LEAF FORMATION, ARRANGED IN WHORLS
OF THREE.

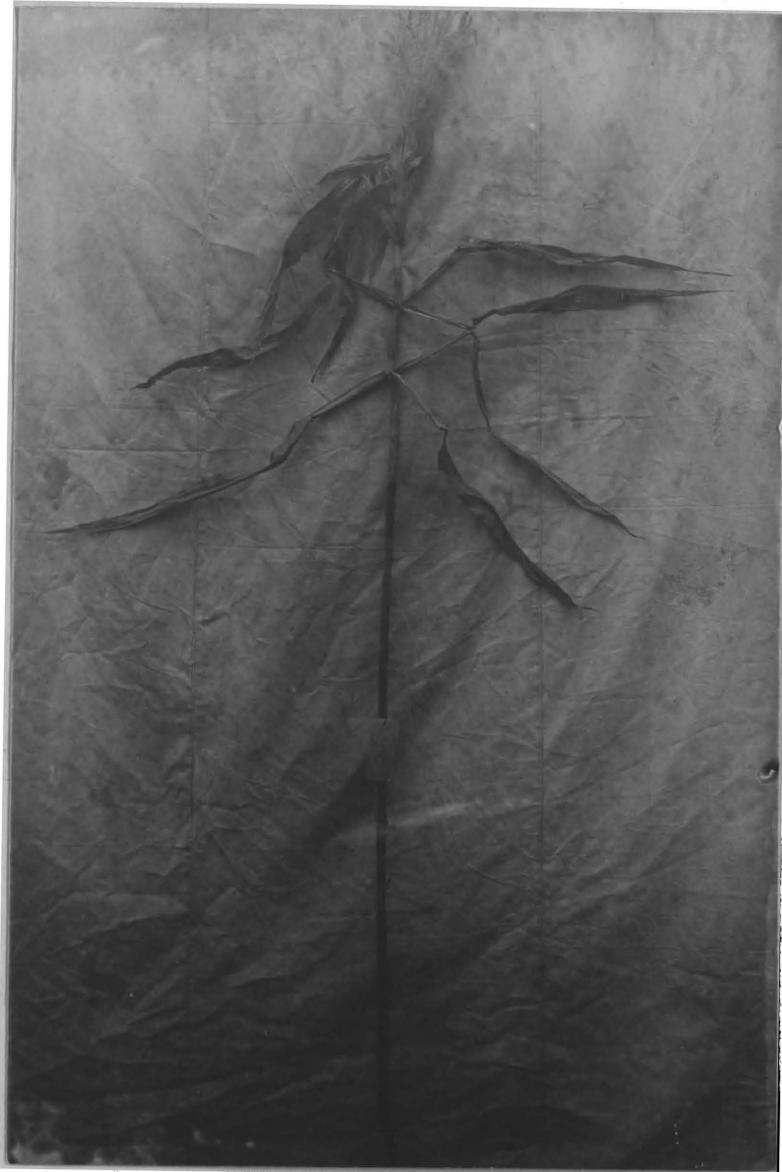


PHOTO. XIII

BARREN STALK 25.



PHOTO. XIV.
EIGHT STALKS SHOWING THE RANGES OF PRODUCTION.
AS SELECTED FROM THE FIELD.

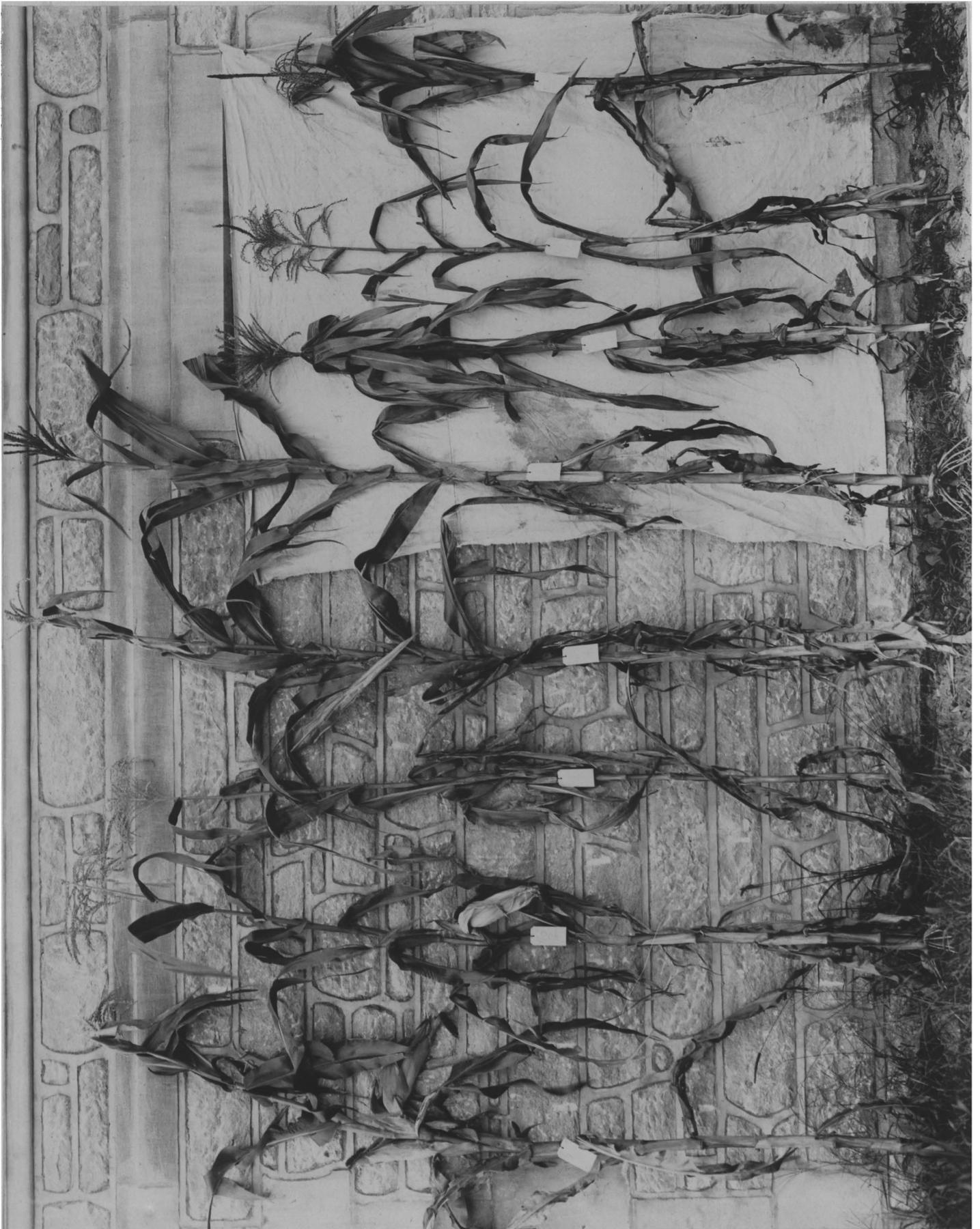
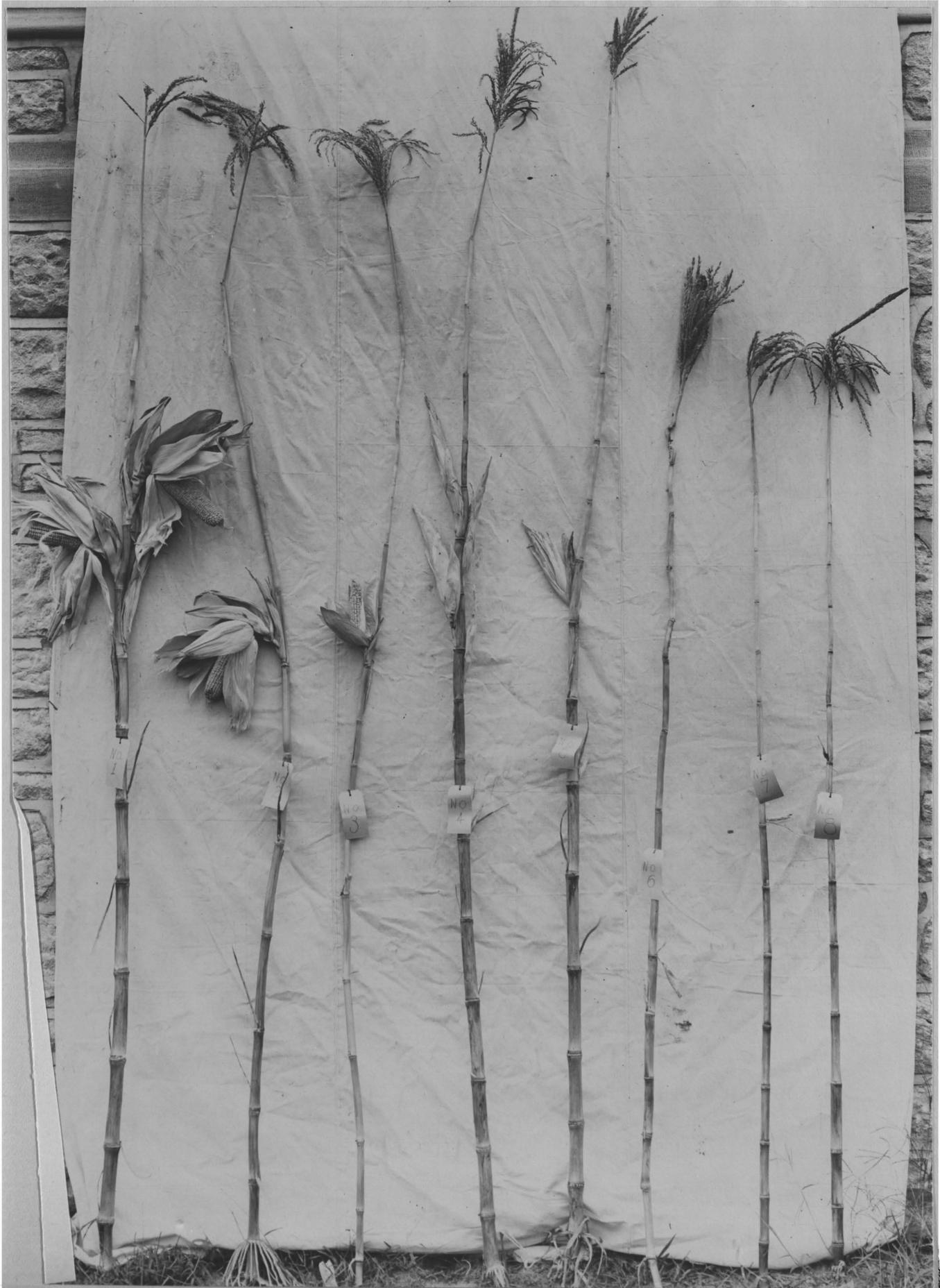


PHOTO. XV

EIGHT STALKS SHOWING THE RANGES OF PRODUCTION.

DISSECTED.



THE EXTREMES OF PRODUCTION.



PHOTO. XVII

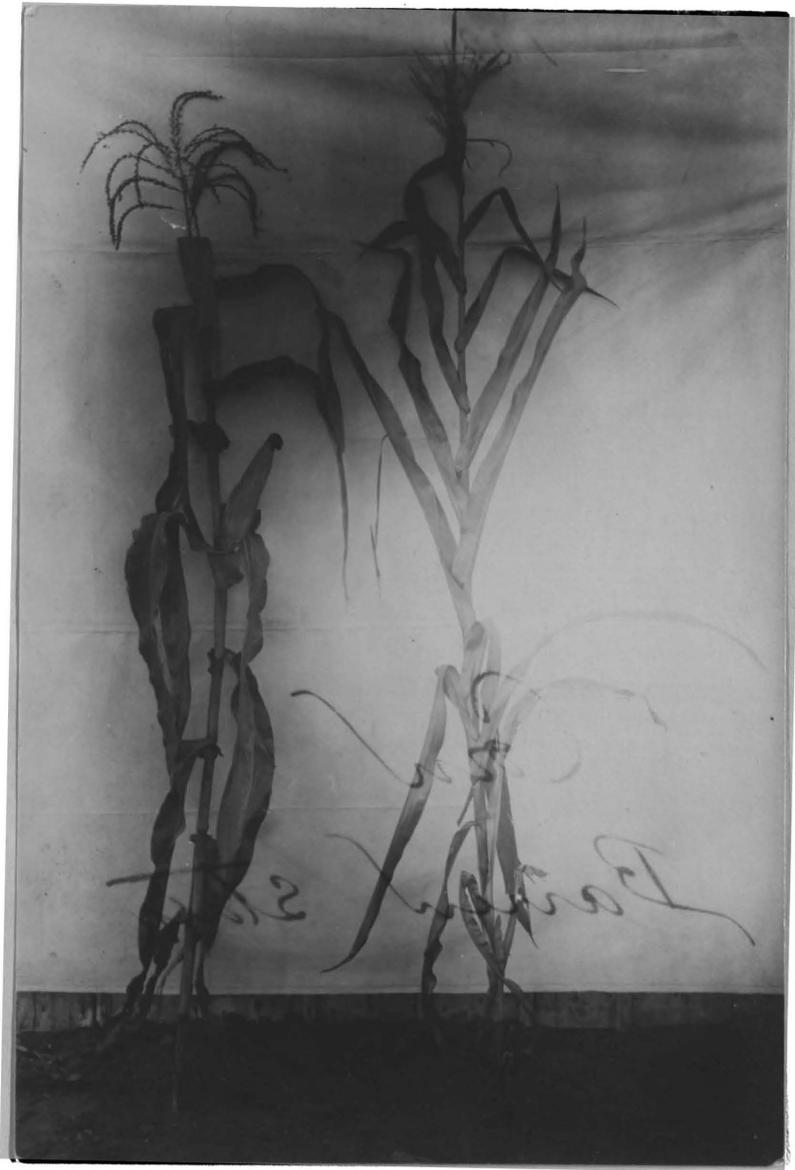
AN IMMENSE STALK, THREE SHOOTS, NO GRAIN.

WHY SUCH A STALK?



PHOTO. XVIII

ANOTHER EXAMPLE OF THE DIFFERENCE
BETWEEN A GOOD AND A BARREN STALK. NOTE
POSE OF EACH.





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