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CORN EXPERIMENTS IN ILLINOIS.

(REPORT OF PROGRESS)

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To the Advisory Committee:—

As you are aware five principal lines of investigation with corn
are being carried on:

1. The breeding of corn to increase the yield per acre and to improve its composition or quality for different kinds of feeding or for factory use as may be desired.
2. A study of the different varieties of corn with a view to determining the quality and existing characteristics of each and the adaptability of the most valuable varieties to different sections of the State.
3. The cultivation and growing of corn with a view to determining the best methods of preparing the ground, of planting the corn, and of cultivating the crop.
4. Methods of harvesting, storing, and preserving the corn crop, in general, and seed corn, in particular.

* Messrs. Hopkins and Smith are responsible for the experiments in corn breeding and for the investigations relating to the composition and feeding value of corn, while Mr. Shamel has had the immediate charge of the cultivation experiments, testing varieties for yield, harvesting and preservation of corn, and testing vitality of seed corn.

5. The determination of the feeding value of corn which has been bred in different ways, the experiments to be conducted in co-operation with the Animal Husbandry and Dairy Husbandry Departments.

1. CORN BREEDING EXPERIMENTS.

The experiments in corn breeding which were begun on a small scale in 1896 have been continued; and although the last two seasons were rather unfavorable, especially that of 1901, nevertheless the results secured are gratifying. The following tabular statements show the average composition of the corn produced in four different fields, each of which has been bred for a different purpose since 1896, although at that time the seed for each of these four fields was selected from a single lot of corn of a variety which had been grown by the Illinois Experiment Station for many years, considerable care having been taken to keep the variety pure and distinct. These four different lots of corn have been bred continuously for the different purposes, as follows:

Field No. 1, for high protein content.

Field No. 2, for low protein content.

Field No. 3, for high oil content.

Field No. 4, for low oil content.

The results now include the corn crops for seven years, as follows:

TABLE 1. BREEDING CORN TO CHANGE THE PROTEIN CONTENT.
(Average per cent. protein in crops.)

Year.	Field No. 1, High-protein corn.	Field No. 2, Low-protein corn.	Difference, per cent.
1896	10.92	10.92	.00
1897	11.10	10.55	.65
1898	11.05	10.55	.60
1899	11.46	9.86	1.60
1900	12.32	9.34	2.98
1901	14.12	10.05	4.07
1902	12.32	8.32	4.00

It will be observed that the corn bred for a higher protein content shows almost a continuous increase while the low-protein corn has decreased very markedly during the same years. The season of 1901 was abnormally dry and there was a very decided seasonal influence toward the production of high-protein corn, especially on the high-protein field which was located on slightly higher land and

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suffered more from drouth than the other fields. On the contrary, the abnormally wet season of 1902 favored the production of low-protein corn. The last column in the above table shows the differences in the percentages of protein contained in the two fields of corn, for the seven different crops. This difference, which was zero in 1896, increased almost continuously and amounts to 4.00 per cent. of protein in 1902. This increasing difference between the protein content of the corn grown on the two fields is the most reliable and trustworthy index, or measure, of the effect of breeding, as it is practically independent of seasonal influences. Thus, although the low-protein corn increases in protein in 1901 and the high-protein corn decreases in protein in 1902, the difference between the two fields shows very markedly the effect of breeding.

It should be stated that the "high-protein field", for example, does not refer to any single piece of ground. The fields occupied have been purposely interchanged to avoid the influence of soil differences. In fact the soil which grew low-protein corn (10.55 per cent.), in 1898, produced high-protein corn (12.32 per cent.), in 1900, and was again used to produce low-protein corn (8.32 per cent.), in 1902.

We are glad to state that we now have a sufficient quantity of good seed corn saved from the best yielding rows of the high-protein field to plant a considerable acreage of this high-protein corn next season and from that crop we hope to have sufficiently large areas grown by regular corn breeders in 1904 that it may be supplied to any Illinois corn grower who may desire to plant it.

TABLE 2. BREEDING CORN TO CHANGE THE OIL CONTENT.
(Average per cent. oil in crops.)

Year.	Field No. 3, High-oil corn.	Field No. 4, Low-oil corn.	Difference, per cent.
1896	4.70	4.70	.00
1897	4.73	4.06	.67
1898	5.15	3.99	1.16
1899	5.64	3.82	1.82
1900	6.10	3.54	2.56
1901	6.09	3.43	2.66
1902	6.23	2.95	3.28

As shown in Table 2, the oil has been increased in the corn from 4.70 per cent., in 1896, to 6.23 per cent., in 1902; while, on the low-oil field, the percentage of oil in the corn has been reduced contin-

uously from 4.70 to 2.95. The last column in Table 2 shows that the difference between the percentages of oil in the corn of the two fields has grown greater every year from zero, in 1896, to 3.28 per cent., in 1902.

As yet no direct comparison has been made to test the yield of these four strains of corn as compared with other standard varieties, but such a test will be made in 1903. During the season of 1902 these four isolated fields yielded from 65.2 to 75.7 bushels per acre with two stalks in the hill. By referring to Table 6 and noting the yields obtained from other standard varieties grown with two stalks in the hill at Urbana and other places in the State, it will be seen that these four strains of corn are capable of making good yields.

As stated above, these four strains of corn were all derived from a single variety and from a single lot of uniform seed ears selected in 1896. This variety of corn has been grown upon the Experiment Station farm every year since 1887. Previous to that time it had been carefully grown for several years by Mr. F. E. Burr of Champaign county, and it was known locally as Burr's White; and this name has been used in our own records and bulletins whenever reference to this variety has been made in the past. The fact that these strains of corn are no longer typical Burr's White, and the fact that this corn was carefully grown for several years prior to 1896 by the Illinois Experiment Station and that since that time it has been most carefully bred by this Station for improvement in both yield and quality, so that we have developed from this variety four different strains of corn each of which has an established pedigree covering seven generations,—these facts have seemed to justify giving this corn a name which shall be distinctive and which shall also show its Illinois breeding; and henceforth it will be known in the records and publications of the Illinois Experiment Station as "Illinois" corn, the four different strains being designated as:

1. "Illinois" High-Protein.
2. "Illinois" Low-Protein.
3. "Illinois" High-Oil.
4. "Illinois" Low-Oil.

Another reason why this name seems appropriate is that the name has already been used to a considerable extent by people living in other states when making reference to this special corn, in correspondence and in the agricultural and scientific press.

Besides these original experiments in corn breeding we also have a large number of more recently established breeding fields, some of which are being carried on on the Experiment Station farm at Ur-

bana, while others are being conducted in coöperation with several of the most reliable seed corn breeders in the state.

In these different fields we are breeding nearly all of the best known varieties of corn grown in Illinois, and for many different purposes. As a rule each of these different varieties is being bred for the special purpose for which it seemed best adapted at the beginning, although in some cases one variety is being bred in two or three different ways.

All breeding is done by the row system, which is described in bulletins Nos. 55, 63, and 82, and which has also been adopted by some other Experiment Stations and by the Illinois Seed Corn Breeders' Association. All of the breeding plots whether operated entirely by the Experiment Station or in coöperation with other seed corn breeders, have for one of the principal objects an increase in yield, and in some cases this is the only object, but usually the purpose of breeding also includes improvement in the quality or composition of the grain.

Following is a list of the regular breeding fields with which we are now working :

1. "Illinois" High-Protein, bred for yield and for high protein since 1896 by the Illinois Experiment Station, at Urbana.
2. "Illinois" Low-Protein, bred for yield and for low protein since 1896 by the Illinois Experiment Station, at Urbana.
3. "Illinois" High-Oil, bred for yield and for high oil since 1896 by the Illinois Experiment Station, at Urbana.
4. "Illinois" Low-Oil, bred for yield and for low oil since 1896 by the Illinois Experiment Station, at Urbana.
5. Leaming, bred for yield and for high protein since 1900 by the Illinois Experiment Station, at Urbana.
6. Leaming, bred for yield and low protein and high oil since 1900 by the Illinois Experiment Station, at Urbana.
7. Boone County White, bred for yield and for low protein and low oil since 1900 by the Illinois Experiment Station, at Urbana.
8. Silver Mine, bred for yield and for low protein since 1900, in coöperation with F. A. Warner, at Sibley.
9. Riley's Favorite, bred for yield and for high protein since 1900 in coöperation with F. A. Warner, at Sibley.
10. Reid's Yellow Dent, bred for yield and for high protein and low oil since 1900, in coöperation with James L. Reid, at East Lynn.
11. Leaming, bred for yield and for high oil since 1900, in coöperation with E. E. Chester, at Champaign.

12. Leaming, bred for yield and for high protein and high oil since 1900, in coöperation with James O. Toland, at Arcola.

13. Leaming, bred for yield and for high protein since 1901, in coöperation with James H. Coolidge, at Galesburg.

14. Boone County White, bred for yield and for high protein since 1901, in coöperation with A. P. Grout, at Winchester.

15. Leaming, bred for yield and for high protein since 1901, in coöperation with E. E. Chester, at Champaign.

16. Reid's Yellow Dent, bred for yield and for high protein and high oil since 1901, in coöperation with James L. Reid, at East Lynn.

17. Boone County White, bred for yield and for high oil since 1901, in coöperation with C. W. Rolfe, at Alvan.

18. Boone County White, bred for yield and for high oil since 1901, in coöperation with John R. Clisby, at Arcola.

19. Boone County White, bred for yield and for high oil since 1901, in coöperation with Funk Brothers' Seed Company, at Bloomington.

20. Leaming, bred for yield and for high protein and high oil since 1901, in coöperation with Funk Brothers' Seed Company, at Bloomington.

In all of the above fields the ultimate selection of seed each year is based upon the chemical analysis of the individual seed ears. In the following fields the chemical selection of seed ears is based upon the mechanical examination of sections of kernels, but the efficiency of the selection is ascertained by chemical control as explained in Bulletin No. 82, "Methods of Corn Breeding."

21. Leaming, bred for yield and for high protein since 1901 by the Illinois Experiment Station, at Urbana.

22. Leaming, bred for yield and for low protein since 1901 by the Illinois Experiment Station, at Urbana.

23. Leaming, bred for yield and for high oil since 1901 by the Illinois Experiment Station, at Urbana.

24. Leaming, bred for yield and for low oil since 1901 by the Illinois Experiment Station, at Urbana.

25. Reid's Yellow Dent, bred for yield and for high protein since 1901, in coöperation with John G. Pratt, at Virginia.

26. Reid's Yellow Dent, bred for yield and for high protein since 1901, in coöperation with Ralph Allen, at Delavan.

Besides the above fields which are being bred for both yield and for improvement in chemical composition, the Experiment

Station is breeding two fields for increase in yield only, one of Leaming, and one of Boone County White, and the same methods are now being employed by some other corn breeders in breeding for increasing the yield only.

Aside from the four breeding fields of "Illinois" corn which were begun in 1896, none of the breeding has been continued for a sufficient length of time to markedly affect the original characteristics of the different varieties of corn which are being bred, although some evidences of improvement are already beginning to appear. Of course, an exact pedigree is being kept of all of the different kinds of corn which are being bred and a registry is being kept of all pedigrees, so that, as soon as any variety or strain of corn is sufficiently well bred and is grown in sufficient quantity to warrant putting it on the market as pedigreed seed corn, the actual pedigree of the corn can always be furnished to the purchaser with each lot of seed corn purchased.

2. VARIETIES OF CORN.

In connection with our experiments in corn breeding we have carried on considerable work relating to the composition of different varieties of corn, partly to ascertain which varieties were best adapted to breeding for different purposes and partly to learn the comparative value of different varieties as they now exist for feeding or for manufacture. In collecting these samples for analysis we have as a rule made composite samples of corn from at least 200 different ears in order that we might secure a truly representative sample of the corn in each lot. These investigations have confirmed the indications of our previous work; namely, that the soil and the season have a considerable influence upon the composition of the corn. Thus, if we exclude the strains of corn which had been changed by several years' breeding, the average protein content of all the varieties analyzed from the 1900 crop was 10.97, while 11.45 is the average for the abnormally dry year of 1901, and, from data thus far secured from the abnormally wet year of 1902 it appears that the general average for last year will be about 10.50 per cent. of protein.

The variation found in single varieties grown in different parts of the State and during different seasons is even greater than the above figures, as may be seen from Table 3, which gives the highest and lowest percentage of both protein and oil which we have found in analyzing representative samples from a large number of different lots of each of the common varieties mentioned. In case

of the Leaming, representative samples from more than thirty different lots of corn have been analyzed. For comparison the highest and lowest percentages yet obtained as averages of entire crops of our different strains of "Illinois" corn are also mentioned.

TABLE 3. PERCENTAGES OF PROTEIN AND OIL FOUND IN REPRESENTATIVE SAMPLES OF MANY DIFFERENT LOTS OF THE FOLLOWING STANDARD VARIETIES OF CORN.

Variety.	Number of lots analyzed	Protein per cent.				Oil per cent.			
		Aver'ge	Lowest	Highest	Difference.	Aver'ge	Lowest	Highest	Difference.
Boone Co. White	12	10.84	10.19	11.49	1.30	4.85	4.52	5.09	.57
Leaming	34	11.49	10.67	12.57	1.90	5.34	4.38	5.88	1.50
Reid's Yel. Dent	10	10.97	10.61	12.04	1.43	4.76	4.50	5.07	.57
Silver Mine	4	11.13	10.00	11.88	1.88	4.35	4.23	4.45	.22
Golden Eagle	3	11.08	11.05	11.14	.09	5.07	4.45	5.71	1.26
Riley's Favorite	6	11.32	11.01	12.09	1.08	5.26	4.98	5.66	.68
"Illinois". (4 strains)		10.92*	8.32	14.12	5.80	4.70	2.95	6.23	3.28

* Protein and oil in original Burr's White.

As a rule some varieties of corn are found to contain a slightly higher percentage of protein and of oil than other va-

rieties; but, as will be seen from Tables 1, 2, and 3, the "Illinois" corn has been so changed by breeding that we now have strains of this white corn with percentages of protein and of oil both above and below the extreme limits of all other varieties.

In variety tests for yield, seed of the best known varieties was obtained from several different growers and three or four separate trials were made with each lot of seed secured. Table 4 gives a summary of the results secured including the number of lots of seed obtained and the total number of separate trials with each variety.

Table 4. VARIETY TESTS FOR YIELD (bushels per acre.)

VARIETY.	Number of lots tested.	Total number of tests.	Lowest yield obtained.	Highest yield obtained.	Average yield of variety.
Boone Co. White.....	8	32	65.4	88.8	78.2
Leaming	5	20	68.4	88.8	79.6
Reid's Yellow Dent....	5	19	67.2	93.3	80.0
Silver Mine.....	4	15	59.4	88.0	72.2
Golden Eagle	3	12	65.4	78.6	72.1
Riley's Favorite.....	2	8	66.6	75.5	69.7

It will be observed, for example, that eight different lots of Boone County White corn were tested, four different trials of each lot being made, or a total of 32 separate trials with Boone County White seed. Of these 32 trials the lowest yield obtained was 65.4 bushels; the highest yield 88.8 bushels, and the average yield 78.2 bushels per acre.

Of these six recognized standard varieties, the Boone County White, Leaming, and Reid's Yellow Dent gave the best average yields. These three varieties of corn are rapidly becoming well known and very widely grown throughout the corn belt of Illinois.

During the coming season the Experiment Station expects to extend the testing of varieties to every corn experiment field in the State in order to determine more definitely what varieties of corn are best adapted to different sections of Illinois. This will include a field located in Northern Illinois. No corn experiment field has yet been located in Southern Illinois for the reason that the most urgent need for that section is for soil investigations. A large amount of the soil work is being done in that part of the State, and the soil experiment fields also include corn in crop rotations.

3. CORN CULTIVATION EXPERIMENTS.

During the season of 1902 five different corn experiment fields were conducted in different sections of the State; namely, one at

Urbana; one at Sibley, in coöperation with F. A. Warner; one at Bloomington, in coöperation with J. D. Funk; one at Jacksonville, in coöperation with H. S. Stevenson; and one at Decatur on the farm of J. M. Clokey.

The principal lines of work included in these experiments were:

- (1) *Methods of preparing the seed bed.
- (2) Effect of thickness of planting.
- (3) Methods of cultivation.

Three different methods of preparing the seed bed were tried:

- (A) Plow the ground early in the spring and drag immediately afterward; let it lie till planting time; then disk, harrow, and plant.
- (B) Plow the ground early in the spring; let it lie till planting time; then harrow and plant.
- (C) Leave the ground till near planting time; then disk, plow, drag, disk, harrow, and plant.

The yields of corn produced in those experiments are shown in Table 5.

TABLE 5. EFFECT OF METHOD OF PREPARING SEED BED.
(Yield, bushels per acre.)

Method Employed.	Trial No.	Bloomington Field.	Jacksonville Field.	Decatur Field.	General average.
A. Plow, drag, let lie; disk, harrow, plant.	1	65.3	71.3	49.9	.....
	2	72.1	77.3	.....	.....
	Ave.	68.7	74.3	49.9	64.3
B. Plow, let lie, harrow, plant.	1	77.4	96.6	43.0	.....
	2	70.0	74.0	.....	.....
	Ave.	73.7	85.3	43.0	67.3
C. Disk, plow, drag, disk, harrow, plant.	1	72.7	134.7	46.2	.....
	2	69.4	73.3	.....	.....
	Ave.	71.1	104.0	46.2	73.8

From the discordant nature of these results it is evident that the principal effect was due to soil differences rather than to the method of preparing the seed bed. This is particularly true with respect to the field at Jacksonville, which, although exceedingly rich, was found to be so lacking in uniformity as to render the experiments of little or no value. No doubt the excessive rainfall is somewhat responsible for these abnormal variations. The results from the Bloomington field are not in harmony and no two general averages

* Not included in experiments at Urbana or Sibley.

from the three fields agree as to the best method of preparing the seed bed. The general average shows the best results from method C., but this average is evidently unduly influenced by the abnormal results from Jacksonville, which do not agree among themselves.

(2) Effect of thickness of planting.

This experiment included the planting of five different rates of thickness in the hill; namely, 1 kernel, 2 kernels, 3 kernels, 4 kernels, and 5 kernels. The yields of corn produced are shown in Table 6.

TABLE 6. EFFECT OF THICKNESS OF PLANTING.
(Yield, bushels per acre.)

Thickness.	Urbana Field.	Sibley Field.	Bloomington Field.	Jacksonville Field.	Decatur Field.	General Average.
1 Stalk...	28.7	41.5	42.6	55.5	36.3	40.9
2 Stalks...	55.0	79.9	67.3	72.8	53.3	65.7
3 Stalks..	67.4	88.8	86.6	86.2	59.6	77.7
4 Stalks..	73.1	82.8	90.4	88.4	53.0	77.5
5 Stalks..	84.5	89.2	98.8	90.2	53.0	83.1

These results are in harmony with themselves and with many previous experiments conducted by this station, showing that the largest yield of corn (and stover also) is usually obtained from planting 4 to 5 kernels in the hill. When corn is to be harvested by machinery, and then fed as cut fodder or as ensilage, or husked by a machine, undoubtedly the most profitable results will be secured from planting 4 to 5 kernels in the hill; but if it must be husked by hand probably not more than 3 kernels should be planted.

In this connection it may be stated that experiments for next season will include different distances between the hills as well as different numbers of kernels in the hill.

(3) Methods of cultivation.

Three different methods of cultivation were tried:

- (A) Deep cultivation with large shovels.
- (B) Medium cultivation with small shovels.
- (C) Shallow cultivation with weeders only.

Table 7 gives the yields of corn produced by these different methods of cultivation.

TABLE 7. EFFECT OF METHOD OF CULTIVATION.
(Yield, bushels per acre.)

Method Employed.	Trial No.	Urbana Field.	Sibley Field.	Bloomington Field.	Jacksonville Field.	Decatur Field.	Gen. Ave.
Deep cultivation ; large shovels.	1	50.2	34.9	77.1	115.3	57.7	
	2	67.8	58.4	86.5	85.3	57.5	
	3	53.8	76.8	77.4	79.3	.....
	Ave.	57.2	56.7	80.3	93.3	57.6	69.0
Medium cultivation ; small shovels.	1	55.3	42.8	79.1	70.7	56.6	
	2	71.6	71.1	86.1	81.3	53.7	
	3	74.1	74.9	75.4	70.7	.....
	Ave.	67.1	62.7	80.2	74.2	55.2	67.9
Shallow cultivation ; weeders.	1	58.5	40.6	82.2	73.3	52.3	
	2	67.5	69.2	73.4	74.7	.....
	3	67.7	71.1	70.7	67.3	.....
	Ave.	64.6	60.3	75.4	71.7	52.3	64.9

These results show some marked differences, but the fact that there is some measure of agreement among the different trials in a given field indicates that one method of cultivation may prove to be best for one type of soil while another method may be best for another soil. Thus, for instance, the results at Urbana point very strongly to the conclusion that medium or shallow cultivation is decidedly better than deep cultivation, and we may well call attention to the fact that this result has almost invariably been obtained in past years from similar experiments conducted upon the University grounds. On the other hand, in every trial at Jacksonville and Decatur deep cultivation has given the largest yields.

Probably no question relating to the cultivation of corn has been the subject of more controversy than the matter of deep and shallow cultivation. The results already obtained certainly emphasize the importance and the wisdom of having these experiments in corn cultivation carried on on different kinds of soil and in different sections of the State.

In addition to the above cultivation experiments, some data is being accumulated relating to fall and spring plowing, and the value of listing as compared with ordinary cultivation.

4. STORING AND PRESERVATION OF CORN.

Two large cribs were built upon platform scales, one at Urbana and one at Sibley. About 350 bushels of corn were placed in the

Urbana crib and about 300 bushels in the crib at Sibley, late in the fall of 1901. Exact weights of the corn are taken every week. The results show that the corn both loses and gains in weight, depending upon its moisture content and the humidity of the atmosphere. The following table shows the actual weights of the corn in each crib at intervals of six months.

	Urbana (pounds)	Sibley (pounds)
First weight in December, 1901	24,460	20,625
First weight in June, 1902	24,670	19,600
First weight in December, 1902	24,220	19,670
Weight on January 1, 1903.....	24,500	19,860

There has been practically no loss in the weight of corn in the Urbana crib, probably owing to the fact that the corn was well cured and dried in the field before being placed in the crib. The Sibley corn appears to have been less thoroughly cured when placed in the crib and it shows a loss of 1025 pounds on 20,625 (almost exactly 5 per cent.) during the first six months, but after that time no further marked change has occurred.

The experiments will be continued till early next fall, when the cribs will be emptied and refilled with new corn as early in the fall as it will be safe to crib. During the present experiment the cribs are protected only by their own roof so that the weight is influenced by a direct fall of rain or snow. When they are refilled they will be protected by a higher independent roof, the sides being exposed as at present. This will still maintain the common method of keeping corn in the open crib, but it will reduce the error of weighing the snow, sleet, or rain which now falls directly upon the crib roof.

Experiments are in progress in coöperation with the Animal Husbandry Department to determine the best methods of harvesting and preserving the corn crop for use in feeding beef cattle. These experiments are being conducted upon the farm of Mr. E. D. Funk in McLean county and with Mr. Funk's assistance. The experiments include the preservation and use of corn as ensilage, as shock corn, and as shredded corn fodder. Final results are not yet obtained.

Experiments have also been begun to determine the most practical and economic methods for preserving seed corn, the corn being tested from time to time for vitality or germinating power. A very large amount of data is being accumulated in these experiments, but the work is not yet completed and it is not possible to draw definite conclusions at the present time, nor is it practical to try to publish all of the data now on hand, in this brief report.

(5) THE FEEDING VALUE OF IMPROVED CORN.

A series of experiments is being conducted in coöperation with the Animal Husbandry Department, with a view to ascertaining the value of high-oil corn and low-oil corn in pork production, but as yet the work is in the preliminary stage. These experiments will be continued and it is also expected to undertake experiments to determine the feeding value of high-protein corn as compared with ordinary corn and with low-protein corn, as soon as we have these different kinds of corn sufficiently well bred and in sufficient quantities to justify the work.

In conclusion we may say that the funds appropriated for conducting corn experiments are all being used. If continued, it is believed they are sufficient to maintain the experiments now in progress and admit of some further extension into other sections of the State. The funds appropriated are being somewhat augmented by the receipts which are derived from the sales of produce grown upon the corn experiment fields, all receipts being again used in the work of corn investigation.