MISSOURI

AGRICULTURAL COLLEGE EXPERIMENT STATION.

BULLETIN NO. 14.

FIELD EXPERIMENTS WITH CORN.

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II. MANURES.
III. PREPARATION OF SOIL FOR PLANTING.
IV. DISTANCE AND THICKNESS OF PLANTING.
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INTRODUCTORY.

In carrying out the objects of the organization of an "Agricultural Experiment Station," we cordially invite the coöperation of all persons interested in its success. Suggestions as to lines of experimental work, problems to be solved, inquiries relating to agriculture, horticulture, stock, and the dairy, will be cheerfully received, and answered as far as possible; but no work will be undertaken unless of public value, and the results of which we are at liberty to use for the public good.

Specimens of grains and grasses, seeds of fruit and forest trees; vegetables, plants and flowers that are true to name; varieties of beneficial and injurious insects; samples of mineral waters and ores, and whatever may illustrate any department of agriculture, will be gladly received, and due acknowledgments made in annual reports. Directions for collecting, packing and shipping such specimens will be furnished on application.

Bulletins will be issued at least quarterly, giving the results of experimental work as fast as completed, together with such suggestions and information as may be thought valuable to the farmers of Missouri.

The bulletins and reports of this Station are sent free to every citizen of Missouri who applies for them. Copies are sent as soon as issued to every newspaper in the State, to every Grange, Farmers' Alliance, or other Agricultural organization, whose address can be obtained. Bulletins and reports are also sent to the leading Agricultural papers of the country, and will be sent to *any* paper that may desire to exchange.

Letters relating to any special line of work should be directed to the officer in charge of that division, but all general correspondence relating to the work of the Station should be addressed to

EDWARD D. PORTER,
Director of Experiment Station.

Columbia, Boone Co., Mo.

DEPARTMENT OF AGRICULTURE.

BY
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ASSISTANT AGRICULTURIST.

FIELD EXPERIMENTS WITH CORN.

The field experiments with corn reported in the following pages have been, with a few exceptions, carried on during the past two years.

They were mainly planned by Prof. J. W. Sanborn, formerly Director of the Station, and, at the time of his retirement from the Station, June 1, 1889, were, for the most part, under way.

The completion of the work devolved upon the writer, and each line of work was carried out in accordance with the original plans, as far as the unfortunate circumstances of the destruction of our barn, together with all equipments for work, and the depleted condition of the Station treasury would permit. Prof. Sanborn's successor, Dr. Edward D. Porter, took charge in September of the same year, and encouraged the full completion of the investigations then in hand. It was deemed advisable to make a trial of the same experiments during the year, 1890, which has been done, the plan being modified in some of the work; some lines dropped and others extended. Yet, the general plan has been adhered to, and the same methods adopted in the second as in the first year's work. The first year's experience demonstrated that some of the land used was unfit for plat experimentation, and has been turned back to the general tillage land of the farm. This restricted the work to a slight extent, but not materially.

This report covers the work in the following lines:

I. Test of varieties.
II. Manures.
III. Preparation of soil for planting.
IV. Distance and thickness of planting.
V. Cultivation of corn.
  (*a*) Depth of cultivation.
  (*b*) Effect upon soil moisture.
  (*c*) Frequency of cultivation.
  (*d*) Hilling and level culture.
  (*e*) Tilled one way vs. cross-tilled.
VI. Subsoiling for roots and corn.
VII. Drainage for roots and corn.

I.—TEST OF VARIETIES.

A satisfactory comparative test of different varieties of corn is beset with many difficulties. When the varieties are grown side by side the influence of cross-fertilization is plainly visible the first season, exerting an influence upon the crop that cannot be measured; while, if grown upon widely separated areas, a greater element of error is introduced in difference of character of soil, exposure, etc. Moreover, the list of varieties, as usually tested, is made up from the stock of seedsmen from the North, South, East and West, which brings together seed grown under widely different conditions of soil and climate. This, doubtless, exerts an influence upon the first crop, at least, and, when grown side by side in the test, they are so thoroughly mixed as to be unfit for seed for the succeeding year.

Frequent calls are made for the data gathered in a variety test, however, and, to meet this demand, forty-one varieties were tested in 1889.

The soil, a light sandy loam, had been in clover, previous season. To the clover sod was added a liberal application of barnyard manure, and the land plowed in the fall.

Four rows of each variety, two hundred and fifty-one feet long, the rows being three feet and nine inches apart, with the hills the same distance apart in the row, were planted April 26 and 27. The land had been thoroughly prepared and was in good tilth.

After carefully marking off the field, as above stated, the seed was planted by hand and covered with a hoe to insure uniform and accurate distribution.

Cultivation, shallow, with the Albion Spring Tooth Cultivator, on May 14, 27, June 5, and "layed by" with the diamond plow on June 20. Land free from weeds and thoroughly cultivated.

The season was favorable up to July 15, and the corn made a vigorous growth. At this time, a severe drouth, accompanied by excessive temperature, set in and continued to September 10, materially reducing the yield from the earlier prospect.

The corn was cut and put up in small shocks, September 5 and 6. Husked and weighed, October 9 and 10. The fodder weighed, November 22. The weather had been dry, and the fodder had become thoroughly dry—having lost, perhaps, all the moisture it would in open air. This accounts for the small number of pounds of fodder per bushel of corn shown in the subjoined table of yields.

TABLE I. SHOWING NAME, YIELD, ETC., OF EACH VARIETY TESTED.

Number.	NAME OF VARIETY.	Color and Description.	Date of Maturity.	Height of Stalk, feet.	Height of Ear, feet.	Pounds of Merchantable ears per plat.	Pounds of Nubbins per plat.	Whole Yield per acre, bushels.	Fodder Yield per acre, pounds.	Pounds Fodder per bushel corn.
1	Giant White Normandy	White	Late	10.6	5.6	261	85	49.4	3241	65.6
2	Champion Early White.	White	Med.	8.6	3.6	252	96	49.9	2070	41.5
3	St. Charles White.....	White	Late	9.5	5.3	318	77	56.4	3100	55.0
4	Cuban Queen—standard	Yellow	Early	8.5	4.0	234	55	41.3	2170	52.5
5	Hickory King.....	White	Late	10.5	5.2	257	23	40.0	3290	82.2
6	Blount's Prolific.....	White	Med.	9.8	4.9	293	44	48.2	3210	66.6
7	Wabash.....	White	Late	11.0	6.6	310	50	51.5	4040	78.4
8	Pisa King.....	White	Late	10.8	6.1	265	100	52.0	3300	63.4
9	Hickory King.....	White	Late	9.4	4.6	253	58	44.4	3470	78.1
10	Golden Dent.....	Yellow	Late	9.5	4.9	285	83	52.6	3370	64.1
11	Queen of Prairie.....	Yellow	Early	7.8	3.2	218	44	37.4	1760	47.3
12	Cuban Queen—standard	Yellow	Early	8.6	4.1	267	57	46.3	2380	51.4
13	Maryland Dent.....	Yellow	Late	9.7	5.0	265	78	49.0	3350	68.3
14	Leaming.....	Yellow	Med.	9.5	4.5	241	84	46.4	3740	80.6
15	Golden Beauty.....	Yellow	Late	10.4	4.9	306	72	54.0	3530	65.4
16	Farmer's Favorite.....	Yellow	Med.	9.6	4.2	241	47	41.0	2080	50.7
17	Chester Co. Mammoth .	Yellow	Med.	10.5	4.8	349	69	59.7	3600	60.3
18	Pride of North.....	Yellow	Med.	10.3	5.0	348	45	56.0	3160	56.4
19	Edmund's Dent.....	Yellow	Early	8.8	4.0	356	62	59.7	2480	41.5
20	Cuban Queen—standard	Yellow	Early	9.5	5.0	323	51	53.3	2880	54.0
21	North Star.....	Yellow	Early	8.3	3.8	199	69	38.3	1960	51.2
22	Woodward's Yel. Dent.	Yellow	Early	8.7	3.9	262	70	47.4	2120	44.7
23	Yellow Mammoth King	Yellow	Med.	10.8	5.5	372	37	58.4	3760	64.4
24	Logan.....	Yellow	Med.	10.8	5.6	412	30	63.0	3680	58.4
25	Imperial.....	Yellow	Med.	10.8	6.2	403	35	62.6	4120	65.8
26	Murdock's Improved...	Yellow	Med.	10.7	5.6	388	40	61.0	3910	64.1
27	Riley's Favorite.....	Yellow	Med.	11.0	5.3	364	52	59.4	4180	70.4
28	Cuban Queen—standard	Yellow	Early	10.2	4.8	360	17	54.0	2720	50.4
29	Murdock's Improved...	Yellow	Med.	10.6	5.5	385	42	61.0	3850	63.1
30	Long John*.....	White	Early	8.3	3.0	215	25	33.0	2580	78.0
31	Calico Dent.....	Calico	Late	11.4	6.7	361	45	58.0	4660	80.3
32	Calico Dent.....	Calico	Med.	9.8	4.5	281	58	48.6	2660	54.7
33	Cranberry White.....	Calico	Early	9.0	5.2	320	36	51.0	3850	75.5
34	Evan's Red.....	Red	Med.	9.3	4.7	382	17	57.0	3240	56.8
35	Cuban Queen—standard	Yellow	Early	9.5	4.6	331	66	55.0	3230	58.7
36	Queen of the Valley....	White	Med.	9.6	5.1	229	84	44.7	3140	70.2
37	Red Cob Gourd.....	White	Late	9.8	5.7	308	82	56.0	4380	60.2
38	Little Willis.....	White	Late	10.6	6.1	327	48	53.6	4640	78.2
39	Murdock's.....	White	Early	8.2	4.4	258	41	42.7	2090	86.6
40	Strawberry Corn.....	White	Early	9.0	4.5	249	105	50.6	3480	44.0
41	Three Months' Corn....	White	Med.	10.0	5.2	268	46	45.0	3120	69.4

* 90 day flint.

In the classification of varieties into early, medium and late maturing, the standard has been wholly arbitrary. Into the early class are grouped those varieties maturing within 110 days, while those maturing within 120 days are entered in the medium, and those requiring 130 days are classed as late maturing. No variety tested failed to mature.

TABLE II. SUMMARY SHOWING YIELD, ETC., OF EARLY, MEDIUM AND LATE MATURING VARIETIES.

ITEMS.	Average of 13 early maturing varieties.	Average of 16 medium maturing varieties.	Average of 12 late maturing varieties.	Average of all varieties tested.
Average height of stalk—feet..	8.8	10.1	10.3	9.7
Average height of ear—feet...	4.2	5.0	5.5	4.9
Average yield of good ears—lbs	276	325	293	300
Average yield of nubbins—lbs.	54	52	59	54
Average yield per acre—bush..	47	53.9	51.4	50.9
Av. yield fodder per acre—lbs.	2592	3350	3696	3209
Av. lbs. fodder per bu. corn...	54.6	61.6	72.1	63.0

From this table it appears that the medium maturing varieties average the largest yield of corn, the late maturing next, and early varieties the smallest. The time of maturity also materially affects the height of the stalks and ears, and the number of pounds of fodder—without the ears—per bushel of corn.

Similar results were obtained at the Illinois Experiment Station as shown by the following summary from Bulletin No. 4:

TABLE III. SHOWING SUMMARY OF RESULTS OF VARIETY TESTS AT ILLINOIS EXPERIMENT STATION.

ITEMS.	Average of 27 early maturing varieties.	Average of 32 medium maturing varieties.	Average of 15 late maturing varieties.
Average height of stalk—feet	9.8	11.5	12.2
Average height of ear—feet.....	4.5	5.5	6.2
Average yield per acre—bushels....	75.6	89.8	83.2

HEIGHT OF STALK TO YIELD.

Grouping the figures with a view to determine whether there is a constant relation between the height of the stalk and yield we have the summary given below showing average results from the five varieties giving the smallest yield and the five varieties giving largest yield, as well as the yield of the five varieties having the shortest stalks and the five having the tallest stalks.

TABLE IV. SHOWING RELATION OF HEIGHT OF STALK TO YIELD OF VARIETY.

ITEMS.	Average of 5 varieties showing smallest yield.	Average of 5 varieties showing largest yield.	Average of 5 varieties having shortest stalks.	Average of 5 varieties having tallest stalks.
Height of stalk—feet..... ...	8.5	10.7	8.3	11.0
Height of ear—feet....	3.9	5.5	3.9	6.0
Yield of corn per acre—bu ...	40.1	61.5	41.4	55.9
Yield of fodder per acre—lbs..	2012	3832	2074	3988
Pounds fodder per bushel corn.	50.2	62.3	50.1	71.3

The average of the five varieties giving the smallest yield and of the five varieties having the shortest stalks is practically identical throughout. On the other hand, there is no relation between the average of the five varieties having the tallest stalks and the five varieties giving the largest yield.

The table points to the conclusion that the limit of profitable production has been reached in our very early varieties with a small growth of stalk, except when grown for a special purpose.

SUMMARY.

I. Of the white late varieties may be mentioned the St. Charles White and Pisa King; and among the medium maturing, Blount's Prolific and Champion Early White Pearl. Of the late yellow varieties, Golden Beauty was

the most desirable, while among the medium maturing may be selected Logan, Imperial and Murdock's Improved, and from the early varieties may be named Edmund's Dent and Cuban Queen.

II. The date of maturity materially affects the yield, the height of stalk and ear and the proportion of stalks to ears.

II. MANURES.

As the experiments with different manures were made with corn, a summary of the results are herein reported.

The object was to determine the best method of preparing and applying barnyard manures, and also to compare the value of the dung excreted by the different farm animals. It is designed to continue this work for a number of years, giving the same plats similar treatment from year to year. The superiority of a certain manure or method of preparing the same may, at first, be so slight as to be scarcely appreciated, yet, if continued for a considerable length of time, the effect is cumulative and will be more marked as the experiment continues.

In both seasons the plats were planted in corn for ensilage, a common medium Yellow Dent variety being used, in rows 40 inches apart, with the plants 7 inches apart in the row. Owing to the destruction by fire of our silo, the crop was field-cured, and the weight of the dried stalks and ears together was taken. In all cases the manure was plowed under. No manure was applied in 1890, which affords an opportunity to study the influence of an application of manure upon the second crop, as well as a determination of the points originally contemplated.

The details are given in the following table:

TABLE V. SHOWING YIELD PER ACRE FROM DIFFERENT MANURES.

Plat No.	KIND OF MANURE.	1889. Corn & fodder per acre. lbs.	1890. Corn & fodder per acre. lbs.	Average for two years.
1	No manure	5060	3520	4285
2	Fermented manure 2275 lbs	7800	5750	6775
3	Unfermented manure 2275 lbs	6210	6150	6190
4	No manure	5250	4490	4870
5	Solid and liquid manure 1140 lbs	8200	5630	6915
6	Solid manure alone 1140 lbs	7520	5360	6440
7	Cattle manure 2000 lbs	9080	5550	7315
8	Horse manure 2000 lbs	9220	6700	7960
9	No manure	5090	4590	4840
10	Composted with equal weight of clay, 2000 pounds manure	8400	6530	7465
11	Not composted, 2000 lbs	8400	6320	7360
12	No manure	6790	5110	5950
	Average yield of 8 manured plats	8104	5999	7051
	Average yield of 4 unmanured plats	5547	4427	4987
	Per cent. of gain from manuring	46.1	33.2	39.6

In all cases, unless otherwise specified, cattle manure was used, being taken from cattle on experimental feed in the barn, and represents, as nearly as is possible, uniformity in composition.

A trial of the different methods of applying barnyard manure was also made in 1889, the results of which are shown in the following table:

TABLE VI. SHOWING RESULTS FROM MANURES DIFFERENTLY APPLIED.

Plat No.	APPLICATION.	Yield per acre of corn and fodder: lbs.
26	Plowed under 1400 pounds	6430
27	Harrowed under 1400 pounds	5560
28	No manure	4600
29	Cross-plowed under 1400 pounds	5680
30	Left absolutely on top 1400 pounds	5420

SUMMARY.

A glance at Table V., showing the average of the manured and unmanured plats, ought to impress upon every farmer in the state the great value of barnyard manure. No new fact is demonstrated by these figures, yet they teach an important lesson. To produce the gain therein noted an application of less than ten loads per acre, such as is ordinarily hauled by the farmer, was required. So far the results seem to show that in the case of the fermented manure a greater proportion of the plant food furnished was available during the first year and was more completely exhausted by the crop than with the unfermented manure.

Horse manure, as might be expected, gave better returns than an equal weight of cattle manure.

No advantage was gained from mixing an equal weight of clay with the manure.

The trial with solid and liquid manure both saved together, and of solid manure without the liquid, shows quite clearly the waste in the system of saving manure that looks only to the preservation of the solid excrement.

Manure plowed under gave better results than did any any other method of applying tested.

A trial of the value of lime, salt and land plaster showed no increase of crop, while wood ashes made a material gain.

A trial of commercial fertilizers did not show sufficient increase of crop to warrant their use.

So far it appears from these trials that potash is the element most desired by corn on our land.

Other trials with manures were made, and are under way which will be reported when further data is collected.

III. PREPARATION OF SOIL FOR CORN.

Under this head will be given the results of experiments which for the most part have been carried through two years and involving several principles in tillage.

The soil used in these and all trials hereafter reported is an upland clay loam from eight to twelve inches deep with a stiff retentive clay sub-soil, and having good surface drainage. Previous cropping, 1886, oats ; 1887, clover ; and, 1888, corn.

One-tenth acre plats are used throughout. To avoid needless repetition let it be here stated that the variety of corn grown in 1889 was St. Charles White, a large, late maturing White Dent, and in 1890 Cuban Queen, a small early maturing yellow variety. Planted in rows three feet and nine inches apart each way, with two stalks per hill, from May 2d to 10th in each season after the ground had been thoroughly prepared. Cultivated four times shallow with the Albion Spring Tooth Cultivator, about May 18, June 1, 10 and 20. This statement of cultivation applies to all experiments excepting trials of methods of tillage.

FALL AND SPRING PLOWING.

To compare the value of fall and spring plowing, four plats were plowed on November 24, 1888, to a depth of eight inches, leaving each alternate plat to be plowed to the same depth the following spring. This latter set was plowed April 13, 1889, and all equally prepared. One set of four plats, comprising two fall and two spring plowed, were planted in corn for ensilage, and the remaining four were planted to Danver's Half Long Orange Carrots. The results of both sets are given in Table VII. below.

TABLE VII. SHOWING YIELD WITH FALL AND SPRING PLOWING.

Plat No.	WHEN PLOWED	Yield of dried corn and fodd'r per acre lbs.	Yield of carrots per acre lbs.
78	Spring Plowing	7240	.....
79	Fall Plowing	7130	.....
80	Spring Plowing	9200	.....
81	Fall Plowing	8690	.....
95	Spring Plowing	.....	16010
96	Fall Plowing	.....	16180
97	Spring Plowing	.....	13810
98	Fall Plowing	.....	14150
	Average of Spring Plowing	8220	14910
	Average of Fall Plowing	7910	15165
	Gain in favor of Spring Plowing	310	.....
	Gain in favor of Fall Plowing	.....	255

So far the results fail to show any special advantage from either as the results are so slight as to be within the limit of error.

BROAD AND NARROW FURROWS.

The above terms are used to denote the degree of thoroughness in plowing the land under experiment. In the case of the narrow furrow the ground was most thoroughly plowed—an ordinary 12-inch plow being made to cut only about 7 inches. By this means the soil to the depth plowed (8 inches) was completely inverted and well pulverized. In the broad furrow the same plow was made to cut about 16 inches to the required depth, leaving, therefore, about one-fourth of the soil virtually undisturbed—a system in vogue in some sections in preparing land for oats and known in the parlance of the farmer as "cutting and covering." By the side of these plats was one having no preparation whatever. This plat was marked off and seed deposited in holes dug with a hoe. The culture was level and shallow. In both seasons the same plats were used. The results for both seasons are given separately in the following table:

TABLE VIII. RESULTS WITH DIFFERENT METHODS OF PLOWING.

Plat No.	TREATMENT.	1889.				1890.			
		Good ears per plat, lbs.	Nubbins per plat, lbs.	Yield per acre, bu.	Fodder per acre, lbs.	Good ears per plat, lbs.	Nubbins per plat, lbs.	Yield per acre, bu.	Fodder per acre, lbs.
72	Lap Furrow—narrow	196	80	39.4	3020	159	59	31.0	1690
73	Lap Furrow—broad	199	90	41.3	3180	148	82	32.9	1690
74	No Plowing	189	115	43.3	2650	130	71	28.7	1490
75	Ordinary Plowing	205	84	41.3	3060	136	96	33.1	1630

TABLE IX. SUMMARY FOR TWO YEARS.

TREATMENT.	Corn per acre bu.	Fodder per acre lbs.
Lap Furrow—narrow	35.2	2355
Lap Furrow—broad	37.1	2435
No Preparation	36.0	2070
Ordinary Plowing	37.2	2345

The results are, to say the least, surprising. The two seasons were in many respects similar, and the yield of the plat having no preparation before planting and the soil stirred to a depth of about two inches in cultivating, averaged for the two seasons more corn than the plat having thorough preparation. Yet the decline in the second year is very marked. In 1889 this plat gave the largest yield, while in 1890 it gave the smallest of the set. This plat uniformly gave less fodder than those adjoining. Whether a further continuation of cropping without plowing will result in a further decrease in the crop remains to be seen.

In 1889 a period of excessive rainfall extending from May 15 to June 1 brought out some interesting facts in the growth of the corn planted on these differently prepared plats.

During the time the soil was completely saturated with water the plants on the thoroughly prepared land made little or no growth, became pale and apparently suffered materially. The plants on the plat having no preparation continued to grow vigorously and maintain a rich, healthy color. This was less marked on the plat having partial preparation, the plants appearing to occupy an intermediate position as it were. There is no material difference in the surface drainage of the plats. This was followed by a drouth and excessive temperature during which time the order of growth was completely reversed—the plants on the thoroughly prepared land making a good growth and showing the effects of the drouth much less than on either of the other plats.

These phenomena have been observed before by the writer and are not new to the experienced and observant corn grower.

To what extent we may depend upon the disintegrating and pulverizing influences of nature in freezing and thawing to supplant the artificial methods in vogue, if at all, yet remains an unsolved problem.

These results are but one of many indications that our knowledge of the true principles of tillage and soil physics is exceedingly meager.

DEEP AND SHALLOW PLOWING.

In 1890 a trial of deep and shallow plowing for corn and the effect of thoroughly pulverizing the first few inches of the soil with some tillage implement was made. The subjoined table shows the details and results:

TABLE X. YIELD FROM DEEP AND SHALLOW PLOWING.

Plat No.	PREPARATION.	Good ears yield per plat lbs.	Nubbins yield per plat lbs.	Yield per acre bu.	Fodder yield per acre lbs.
78	Plowed Deep—10 inches.....	175	72	35.3	1740
79	Plowed Shallow—4 inches	232	68	42.8	1800
80	Plowed Deep—10 inches.....	278	51	47.0	2000
81	Plowed Shallow—4 inches....	271	73	49.1	2200
76	Spring Tooth Cultivator—2 in.	106	62	24.0	1410
77	Disc Harrow—3 inches.....	117	74	27.3	1630
78	Ordinary Plowing—8 inches...	136	96	33.1	1630
	Average of Deep Plowing.....	.....	.....	41.1	1870
	Average of Shallow Plowing..	.....	.....	45.9	2000
	Average with Cultivators.....	.....	.....	25.7	1530
	Inc. Shallow over Deep Plow'g	.....	.....	4.8	130
	Per ct. Inc. with Shallow Plow'g	.....	.....	11.6	.....

It must be borne in mind that this trial covers but one season and falls far short of warranting a conclusion, although the results point favorably to shallow plowing.

VI. SUBSOILING.

It has been assumed by many writers that subsoiling would prove especially advantageous on soils having an outlet for the surplus water in times of excessive rainfall and that the increased water-holding capacity during these times has accounted for the unfavorable results obtained in many cases from this method of preparing land. With a view of testing this question four plats of uniform quality were carefully tile-drained in the fall of 1888. The plats are 33 feet wide and through the center of each was laid a line of two-inch drain tile 32 inches deep connecting with a five-inch main belonging to another system. They also have good surface drainage.

On May 10, 1889, plats 1 and 3 were subsoiled by following the breaking plow, which was run to a depth of 7 inches, with a subsoil plow run to a depth of 5 inches, loosening the soil to a depth of 12 inches. The subsoil plow did not invert the soil, but merely loosened it. Plats

2 and 4 were prepared in a similar manner with the exception of subsoiling. On May 22, the group was planted to Improved American Rutabagas. The same plats were treated in a like manner in 1890, and planted to corn.

In the following table is given the results for both seasons.

TABLE XI. SHOWING RESULTS WITH SUBSOILING FOR ROOTS AND CORN.

Plat No.	PREPARATION.	1889.	1890—CORN.			
		Rutabagas, yield per acre. lbs.	Good ears, yield per plat. lbs.	Nubbins, yield per plat. lbs.	Yield per acre. Bu.	Fodder, yield per acre. lbs.
82	Subsoiled	22000	352	49	57.3	2380
83	Not subsoiled	25965	312	89	57.3	2190
84	Subsoiled	24950	306	79	55.0	2110
85	Not subsoiled	22930	336	52	55.5	2090
	Average of subsoiled	23475	.....	.....	56.1	.....
	Average of unsubsoiled	24447	.....	.....	56.4	.....
	Increase from unsubsoiled	972	.....	.....	.3	.....

From which it appears that no benefit was derived from subsoiling in either season. In both seasons a drouth occurred in August which afforded a good opportunity for subsoiling to show to advantage if the theories of its advocates are correct.

The experiment will be continued.

V. CULTIVATION OF CORN.

A number of trials in culture of corn were made with the primary object of comparing different methods and to find the most efficacious, and with the further object of endeavoring to determine the true functions of tillage.

DEEP AND SHALLOW CULTIVATION.

A trial of deep and shallow culture of corn was made in 1889 and 1890. The same plats were used in both seasons. Belonging to this set is a plat that has been grown in corn during the past two years without any tillage whatever, the weeds being kept down by scraping the surface

with a sharp hoe. This operation was necessary twice during each season about May 26 and June 18.

In the trial of depth of tillage different implements were used leaving the soil in very different conditions. For deep tillage the ordinary field cultivator was used, running to a depth of from five to six inches. At first the narrow shovels or bull tongues were used, and afterward the ordinary shovels, care being taken to avoid ridging or hilling as much as possible.

For shallow tillage an implement designed by Prof. Sanborn and made by a local blacksmith was used. It is a modification of the principle of the Tower Shallow Cultivator and has a number of narrow knives running an inch or more under the surface loosening the soil and effectually destroying the weeds in its path, but not lifting the soil sufficiently to cover the weeds in the hill unless quite small.

The result of the two years' work is given in the table below.

TABLE XII. SHOWING RESULTS WITH DEEP AND SHALLOW CULTIVATION OF CORN.

KIND OF CULTIVATION.	1889.				1890.			
	Good ears, yield per plat, lbs....	Nubbins, yield per plat, lbs.....	Yield per acre, bus.	Fodder per acre, lbs	Good ears, yield per plat, lbs.....	Nubbins, yield per plat, lbs.....	Yield per acre, bus.	Fodder per acre, lbs .....
Deep Cul. 4 times...	397	66	66.2	3240	270	57.5	46.8	2020
Shallow Cul, 4 times.	487	46.5	76.2	3560	287	71	51.1	2340
Stand. Cul. 4 times..	466.5	48.5	73.6	3610	200	71.5	38.8	1760
Deep Cul. 4 times...	405	53.5	65.5	3220	210	40	35.7	1630
Shallow Cul. 4 times.	560	27.5	84.	4280	341	55	56.6	2070
No Tillage.....	532.5	41	82.	3900	259.5	60.5	45.7	1570

TABLE XIII. AVERAGE YIELD OF DEEP AND SHALLOW TILLED PLATS.

KIND OF CULTIVATION.	1889. Corn per acre Bu.	1890. Corn per acre Bu.	Aver'ge Corn per acre Bu.
Deep Tillage—average of 2 plats	65.8	41.2	53.5
Shallow tillage—average of 2 plats	80.1	53.8	66.9
No tillage—1 plat	82.0	45.7	63.8
Standard—1 plat	73.6	38.8	56.2
Increase of shallow over deep tillage	14.3	12.6	13.5
Per cent. increase of shallow over deep tillage	21.7	30.6	25.2

The Illinois Experiment Station has conducted similar experiments with similar, though less marked, results, as is shown in the subjoined summary of results from Bulletin 13 of that Station.

TABLE XIV. SHOWING RESULTS WITH DEEP AND SHALLOW CULTIVATION AT ILLINOIS EXPERIMENT STATION.

KIND OF CULTIVATION.	Bushels corn per acre.			
	1888.	1889.	1890.	Aver'ge
Shallow tillage—average of 3 plats	94.2	83.1	68.1	81.8
Deep tillage—average of 3 plats	84.9	74.1	63.2	74.1
Increase with shallow—Bu. per acre	9.3	9.0	4.9	7.7
Per cent. increase with shallow tillage	11.0	12.1	7.8	10.3

In the above trials different implements were used. Here we have the effect of the two systems of tillage upon the moisture in the soil, the destruction of weeds and stiring of the soil as shown in the yields.

In the following trial of depth of cultivation the work was done with the hoe, and the tillage, in all cases, was similar, except in depth to which the soil was stirred.

TABLE XV. SHOWING RESULTS FROM HOEING CORN.

DEPTH OF TILLAGE.	1889.				1890.				Av.
	Good ears—yield per plat. lbs.	Nubbins—yield per plat. lbs.	Yield corn per acre. Bu.	Fodder per acre. lbs.	Good ears—yield per plat. lbs.	Nubbins—yield per plat. lbs.	Yield corn per acre. Bu.	Fodder per acre. lbs.	Corn per acre.
Hoed 1 inch deep	528	71	85.6	3600	234	158	56.0	3280	70.8
Hoed 2 inches deep	444	40	69.0	3430	250	115	52.2	3100	60.6
Hoed 3 inches deep	540	46	33.7	3770	225	113	48.3	2300	66.0
Hoed 4 inches deep	538	60	85.5	3760	262	95	51.1	2310	68.3
Hoed 5 inches deep	....	....	....	....	255	91	49.4	2200	....
Standard	583	63	92.7	3550	257	71	47.0	2000	69.8

A study of the table shows less difference when depth alone is considered between the deep and shallow-tilled plats than in the trial just preceding this.

INFLUENCE OF TILLAGE UPON SOIL MOISTURE.

To study the influence of depth of tillage upon soil moisture, the soil of the deep and shallow-tilled plats reported in Table XIII. was sampled in 1890, each week for eleven weeks, ending August 6th, to a depth of seven inches, and the moisture determined by the Chemical Department. The plat having no tillage was also sampled in the same manner and at the same time.

TABLE XVI. SHOWING INFLUENCE OF DEPTH OF TILLAGE UPON SOIL MOISTURE.

Date of Sampling.	Deep tillage. Per cent. of moisture.	Shallow tillage. Per ct. of moisture.	No tillage. Per cent. of moisture.	Rainfall during previous week, inches	NOTES.
					Abundance of moisture.
May 27.	19.630	19.860	22.000	1.79	Ground just dry enough to plow.
June 3.	17.620	25.620	18.700	.....	Rain needed ; corn beginning to wilt.
June 11.	24.285	27.618	23.596	1.84	Water standing in furrows.
June 18.	17.565	21.721	17.565	.21	Getting dry.
June 25.	17.069	18.464	17 791	1.35	Water enough for good growth corn 3 [feet high.
July 2.	10.976	12.644	12.636	.....	Quite dry ; corn twisting.
July 9.	10.295	10.386	10.280	.42	Suffering for rain.
July 17.	18.684	19.976	17.522	2.09	Water enough for good growth.
July 24.	17.850	19.156	19.661	2.46	Water enough for good growth.
July 31.	15.716	16.091	13.031	.....	Getting dry.
Aug. 6.	12.931	12.411	12.566	.12	Still dryer.
Aver'ge	16.611	18.541	16.849	.93	.....

By this table the shallow-tilled plats contained on an average for the season tested, 10 per cent. more moisture than the plat having no tillage, and 11.6 per cent. more than the plats receiving deep tillage.

The results are surprising. It was expected that the plat receiving no tillage would show the smallest content of moisture. But there appears to be no difference between this and the deep-tilled plats, By this table the amount of moisture is uniformly greater in the shallow-tilled soil than in either of the others tested.

A trial by the New York Experiment Station showed that the moisture increased regularly with the depth of tillage, which is not in accord with our results. Yet the cases are not analogous since, in the New York experiment, the cultivation was done with a spade and the surface was carefully raked and fined to form a perfect mulch.

In our trial, as has been already stated, the tendency in deep tillage, with our ordinary field cultivators, is to

leave the loose soil in ridges, forming a mulch deeper than is necessary on portions of the surface, and leaving a portion without any covering to check evaporation. More surface is necessarily exposed to the air and sun when uneven than when level.

The reader will understand the action of a mulch to be the breaking of the upward flow of moisture that occurs during most of the growing season, before it reaches the surface, where it would soon be evaporated. It also prevents the soil from cracking and admitting warm, dry air to take up moisture.

The system of tillage, other things being equal, that forms the most complete mulch, best conserves soil moisture.

I do not understand the increase in moisture in the shallow-tilled plats on June 3, while in each of the adjoining plats a decrease occurred.

MULCHING CORN.

A trial of mulching corn in 1889 to determine to what extent the conservation of moisture and the prevention of the growth of weed would answer the purposes of tillage. At the outset, allow it to be stated, that this was not attempted in the hope that it might become a practice, but we were simply in search of a principle. In no case was any tillage given the mulched plats. On one plat a layer of finely pulverized earth, one-half an inch deep, was carefully spread over the surface, and in the other cases sand and chaff were spread to the same depth. The mulch was repeated once. Size of the plats, one-thirtieth of an acre.

In the table below is given the results, together with the yield of an adjoining one-tenth acre plat, having standard cultivation and one cultivation with a scuffle hoe, to a depth of one-half inch.

TABLE XVI. SHOWING EFFECT OF MULCHING CORN 1889.

TREATMENT.	Good ears per plat lbs.	Nubbins per plat lbs.	Yield per acre bu.	Fodder per acre lbs.
Mulched with Fine Earth.....	105.0	30.0	57.9	3680
Mulched with Sand.....	109.5	37.5	63.0	3480
Mulched with Chaff.....	92.5	34.5	54.4	3840
Cultivated with Albion 2 inches ...	98.0	33.0	54.6	3340
Cultivated with Scuffle Hoe ½ inch.	118.5	24.0	61.1	3464
Average of Mulched Plats.....	.....	.....	58.4	.....
Average of Cultivated Plats.....	.....	.....	57.8	.....
Difference in favor of Mulching....	.....	.....	.6	.....

In this case the mulch prevented the evaporation of moisture as effectually perhaps as thorough tillage, and also prevented the growth of weeds.

Here two of the conditions of tillage are filled, and the stirring of the soil alone omitted, with the result of no diminished yield.

In the case of the plat having no tillage but the weeds removed, evaporation was unchecked and the soil remained unstirred. Yet the yield was fully up to the average of adjoining plats having thorough cultivation.

So far no benefit has been derived from more tillage than is necessary to kill weeds, which is thoroughly in accord with results of similar experiments by Dr. Sturtevant of New York, and Prof. Morrow of Illinois.

The whole field needs further investigation, and a fair and unbiased interpretation of the results, which, I am confident, will at least modify current ideas of the functions of tillage.

ROOT PRUNING IN TILLAGE.

Experiments are numerous showing the ill effects of root pruning. In this trial my object was to eliminate this factor from a comparison of deep and shallow culture; or to compare the effect of these two methods of tillage when the roots were equally pruned.

Two one-tenth acre plats, in 1890, were devoted to this test in both of which the roots of the growing plants were artificially pruned to a slightly greater extent than was assumed to be done by deep tillage. One plat was cultivated deep and one shallow, in the manner already described, with the result shown in Table XVII.

TABLE XVII. RESULTS WITH DEEP AND SHALLOW TILLAGE WHEN ROOTS ARE EQUALLY PRUNED.

TREATMENT.	Corn per acre bu.	Fodder per acre lbs.
Shallow Tilled—roots pruned	53.0	1740
Deep Tilled—roots pruned	48.0	1900
Increase with Shallow Tillage—bushels	5.0	.....
Per cent. Increase from Shallow Tillage	10.4	.....

This table appears to show that only a part of the difference noted in the first table of depth of cultivation is due to root pruning, and that there is a further advantage presumably in moisture conserved.

EFFECT OF TILLAGE AT DIFFERENT PERIODS OF GROWTH.

There often comes a time to the practical corn grower when, owing to delay occasioned by wet weather, the implements that till shallow and level will not answer to destroy the weeds in the row. Hand hoeing is too expensive and deep tillage must be resorted to.

The following trial was designed to discover the stage of growth of the plant at which the ill effects of deep tillage are least felt. The trial was made in 1890 and it was my design to make it elaborate and thorough, but owing to the lack of suitable land not otherwise provided for the work was limited to two standard sized plats. In one the shallow cultivator was used in the first two cultivations and the deep cultivator in the last two. In the other plat the order was reversed. The table below shows the results.

TABLE XVIII. TABLE SHOWING EFFECT OF DEPTH OF TILLAGE AT DIFFERENT PERIODS OF GROWTH, 1890.

TREATMENT.	Bushels corn per acre.	Pounds fodder per acre.
Cultivated shallow early and deep afterwards..... ...	48.1	2070
Cultivated deep early and shallow afterwards.....	42.8	2000
Increase from shallow early.....	5.3	
Per cent of increase from shallow early.....	12.4	

In this trial the plants were fully two feet high without raising the blades when the method of cultivation was changed. It seems to show that less damage is done by deep tillage after the plants have attained this size than when smaller. This runs counter to the general impression of farmers but appears to be in accord with reason since the mutilation of roots by deep tillage early is relatively much greater than when the plant is more fully developed.

Too much reliance should not be placed in a single trial, covering but one season.

FREQUENCY OF CULTIVATION.

In the subjoined table is given the results of duplicate tests of the effect of different amounts of cultivation for the two years. In all cases the same implement was used, namely, the Albion Spring Tooth Cultivator.

TABLE XIX. SHOWING RESULT OF DIFFERENT AMOUNTS OF CULTIVATION 1889 AND 1890.

Plat No.	NUMBER OF TIMES CULTIVATED.	1889.				1890.				Average yield of corn per acre.
		Good ears, yield per plat, lbs.	Nubbins, yield per plat, lbs.	Yield per acre, bu.	Fodder, yield per acre, lbs.	Good ears, yield per plat, lbs.	Nubbins, yield per plat, lbs.	Yield per acre, bu.	Fodder, yield per acre, lbs.	
110	No Tillage	532.5	41.	82.	3900	259.5	60.5	45.7	1570	63.8
111	Tilled five times	496.	27.5	75.	3760	254.	66.	46.0	1540	60.5
112	Tilled four times	533.	30.	80.5	4000	281.	66.	49.6	1540	65.0
113	Tilled three times	515.	30.	78.0	4230	269.	50.	45.6	1470	61.8
114	Tilled two times	531.	35.	80.7	4070	272.	42.5	44.9	1660	62.8
115	Tilled one time	493.	44.	77.	3810	235.	77.	44.6	1650	60.8
119	Tilled five times	379.	47.	61.	3580	302.5	50.	50.3	1960	55.6
120	Tilled four times	399.	52.	64.5	3800	260.	77.	48.2	2140	56.3
121	Tilled three times	379.	60.	62.7	3930	254.	70.	46.3	2010	54.5
122	Tilled two times	412.	57.5	67.1	3140	170.	102	38.9	1900	43.0
123	Tilled one time	393.5	48.5	63.1	3270	117.	65.	26.	1750	44.5

TABLE XX. SUMMARY SHOWING RESULTS OF FREQUENCY OF CULTIVATION BY YEARS.

CULTIVATION.	1889.		1890.		Average.	
	Average yield corn per acre. Bu.	Average yield fodder per acre. lbs.	Average yield corn per acre. Bu.	Average yield fodder per acre. lbs.	Average yield corn per acre. Bu.	Average yield fodder per acre. lbs.
No tillage—surface scraped	82.0	3900	45.7	1570	63.8	2735
Tilled 5 times	68.0	3670	48.1	1750	58.1	2710
Tilled 4 times	72.5	3900	48.9	1840	60.7	2870
Tilled 3 times	70.3	4080	45.9	1740	58.1	2910
Tilled 2 times	72.9	3605	42.0	1780	57.9	2692
Tilled 1 time	70.0	3540	35.3	1700	55.2	2620

A study of these figures fails to show any relation between the amount of tillage and the yield. In the case of plat 123, in 1890, the weeds were not removed until June 15, at which time they had made a heavy growth,

and, doubtless, reduced the yield to the figures shown. In all other cases the weeds were destroyed by hoeing regularly.

This is in accord with the results of similar trials at the Experiment Stations of New York, Ohio and Illinois.

LEVEL VS. HILL CULTIVATION.

In 1889, a trial of the effect of level and hill culture was made. Four plats were devoted to this test, each one of which had the same amount of tillage to the same depth and with the same implements; excepting that plats 1 and 3 were hilled, while 2 and 4 were left level. The hilling was done with a hoe, and the level plats were tilled with this implement to the extent required to hill the other plats so that any material difference in the yield may be reasonably attributed to the fact that the plat was or was not hilled.

The table below gives the results for duplicate trials:

TABLE XXI. RESULTS OF HILLED AND LEVEL CULTURE CORN.

Plat No.	TREATMENT.	Yield per plat, good ears. lbs.	Nubbins, yield per plat. lbs.	Yield per acre. Bu.	Fodder per acre. lbs.
105	Level culture	440	44	69.2	3690
106	Hilled	416	52	67.0	3410
107	Standard—ordinary	387	65	64.7	3080
108	Level	434	52	69.5	3850
109	Hilled	492	45	76.8	3480

Average of level culture, 69.3 bushels per acre.
Average of hilled culture, 71.9 bushels per acre.
Difference in favor of hilling, 2.6 bushels per acre.

The results are quite inconclusive, but appear to show that, for this season, no damage was done by hilling. The soil of plat, number 109, is either above the average of the set in fertility, or else number 106 is below, as no gain is shown excepting in the former.

TILLING ONE WAY VS. CHECK TILLAGE.

A test of cultivating corn one way throughout the season, compared with cross-plowing once, was made in 1889 and 1890, with the following results :

TABLE XXII. RESULTS FROM CROSS TILLAGE AND TILLING ONE WAY COMPARED.

Plat No.	CULTIVATION.	1889.				1890.				Average yield of corn per acre, bu.
		Good ears, yield per plat, lbs.	Nubbins, yield per plat, lbs.	Yield per acre, bu.	Fodder, yield per acre, lbs.	Good ears, yield per plat, lbs.	Nubbins, yield per plat, lbs.	Yield per acre, bu.	Fodder, yield per acre, lbs.	
116	Cross Tilled	459	44	72.	3120	292	26	45.5	1580	58.7
117	Tilled one way	447	36	69.	3600	196	71	38.1	1470	53.6
124	Cross Tilled	406	54	65.7	3380	257	66	46.2	1660	55.9
125	Tilled one way	399	61	65.7	3670	223	91	44.9	1640	55.3

TABLE XXIII. SUMMARY FOR TWO YEARS.

CULTIVATION.	1889.		1890.		Average.	
	Bushels Corn Per acre.	Pounds Fodder Per Acre.	Bushels Corn Per Acre.	Pounds Fodder Per Acre.	Bushels Corn Per Acre.	Pounds Fodder Per Acre.
Cross Tilled	68.8	3250	45.8	1620	57.3	2435
Tilled One Way	67.3	3635	41.5	1555	54.4	2595
Increase With Cross Tillage	1.5	....	4.3	....	2.9	....

It appears that a slight advantage resulted from cross plowing once as compared with tilling one way throughout the season.

THICKNESS OF PLANTING.

In both seasons eleven one-tenth acre plats were devoted to a study of the proper distance and proper number of plants to be grown upon a given area to produce the

heaviest yield. The trial also shows the effect of distributing the seed in hills or drills.

The details are given in the subjoined table:

TABLE XXIII. DISTANCE AND THICKNESS OF PLANTING CORN.

Plat No.	DISTRIBUTION OF SEED.	Number plants per acre, in perfect stand.	1889.				1890.			
			Good ears per plat, lbs.	Nubbins, yield per plat, lbs.	Yield per acre, bu.	Fodder, per acre, lbs.	Good ears, per plat, lbs.	Nubbins, yield per plat, lbs.	Yield per acre, bu.	Fodder, per acre, lbs.
164	Hills 45x45 in. 2 grains....	6480	461	53	73.5	3460	315	30	49.5	2340
165	Hills 45x45 in. 3 grains....	9720	528	51	80.	3970	365	41	58.	2680
166	Hills 45x45 in. 4 grains....	12960	482	61	78.	4330	311	91	57.4	3310
167	Hills 45x22½ in. 2 grains .	12960	497	44	77.4	4540	177	112	41.4	3620
168	Hills 45x22½ in. 1 grain..	6480	373	34	58.	3230	283	47	47.2	2100
169	Hills 45x22½ in. 1½ grains	9720	392	64	65.2	4030	322	40	51.7	2620
170	Hills 45x22½ in. 2 grains.	12960	320	90	58.6	3410	260	109	53.7	3210
171	Hills 45x15 in. 1 grain.....	9720	287	49	48.	3240	281	74	50.8	2460
136	Hills 45x15 in. 1½ grains .	14580	162	144	43.6	3910	78	188	38.	2840
137	Hills 45x15 in. 2 grains....	19440	92	110	29.	4475	29	208	33.9	3490
138	Hills 45x22½ in. 2 grains..	12960	186	108	42.	3960	185	196	54.4	2520

DISTANCE OF PLANTING—AVERAGE FOR TWO YEARS.

DISTRIBUTION OF SEED.	No. of plants per acre in perfect stand.	Good ears, yield per plat, lbs.	Nubbins, yield per plat, lbs.	Yield per acre bushels.	Fodder per acre, lbs.	Pounds fodder per bu. corn.	Per ct. Nubbins to whole yield.
Hills 45x45 inches, 2 grains.....	6480	388	41	61.5	2900	47.2	9.5
Hills 45x45 inches, 3 grains.....	9720	447	46	69.0	3325	48.2	9.4
Hills 45x45 inches, 4 grains.....	12960	396	76	67.7	3820	56.4	16.1
Hills 45x22½ inches, 2 grains.....	12960	323	66	56.0	2600	46.4	17.0
Hills 45x22½ inches, 1 grain.	6480	337	78	59.4	4080	67.0	18.8
Hills 45x22½ inches, 1½ grains.....	9720	328	40	52.6	2665	48.7	10.9
Hills 45x22½ inches, 2 grains...	12960	357	52	58.4	3325	58.6	12.8
Hills 45x15 inches, 1 grain.....	9720	290	99	56.0	3310	59.3	25.4
Hills 45x15 inches, 1½ grains.....	14580	284	61	49.4	2850	57.3	17.7
Hills 45x15 inches, 2 grains.....	19440	120	166	40.8	3375	82.7	58.0

There is not a close relation between the thickness of planting and the per cent. of nubbins. There is, however, a constant relation between the per cent. of nubbins and the yield per acre.

It appears that other factors, aside from the number of plants per acre, affect the yield. So far as our trials show, the distribution of the seed, where the amount remains equal, has an influence.

By grouping the figures with reference only to the number of plants per acre, we have the following exhibit:

THICKNESS OF PLANTING CONSIDERED ALONE.

ITEMS.	6480 plants per acre 2 plats.	9720 plants per acre 3 plats.	12960 plants per acre 3 plats.	14580 plants per acre 1 plat.	19440 plants per acre 1 plat.
Merchantable Ears per plat, lbs	362	355	358	284	120
Nubbins per plat, lbs.....	59	62	65	61	166
Per cent. of Nubbins.....	14.1	15.2	15.3	17.7	58.0
Whole Yield per acre, bu.....	60.4	59.2	60.7	49.4	40.8
Fodder Yield per acre, lbs	3490	3100	3248	2850	3375
Pounds of Fodder per bu. corn.	57.1	52.1	50.5	57.3	82.7

Which shows little or no difference in the yield until we pass beyond 12960 plants to the acre, which is equivalent to one plant every 11 inches in rows, three feet and nine inches apart, or to planting in hills three feet and nine inches apart each way with four plants in a hill. By reference to the table, however, it will be seen that one-half this number of plants per acre, or two plants per hill, gave practically the same yield, which would be more convenient for the husker as the ears are much larger and less in number.

TILE DRAINAGE FOR CORN.

Six one-tenth acre plats were devoted to a test of the value of tile drainage for our soil, three of which were underdrained with three-inch tile, and three undrained. The two sets are separated by a plat not in the trial to avoid the influence of drainage upon the first of the undrained plats.

The plats are 33 feet wide with a line of three-inch tile laid at an average depth of 30 inches, running through the

center of each plat of the drained set and connecting with a five-inch main, emptying in an adjoining meadow. So far they have apparently discharged their functions perfectly.

The crop grown in 1889 was Yellow Globe Mangel Wurtzels, in rows 30 inches apart; and, in 1890, Cuban Queen Corn, in rows three feet nine inches apart each way with three plants in a hill.

The result with both crops is given in the subjoined table:

TABLE XXIV. SHOWING YIELD OF DRAINED AND UNDRAINED PLATS.

Plat No.	TREATMENT.	1889.	1890—Corn.			
		Mangel Wurtzels, yield per acre. Tons	Good ears per plat. lbs.	Nubbins per plat. lbs.	Yield per acre. Bu.	Fodder yield per acre lbs.
88	Drained	10.20	309	79	55.5	2260
89	Drained	9.97	296	63	51.3	1760
90	Drained	9.24	331	62	56.2	1920
91	Half plat separating sets	5.63	181	34	30.9	1050
92	Not drained	9.33	348	64	59.0	1920
93	Not drained	8.37	343	68	59.0	1890
94	Not drained	8.08	304	88	56.0	1690
	Average of drained plats	9.77	...	..	54.3	1966
	Average of undrained plats	8.59	...	..	58.0	1833

The results are in favor of drainage, in 1889, with Mangel Wurtzels, showing a gain of 1.18 tons per acre, or 13.7 per cent. over the undrained plats. In 1890, the results are reversed where corn was grown—the undrained plats showing the heaviest yield by 3.7 bushels per acre, or 7 per cent. On the whole, the season of 1889 was better suited to show the advantages of under drainage, as there was an excessive precipitation during May and early part of June, while, in 1890, the rainfall was more uniformly distributed.

EFFECT OF DRAINAGE UPON SOIL MOISTURE.

During the season of 1890, weekly samples of soil, to a depth of seven inches, were drawn for eleven weeks, ending August 6, from each of these plats, and the moisture determined by the Chemical Department of the Station.

Without burdening this report with the details, suffice it to say that no difference in the per cent. of moisture was found. The average for the season being, for the drained plats, 18.565 per cent. and for the undrained 18.428. In one week one set would contain the most moisture, and, perhaps, the figures would be reversed in the next. Yet the difference, in all cases, was so slight as to be within the limit of error. These fluctuations did not appear to be affected by previous rains, although no good opportunity was offered to draw samples when the soil was thoroughly saturated. The trial is to be continued and the moisture determination begun earlier and continued through the entire season.

There is no difference in yield, so far as our trial has gone, to warrant the expense of tiling our uplands that have moderately good natural drainage.

Experiments in seed selection, depth of planting, time of harvesting corn have been carried on during the two years, but further data will be collected before a report is made.

FINAL SUMMARY AND REVIEW.

I. In the test of varieties, the early-maturing varieties gave an average of the smallest yield of corn and fodder, the shortest stalks and the smallest proportion of stalk to ear. The medium-maturing varieties averaged the largest yield of corn, while the late-maturing varieties gave the largest amount of fodder, the highest stalks and the greatest yield of stalks in proportion to ears.

Edmund's Dent and Cuban Queen—both yellow—led in yield among the early-maturing varieties, while Blount's Prolific and Champion White Pearl of the white varieties,

and Logan, Imperial and Murdock's Improved of the yellow, are the most promising of the medium-maturing. Of the late-maturing, St. Charles White and Pisa King led in the yield among the white varieties, while Golden Beauty was, apparently, the best of the yellow.

II. In the trial of fertilizers, barnyard manure gave an increase from the use of equivalent to about ten loads per acre of 46 per cent. for the first year and 33 per cent. for the second year, with but one application. This is the average of 8 manured, compared with 4 unmanured plats.

Fermented manure appears to give better returns the first year, and show less effect the second year than did the unfermented manure. Horse manure gave better results than cattle manure.

A comparison of the solid and liquid manure from cattle when both were saved together, and an equal weight of solid manure alone showed the largest yield for the two years from the plat having the liquid manure saved with the solid. Plowing under gave better results than any other method of applying tested. No benefit was derived from the use of salt, lime or land plaster, while wood ashes gave a material increase of crop. In the trial of commercial fertilizers the increase was not sufficient to warrant the expense. In these trials corn responded more readily to an application of potash than either phosphoric acid or nitrogen.

III. Preparation for planting:—The trial of Fall and Spring plowing for carrots and corn resulted in a draw. In the test of thorough, little and no plowing for corn for the two years, there was no difference in the yield. The plat having no preparation yielded more corn in 1889 than either of those that had been prepared, and less in 1890. A comparison of deep and shallow plowing for corn in 1890 showed a gain of 4.8 bushels per acre, or 11.9 per cent. in favor of shallow plowing. Depth, 4 inches for the shallow and 10 inches for the deep plowing.

Subsoiling showed no gain in 1889 for rutabagas, nor in 1890 for corn. In both seasons the trial was made on tile-drained land, where subsoiling is supposed to show to the best advantage.

IV. DISTANCE OF PLANTING:—An average of the two seasons' work shows no difference in the yield from planting three feet nine inches apart, each way, with 2, 3, or 4 grains in a hill. When planted either thicker or thinner there was a decreased yield, which, in the case of thicker planting, was accompanied by a material increase in the per cent. of nubbins.

V. CULTIVATION OF CORN.—A trial of deep and shallow tillage gave an increase of 14.3 bushels per acre, or 21.7 per cent. of the whole yield, in favor of shallow tillage in 1889, and an increase for the same method of tillage in 1890 of 12.6 bushels per acre, or 30.6 per cent. as an average of duplicate plats. Average of both seasons for all plats gives an increase of 13.5 bushels per acre, or 25.2 per cent. A plat in the set having no tillage, the weeds being removed with a sharp hoe without stirring the soil, yielded in both seasons, for the same plat, more than the deep-tilled plats, but less than the shallow-tilled. Weekly determinations of soil moisture for 11 weeks, ending August 6, in 1890, showed that the shallow-tilled plats had an average of 11.6 per cent. more moisture than the deep-tilled plats, and 10 per cent. more than the plat receiving no tillage.

In test of different depths of cultivation with the hoe, running from 1 to 5 inches deep, there was less difference in the yield than in any test of depth of cultivation where field implements were used. It is probable that the better conservation of moisture by deep hoeing counteracts and balances to some extent the effect of root mutilation, as the New York Experiment Station has shown that the moisture increased regularly with the depth of stirring. In their test the soil was stirred with a hoe or spade, and

no crop was grown on the land tested. Then a perfect mulch is formed, but, as explained in the body of this report, no such covering is made by the ordinary field cultivator when run deep.

A light mulch of fine earth in one case, of sand in another, and in a third of chaff, spread to a depth of one-half inch, gave as large a yield for 1889 as two adjoining plats having thorough tillage. The mulched plats were never tilled.

In a test of deep and shallow tillage where the root mutilation was equal there was a gain of 5 bushels per acre, or 10.4 per cent. in favor of shallow tillage, due, presumably, to the increased amount of moisture conserved. An effort to determine the stage of development of the plant, at which the ill effects of deep tillage are least felt, showed a gain of 5.3 bushels per acre, or 12.4 per cent. from tilling shallow, when the plants are small, and deep afterwards, as compared with deep tillage, early and shallow afterwards. The trial was not made in duplicate, and covers but one season. The results need confirmation. The result of the experiment, with frequency of tillage for two years, shows no relation between the amount of cultivation and the amount of corn harvested, so long as the weeds are kept down. This is in accord with experiments at New York, Ohio and Illinois Experiment Stations. A test of hilled *vs.* level cultivation, where all other things were equal, showed an increase of 2.6 bushels per acre, or 3.7 per cent. in favor of hilling. The results are not decisive enough to be conclusive, but point to a probable advantage from hilling. A comparison of tilling one way continuously and cross plowing once for both seasons resulted in a gain of 2.9 bushels, or 5.3 per cent. in favor of cross cultivation.

VI. TILE DRAINAGE.—A trial of the value of tile drainage on our rolling clay upland shows a gain of 1.18 tons of Mangels per acre, or 13.7 per cent. in 1889 in favor

of drainage; while, for 1890 with corn, the results are reversed, giving the undrained plats an advantage of 3.7 bushels per acre, or 7 per cent. So far, the results are inconclusive. In 1890, the moisture in the first seven inches of the soil, in both drained and undrained plats, was determined weekly for eleven weeks, ending August 6, showing no difference in favor of either system.