UNIVERSITY OF THE STATE OF MISSOURI.

College of Agriculture and Mechanic Arts.

Agricultural Experiment Station.

BULLETIN NO. 32.

FIELD EXPERIMENTS WITH CORN.

COLUMBIA, MISSOURI.

OCTOBER, 1895.

Statesman Printing House, Columbia, Missouri.

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FIELD EXPERIMENTS WITH CORN.

BY H. J. WATERS AND C. M. CONNER.

A number of experiments in corn growing have been carried on at the Station for three consecutive years. Some of the more important points brought out in the trial are summarized below:

1. Golden Beauty gave the highest average yield, 57.4 bushels per acre of the varieties tested three years, followed by Leaming with an average yield of 56.8 bushels. Both of these varieties are medium maturing yellow dents. Piasa King, Saint Charles White and Chester County Mammoth, all requiring 130 days or more for maturity, were the best of the white varieties tested.

2. An increase of nineteen bushels per acre, or 61.7 per cent, was secured in 1891 from an application of ten tons of fresh barnyard manure to the acre on the average of eight manured and two unmanured plots. This amount of manure applied twice in three years produced an average increase in yield of 36.6 per cent. Little difference was shown in the productiveness of fermented and unfermented

manures when applied to corn. Ten tons of combined solid and liquid manure gave a larger total yield each year than did ten tons of solid manure, although in 1891 more corn was grown on the plot to which the solid manure was applied. Horse manure proved more productive each year than did an equal weight of cattle manure, the average difference for the three years amounting to 7.4 per cent. In 1891 the increased yield of corn was 6.6 bushels per acre, or 11 per cent. Decidedly larger yields were obtained from plowing cattle manure under for corn than from spreading it on freshly plowed ground and harrowing it in, or applying it on the surface after the land was ready to be planted.

3. Breaking the ground to the depth of four and one-half inches gave uniformly better results than were obtained from plowing nine inches deep. Tile drained land plowed to a depth of eight inches and subsoiled seven inches deeper, stirring the soil to the depth of fifteen inches, produced slightly smaller yields of rutabagas, corn and sugar beets than did similar soil not subsoiled.

4. Averaging the three years' work, when corn was planted in hills 3 feet and 9 inches apart each way, the yield increased as the number of stalks in the hill increased. Two stalks per hill gave 54 bushels per acre, while three stalks produced, under otherwise similar circumstances, 57 bushels. Where four stalks were left, the yield was 58 bushels. The large proportion of unmerchantable ears, or "nubbins," produced, and the increased cost of husking from four stalks per hill, however, more than counterbalanced the increase of

yield. Barring excessively dry seasons, these experiments indicate that on strong land this thick planting would be profitable when the fodder is to be fed without husking. On poor land the largest yield, 36 bushels per acre, was obtained by thinning to two stalks per hill, 3 feet, 9 inches each way. On this land four stalks per hill gave 6.6 bushels per acre less, and more than half of the crop was too small to be marketable. One stalk produced within one bushel of as much as two stalks on the poor land, and almost every ear was marketable. A single season's trial showed that when 85 per cent of a perfect stand had been obtained it was more profitable to leave it undisturbed than to either replant the missing hills or replant the entire field. Ninety-four per cent of a stand, however, gave 2.2 bushels more per acre than was obtained from 85 per cent of a stand.

5. Shallow level culture gave the largest yield each year. The gain from this method over deep tillage ranged from 2 1 to 14.3 bushels per acre or from 4 to 30 per cent. In 1890 nearly one-third more corn was produced on the shallow tilled plots than on those receiving the ordinary deep tillage. An average of the result for three years shows a gain of 9.6 bushels per acre or 17.9 per cent.

6. Tile drainage on upland clay with fair surface drainage has not thus far given sufficient increase in the yield of corn, mangels, and sugar beets to warrant the expense of tiling. Weekly moisture determinations indicate that the drained soil is slightly dryer than the undrained soil when an abundance of moisture is present, and that the reverse is

true during a drouth, the drained soil containing the most moisture. The difference does not appear to be great enough, however, to materially affect crop growth.

DETAILS OF THE TRIALS.

The soil upon which these experiments was made is a moderately fertile rolling upland clay loam from 12 to 14 inches deep, overlying a stiff retentive clay subsoil. Previous cropping—oats, clover and corn in the order named. In all cases, excepting variety tests, one-tenth acre plots (2x8 rods) were used. The variety used for the cultural experiments was a medium maturing yellow dent variety, planted in hills, forty-four inches apart each way and thinned to two stalks per hill.

TEST OF VARIETIES.

Twenty-five varieties were grown in 1892, and fifty-six in 1895, with the results shown in the following tables:

TEST OF VARIETIES—YIELD OF CORN.

	NAME.	YIELD OF CORN PER ACRE. BUSHELS.				Number of Ears Per Bu. 1895....	Days to Maturity.	Color.	Flint or Dent.
		1889	1892	1895	Av.				
1	Golden Beauty	54.0	71.7	46.7	57.4	118	122	Yellow	Dent
2	Leaming.....	46.4	69.4	54.8	56.8	98	129	"	"
3	Chester Co. Mam'oth.	59.7	61.8	45.3	55.6	126	118	"	"
4	Pride of the North..	56.0	42.5	40.6	46.3	148	110	"	"
5	Farmer's Favorite...	41.0	45.2	49.5	45.2	120	129	"	"
6	Piasa King.....	52.0	77.8	....	64.9	....	....	White	"
7	St. Charles White....	56.4	73.0	....	64.7	....	....	"	"
8	Giant White N'rm'dy	49.4	61.8	....	55.6	....	....	"	"
9	Murdock's 90 Days..	42.7	60.1	....	51.4	....	....	"	"
10	Prairie Queen.....	37.4	54.3	....	45.8	....	....	Yellow	"
11	Hickory King.....	42.2	44.7	....	43.4	....	....	White	"
12	Meyer's Prolific.....	....	....	93.8	...	86	135	"	"
13	Chester Co. Mam'oth.	....	....	80.8	....	80	129	"	"
14	McBain's White.....	....	....	78.8	....	72	139	"	"
15	Hiawatha.....	....	....	78.4	....	78	133	Yellow	"
16	McBain's Yellow....	....	....	78 3	....	72	139	"	"
17	White Pearl.....	....	....	72.2	....	82	127	White	"
18	Red Cob Ensilage....	....	70.7	....	....	....	...	"	"
19	Boone Co. White.....	....	....	67.9	....	94	129	"	"
20	Bloody Butcher.....	....	....	67.6	....	84	132	Red	"
21	Champaign's Prolific.	....	67.4	....	....	....	....	Yellow	"
22	Virginia Mammoth..	...	67.0	....	....	....	....	White	"
23	Mosby's Prolific.....	....	....	66.4	....	124	149	"	"
24	Blount's Prolific.....	....	...	66.3	....	88	126	"	"
25	Dugan's Prolific.....	....	....	65.5	....	87	128	"	"
26	Mammoth White ...	....	64.0	....	....	....	....	"	"
27	Red Dent.....	....	....	63.5	....	86	129	Red	"
28	Early Eclipse.....	....	63.1	....	....	....	....	White	"
29	Whiteside's Impr'ved	....	....	62.3	....	92	128	"	"
30	Reed's Yellow.....	....	....	58.2	....	94	129	Yellow	"
31	White Hackberry....	...	....	57.4	....	118	132	White	"
32	Stewart's Cal. Yellow	....	56.7	....	....	....	....	Yellow	"
33	Large Calico.	....	....	56.1	....	96	123	Mixed	"
34	Large White Cap....	....	....	55.1	....	126	129	White	"
35	Small Calico.....	....	....	54.9	....	116	123	Mixed	"
36	Israel's Golden.....	....	....	52.1	....	116	123	Yellow	"
37	Golden Dawn.....	....	....	52.0	....	124	122	"	"
38	Calico.....	....	....	51.3	....	90	131	Mixed	"
39	Perkin's White Dent.	....	....	51.2	....	104	130	White	"
40	Black Dent.....	....	....	50.7	....	106	129	Black	"
41	Early White Dent....	....	....	50.5	....	116	132	White	"
42	Illinois Premium....	....	....	50.1	....	126	122	Yellow	"

TEST OF VARIETIES—YIELD OF CORN. (CONTINUED.)

	NAME.	YIELD OF CORN PER ACRE. BUSHELS.				Number of Ears Per Bu 1895.	Days to Maturity.	Color.	Flint or Dent.
		1889	1892	1895	Av.				
43	Red River	....	....	49.7	....	120	131	Red	Dent
44	Edmund's Premium	....	....	49.1	...	118	123	Yellow	"
45	Clarage	....	....	48.9	....	120	122	"	"
46	Riley's Favorite	....	....	48.2	....	128	121	"	"
47	Wason	....	..	47.8	....	134	122	"	"
48	Gourd Seed	....	....	47.6	.. ..	118	123	"	"
49	Ohio Beauty	....	....	46.7	....	124	122	"	"
50	Golden Dent	....	....	45.8	....	130	123	"	"
51	Turner's White Dent	....	....	45.3	....	116	132	White	"
52	Queen of the North	....	....	45.3	....	132	120	Yellow	"
53	Early White Pearle	....	45.1	....	....	....	....	White	"
54	Legal Tender	....	...	45.0	....	132	121	Yellow	"
55	California Golden	....	....	45.0	....	144	121	"	"
56	Knott's Early	....	....	44.6	....	144	121	"	"
57	Early Select	....	....	42.2	....	142	122	"	"
58	Early Huron	....	....	40.9	....	144	119	"	"
59	Canadian Yellow	....	....	40.1	....	150	119	"	"
60	Earliest of All	....	....	39.8	....	142	121	"	"
61	Orange Pride	....	....	39.2	....	138	119	"	"
62	White Maryland	....	....	37.5	....	156	112	White	"
63	Buckeye	....	....	36.8	....	144	118	Yellow	"
64	Claud's Early	...	....	36.0	....	154	119	"	"
65	Golden Gem	....	....	34.8	....	154	115	"	"
66	Small White Cap	....	....	33.9	....	146	123	White	"
67	Wisconsin Wh't Dent	....	33.7	....	....	....	...	"	"
68	King Phillip	....	33.0	....	...	....	....	Red	Flint
69	Yellow Hackberry	....	...	32.4	....	154	115	Yellow	Dent
70	Hominy	....	....	31.9	....	174	123	White	Flint
71	Early Butler	....	31.9	....	...	....	....	Yellow	Dent
72	Large White Flint	....	29.2	...	....	....	...	White	Flint
73	Washukum Flint	....	....	25.5	....	260	115	Mixed	"
74	Golden Dew Drop	....	24.4	....	....	....	....	Yellow	"
75	Longfellow	....	24.4	....	....	....	....	"	"
76	Compton's Field	....	21.3	....	....	....	....	"	"

TEST OF VARIETIES—YIELD OF STOVER.

NAME.	YIELD OF STOVER PER ACRE. POUNDS.				Number of lbs of Stover Per Bu. of Corn....	Height of Stalk..
	1889	1892	1895	Av.		
Golden Beauty.....	3530	5510	2653	3897	67.9	7.6
Leaming	3740	3880	3308	3642	64.1	8.8
Chester Co. Mammoth.....	3600	4110	2046	3252	58.5	7.6
Pride of the North.....	3160	1840	1768	2256	48.7	7.6
Farmer's Favorite.....	2080	3828	2565	2824	62.5	7.6
Piasa King.....	3300	6450	.....	4875	75.1	.....
St. Charles White.....	3100	4680	.....	3890	60.1	.....
Giant White Normandy...	3241	5340	.....	4290	77.2	.....
Murdock's 90 Days.....	2090	4800	.....	3445	67.0	.....
Prairie Queen.....	1760	2596	.....	2178	47.6	.....
Hickory King.....	3470	4885	.....	4177	96.2	.....
Meyer's Prolific.....	.....	.....	5816	.....	62.1	9.0
Chester Co. Mammoth.....	.....	.....	3671	.....	45.4	8.6
McBain's White.....	.....	.....	4830	.....	61.3	10.4
Hiawatha.....	.....	.....	5700	.....	72.7	9 8
McBain's Yellow.....	.....	.....	5760	.....	73.6	9.0
White Pearl.....	.....	.....	4067	.....	56.3	9.0
Red Cob Ensilage.....	.....	4140	.....	.....	58.5	.....
Boone Co. White.....	.....	.....	4832	.....	71.2	8.2
Bloody Butcher.....	.....	.....	4956	.....	73.3	9.6
Champaign's Prolific.....	.....	3450	.....	.....	57.2	.....
Virginia Mammoth.....	.....	6550	.....	.....	97.8	.....
Mosby's Prolific.....	.....	.....	4800	.....	72.3	11.0
Blount's Prolific.....	.....	.....	3229	.....	48.7	9.1
Dugan's Prolific.....	.....	.....	2995	.....	45.7	9.0
Mammoth White.....	.....	6028	.....	.....	94.2	.....
Red Dent.....	.....	.....	3358	.....	52.9	8.6
Early Eclipse.....	.....	4090	.....	.....	64.8	.....
Whiteside's Improved.....	.....	.....	2818	.....	45.2	8.6
Ried's Yellow.....	.....	.....	3232	.....	55.5	9.0
White Hackberry.....	.....	.....	2877	.....	50.1	8.6
Stewart's Cal. Yellow.....	.....	3890	.....	.....	68.6	.....
Large Calico.....	.....	.....	4257	.....	75.9	10.0
Large White Cap..	.....	.....	2164	.....	39.3	7.5
Small Calico.....	.....	.....	3261	.....	59.4	7.6
Israel's Golden.....	.....	.....	2855	.....	54.8	8.0
Golden Dawn.....	.....	.....	2256	.....	43.4	7.6
Calico.....	.....	.....	3845	.....	74.9	9.2
Perkin's White Dent.....	.....	.....	3253	.....	63.5	9.0
Black Dent.....	.....	.....	2625	.....	51.8	8.0
Early White Dent.....	.....	.....	3374	.....	66.8	8.0
Illinois Premium.....	.....	.....	2515	.....	50.2	7.8

TEST OF VARIETIES—YIELD OF STOVER. (CONTINUED.)

NAME.	YIELD OF STOVER PER ACRE. POUNDS.				Number of lbs. of Stover Per Bu. of Corn.	Height of Stalk.
	1889	1892	1895	Av.		
Red River	.....	.....	3458	.....	69.6	8.8
Edmund's Premium	.....	.....	2475	.....	50.4	8.0
Clarage	.....	.....	2554	.....	52.2	7.0
Riley's Favorite	.....	.....	2396	.....	49.7	7.3
Wason	.....	.....	2494	.....	52.2	8.0
Gourd Seed	.....	.....	2160	.....	45.4	7.6
Ohio Beauty	.....	.....	2829	.....	60.6	7.2
Golden Dent	.....	.....	2402	.....	52.4	7.6
Turner's White Dent	.....	.....	2821	.....	62.3	8.6
Queen of the North	.....	.....	2313	.....	51.1	7.6
Early White Pearl	.....	3040	.....	.....	67.4	.....
Legal Tender	.....	.....	2891	.....	64.2	7.6
California Golden	.....	.....	1870	.....	41.5	7.2
Knott's Early	.....	.....	2298	.....	51.5	8.0
Early Select	.....	.....	2115	.....	50 1	7.8
Early Huron	.....	.....	1692	.....	41.4	7.6
Canadian Yellow	.....	.....	1896	.....	47.3	8.2
Earliest of All	.....	.....	1831	.....	46.0	7.0
Orange Pride	.....	.....	2026	.....	51.7	7.2
White Maryland	.....	.....	1621	.....	43.2	7.2
Buckeye	.....	.....	1874	.....	50.9	6.6
Cloud's Early	.....	.....	1585	.....	44.0	7.6
Golden Gem	.....	.....	1770	.....	50.9	7.3
Small White Cap	.....	.....	1785	.....	52.6	7.0
Wisconsin White Dent	.....	1240	.....	.....	36.8	.....
King Phillip	.....	2430	.....	.....	73.6	.....
Yellow Hackberry	.....	.....	1449	.....	44.7	6.6
Hominy	.....	.....	2600	.....	81.5	7.6
Early Butler	.....	2637	.....	.....	82.7	.....
Large White Flint	.....	2123	.....	.....	72.7	.....
Washukum Flint	.....	.....	2260	.....	88.6	6.0
Golden Dewdrop	.....	1496	.....	.....	61.3	.....
Longfellow	.....	1815	.....	.....	74.4	.....
Compton's Field Corn	.....	1540	.....	.....	72.3	.....

Between the earliest and latest varieties tested in 1895, there was a difference of thirty-seven days in the time of ripening. Dividing them into three classes with reference to the length of time required for maturity, classing those which ripened within 120 days as early maturing, those requiring 130 days as medium, and those requiring more than 130 days as late maturing varieties, the relation between the period required for growth and the yield is shown for this year:

	Av. of 12 early Varieties....	Av. of 32 medium Varieties.	Av. of 12 late Varieties....	Av. of all Varieties.....
Average yield of corn per acre, bu.....	37 9	53.0	64.1	51.7
Average yield of stover per acre, lbs....	1858.0	2792.0	4291.0	2980.0
Average height of ear, feet.....	2.9	3.7	4.5	3.7
Average height of stalk, feet.....	7.2	7.9	9.2	8.1
Average number of ears per bushel.....	155.0	117.0	98.0	123.3
Av. No. of lbs. of stover per bu of corn	50.2	53.6	66.9	56.9

The variety having the highest average yield for three years is Golden Beauty, 57.4 bushels per acre, followed by Leaming, 56.8 bushels. Both are medium maturing yellow dents.

The variety having the highest average yield for two years is Piasa King, 64.9 bushels, followed by St. Charles White, 64.7 bushels—both of which are late maturing white dents.

The variety producing the highest yield in 1895 is Meyer's Prolific, 93.8 bushels, followed in order named by Chester County Mammoth, 80.8 bushels; McBain's White, 78.8 bushels; Hiawatha, 78.4 bushels, and McBain's Yellow, 78.3 bushels. Meyer's Prolific and McBain's White are late white varieties, Chester County Mammoth is a medium white, and Hiawatha and McBain's Yellow are late yellow varieties.

TEST OF MANURES FOR CORN.

The purpose of this experiment was to compare different methods of preparing, preserving and applying barnyard manures; to compare the value of solid and liquid manures from cattle; the comparative value of the dung from horses and cattle. The manures were applied in 1889 and 1891 as indicated in the table of yields below. In 1890 the residual effect of the previous manuring was measured.

In all seasons a yellow dent variety of corn was used, planted in rows 40 inches apart, with the plants 7 inches apart in the row. Unless otherwise stated the manure was plowed under.

The fermented and unfermented manures were secured from the same source and in the same manner. Both lots were sheltered, but fermentation in one lot was encouraged as much as possible by having it piled loosely and frequently forked over. The unfermented lot was kept in a compact heap, the surface of which was practically sealed with soft dung. In this lot no perceptible fermentation occurred, while in the other a very high heat was developed, accompanied with rapid decomposition.

In the comparison of combined solid and liquid manure with solid manure alone, the excreta of the same animals were used. In the case of the solid and liquid combined, care was taken to collect all the urine excreted and to thoroughly mix it with the solid dung. No bedding was used. When the solid manure alone was used care was taken to secure the dung without the urine. The same weight of each, viz: 2,000 pounds, was used. In both cases the manures were hauled directly to the field and spread.

In the comparison of methods of applying manure exactly similar material was used. That turned under was applied just before plowing and that applied on the surface was spread after the land had been fully prepared for seeding.

The horse manure represents the dropping from work

horses consuming a liberal quantity of corn, oats and timothy hay. The cattle manure with which it is compared was from stall-fed steers and cows consuming about eight pounds of grain, equal parts by weight of corn meal and wheat bran and all the clover hay and corn stover they would eat.

RESULTS.

In 1889 and 1890 the crop was field-cured and the weight of the cured stalks and ears together was taken. In 1891 the corn was field-cured and husked and the weight of the corn and stover (stalks without ears) was taken separately. The yield of stalks and ears combined is shown in the table, however, to make possible an average for the three years:

KIND OF MANURE.	1889 *Fodder Per Acre Lbs.	1890 *Fodder Per Acre Lbs.	1891 *Fodder Per Acre Lbs.	Average for Three Years.
Fermented manure 10 tons per acre	7800	5750	7385	6978
Unfermented manure 10 tons per acre	6210	6150	7060	6473
No manure	5250	4490	4242	4661
Sol'd and liquid manure 10 tons per acre	8200	5630	7350	7060
Solid manure alone 10 tons per acre	7520	5360	6415	6432
Horse manure 10 tons per acre	9220	6700	7405	7775
Cattle manure 10 tons per acre	9080	5500	7140	7240
No manure	5090	4590	5570	5083
Cattle manure applied on the surface	5420	.....	5920	5670
Cattle manure harrowed in	5560	.....	5645	5602
Average of 2 unmanured plots	5170	4540	4906	4872
Average of 8 manured plots	7376	5848	6790	6654
Pounds gain from manuring	2206	1308	1884	1782
Per cent. gain from manuring	42.7	28.8	38.4	36.6

*By Fodder is meant the whole plant, ears, stalks, blades, etc.

Expressing the results for 1891 in bushels of corn and pounds of stover per acre we have the following exhibit:

KIND OF MANURE.	Corn Per Acre Bus.	Stover Per Acre Lbs.
Fermented manure 10 tons per acre	51.9	3425
Unfermented manure 10 tons per acre	51 2	3800
No manure	25.9	2250
No manure	27.6	2490
Solid and liquid manure combined 10 tons per acre	51.7	3730
Solid manure alone 10 tons per acre	53.5	2670
Horse manure 10 tons per acre	56.6	3445
Cattle manure 10 tons per acre	51 0	3570
No manure	38.8	2855
Cattle manure applied on surface	43.3	2885
Cattle manure harrowed in	39.1	2910
Average of 3 unmanured plots	30.8	2532
Average of 8 manured plots	49.8	3304
Bushels gain from manuring	19.0	772
Per cent. gain from manuring	61.7	30.5

The most important fact brought out by this trial is the value of barnyard manure. It should be remembered that the land upon which these trials were made is above the average of the State in fertility. Barn yard manure applied at the rate of ten tons per acre (less than ten loads) gave an average increase in ears and stover in 1889 of 42.7 per cent. over the unmanured plots. In 1890, without further manuring the plots previously manured gave more than one-fourth larger yields than tne unmanured land. In 1891, from another application of manure, a gain of more than one-third was obtained. In this year the yield of corn was increased 19 bushels per acre, or 61.7 per cent. over the unmanured ground.

The difference between the yields from fermented and unfermented manures is so slight as to be within the limit of error in plot experimentation.

Ten tons of combined solid and liquid manure gave

larger total yields each year than were obtained from an equal weight of solid manure, although in 1891 more corn was grown on the plot receiving the solid manure.

Horse manure proved more productive each year than an equal weight of cattle manure, the difference amounting to 7.4 per cent. as the average of three years. In 1891, the gain in corn per acre was 5.6 bushels per acre, or 11 per cent.

PREPARATION FOR PLANTING.

Several methods of preparing the land for planting to corn were under trial during these years.

One plot 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 entirely inverted and well pulverized. In preparing another plot the same plow was made to cut about 16 inches to the required depth, leaving about one-fourth of the soil in place and practically undisturbed—a system of plowing in vogue in some sections of Missouri in preparing land for oats and known in the parlance of the farmer as "cutting and covering." Adjoining this plot was one of similar soil which was planted without any preparation whatever. The plot was marked off and the seed deposited in holes dug with a hoe.

In 1890 and 1891 two more plots were added to the set. One was pulverized to a depth of from two to three inches with a disc harrow. The other to a slightly greater depth with a common springtooth harrow. All plots were planted alike, at the same time, and given clean, level shallow cultivation.

The results for the three seasons are given separately in the subjoined tables:

PREPARATION FOR PLANTING.

TREATMENT.	1889		1890		1891		Average.	
	Yield of corn per acre, Bu's.....	Yield of stover per acre, Lbs..	Yield of corn per acre, Bu's.....	Yield of stover per acre, Lbs..	Yieldof corn per acre, Bu's.....	Yield of stover per acre, Lbs...	Yield of corn per acre, Bu's.....	Yield of stover per acre, Lbs..
Thoroughly plowed.....	39.4	3020	31.1	1690	41.4	2940	**37.3**	**2550**
Partially plowed.....	41.3	3180	32.9	1690	37.9	2965	**37.4**	**2612**
Not plowed.....	43.3	2650	28.7	1490	30.1	2725	**34 0**	**2288**
Ordinary plowing.....	41.3	3060	33.1	1630	33.1	2745	**35.8**	**2478**
Surface cut with disc harrow.....	....	....	24.0	1410	30.6	2550	**27.3**	**1980**
Surface cut with spring tooth harrow.....	..	....	27.3	1630	32.6	2755	**29.9**	**2192**
*Deep plowing (av. of 2 plots).....	....	....	41.1	1870	44.7	3640	**42.9**	**2755**
†Shallow plowing (av. of 2 plots).....	....	....	46.0	2000	49.2	3855	**47.6**	**2927**

*Nine inches deep.
†Four and a half inches deep.

In 1889 the plot having no preparation for planting gave a higher yield of ears than any of the plowed plots, the difference ranging from two to four bushels per acre.

In 1890 the treatment of all plots being the same as in the previous year the unplowed plot showed a smaller yield than those receiving tillage before being planted. The difference that year amounted to from three to five bushels per acre.

The season of 1891 showed a further decline in the yield of the unplowed plot as compared with the others of the experiment, the difference running as high as eleven bushels per acre. Averaging all years the difference in favor of plowing before planting amounts to about 3.4 bushels per acre. Practically no advantage on the average

was found from thorough plowing over the less thorough plowing.

These results do not warrant the conclusion that tillage before planting corn stubble will not, on the average, sufficiently increase the yield to meet the expense of that tillage. On the other hand it appears that the yield of the thoroughly plowed plot steadily increased in yield in comparison with those but partially prepared, while the yield of the plot planted without plowing steadily declined in comparison with the others. In the third year the difference between the unplowed and the thoroughly plowed plots was 11.3 bushels per acre.

Again it is well known that in excessively wet seasons *very* thorough tillage, to a depth of eight inches, is likely to prove a detriment on land having poor under drainage. For several weeks during the early part of the season of 1889 the ground was almost constantly saturated, with the result that the corn plants on the thoroughly prepared land made little or no growth, lost color, and apparently suffered materially. The plants on the plot having no preparation, however, grew vigorously during this time and maintained a rich, healthy color. This was less marked on the plot having partial preparation. There was no perceptible difference in the surface drainage of the plots.

In times of drought, however, the order is reversed. The latter part of the season of 1891 was too dry for the best development of the corn plant. During this time the plants on the plot without preparation fired or dried and ripened while those on the well prepared land kept green and continued to grow.

The comparatively low yields obtained from land prepared with the disc and spring tooth harrows instead of the turning plow do not indicate that this is likely to be a profitable practice.

In the test of deep and shallow breaking the plots plowed four and one-half inches deep gave uniformly better yields than those plowed nine inches deep. The difference

amounts to 4.7 bushels per acre as the average of two seasons test on duplicate plots. So many factors enter into this problem that additional trials will be necessary before it is finally settled.

SUB-SOILING.

Recent experiments at the *Nebraska Station have shown quite clearly the benefits from sub-soiling, not only for the season in which it is done, but for one or more years thereafter.

These results have awakened a general interest in the subject and numerous inquiries are received from the farmers of different sections of the State concerning the advisability of adopting this method of preparing land for corn, potatoes, etc.

It has already been tried quite extensively in many localities in Missouri with unfavorable results in most cases. It has been urged that these failures were due to the poor underdrainage of our clay soils and that sub-soiling would prove especially efficacious on soils having an outlet for the surplus water in times of excessive rainfall. With a view to determining the correctness of this claim, four one-tenth acre plots of upland clay loam of more than average fertility were carefully tile drained in 1888. The plots are 33 feet wide and through the center of each was laid a line of 3-inch drain tile 32 inches deep connecting with a 5-inch main. The plots have good surface drainage also.

In 1889, plots 1 and 3 of the group were sub-soiled by following the breaking plow, which was run at a depth of seven inches, with a subsoil plow run to a depth of five inches, stirring the soil to a depth of twelve inches. By this process the subsoil is neither inverted nor brought to the surface, but is thoroughly stirred. Plots 2 and 4 were plowed in a similar manner except that they were not sub-soiled.

* Nebraska Experiment Station Bulletin, 43.

The entire group was grown in Improved American Rutabagas.

In 1890, the same plots were subsoiled in the same way but to the depth of eight inches, thus stirring the soil fifteen inches instead of twelve inches, as in the previous year. Cuban Queen Corn was grown on all plots.

In 1891, the same plots were subsoiled to the same depth as in 1890, and all plots planted to French Sugar Beets.

The results are given for the three seasons in the following table:

TREATMENT.	1889	1890—CORN.		1891
	Rutabagas Yield Per Acre Lbs.	Ears, Yield Per Acre. Bu's.....	Stover Yield Per Acre Lbs.	Sugar Beets Yield Per Acre Lbs.
Subsoiled	22000	57.3	2830	13565
Not subsoiled.....	25965	57.3	2190	13320
Subsoiled	24950	55.0	2110	12465
Not subsoiled.....	22930	55.5	2090	12880
Average of subsoiled.....	23475	56.1	2470	13015
Average of unsubsoiled.....	24447	56.4	2140	13100
Gain from subsoiling	.....	....	**230**	.....
Loss from subsoiling	**972**	**.3**	....	**85**

It appears from these results that sub-soiling was accompanied with a loss each year. It may be safely asserted that no returns were obtained from the extra labor and expense involved.

RATE OF SEEDING.

During the three seasons eleven one-tenth acre plots were devoted to a study of the best thickness of planting, and the best distribution of the seed. In 1891, the trial was duplicated on poor land to ascertain whether the fertility of the soil was a factor in determining the best thickness of planting. The trial also enables us to compare the effect of distributing the seed in hills and in drills.

The detailed results are shown in the following table:

RATE OF SEEDING.	1889.			1890.			1891. Rich Land.			1891. Poor Land.			AVERAGE.		
	Yield of Corn Per Acre. Bu's.	Yield of Stover Per Acre. Lbs.	Per Cent. Small Corn.	Yield of Corn Per Acre. Bu's.	Yield of Stover Per Acre. Lbs.	Per Cent. Small Corn.	Yield of Corn Per Acre. Bu's.	Yield of Stover Per Acre. Lbs.	Per Cent. Small Corn.	Yield of Corn Per Acre. Bu's.	Yield of Stover Per Acre. Lbs.	Per Cent. Small Corn.	**Yield of Corn Per Acre. Bu's.**	**Yield of Stover Per Acre. Lbs.**	**Per Cent. Small Corn.**
Hills 45x45, 1 gr	....	......	...	....	......	....	40.4	3390	11	28.9	1640	8	**34.6**	**2515**	**9**
" 2 gr	73 5	3460	10	49.5	2340	9	56.6	4010	16	36.6	3000	14	**54.0**	**3202**	**12**
" 3 gr	80.0	3970	9	58.0	2680	10	61.9	4715	23	31.0	3380	37	**57.7**	**3686**	**20**
" 4 gr	78.0	4330	11	57.4	3310	23	70.4	6095	26	30.0	4000	52	**58 9**	**4434**	**28**
Hills 45x22½, 1 gr	58.0	3230	8	47.2	2100	14	58.1	4965	8	34.5	2900	23	**49.5**	**3299**	**13**
" 1½ gr	65.2	4030	14	51.7	2620	11	65.4	5270	21	36.9	3680	39	**54.8**	**3900**	**21**
" 2 gr	58.6	3410	22	53.7	3210	29	54.8	5790	42	32.7	2765	56	**49.9**	**3794**	**37**
Hills 45x15, 1 gr	48.0	3240	15	50.8	2460	21	62.8	4830	17	37.0	......	33	**49.7**	**3510**	**21**
" 1½ gr	43.6	3910	47	38.0	2840	71	50.6	6235	57	32.9	4750	59	**41.3**	**4434**	**58**
" 2 gr	29.0	4475	54	33.9	3490	88	30.9	7155	76	21.1	4830	66	**28.7**	**4987**	**71**

It appears on the average for three years that when planted in hills 3 feet 9 inches apart each way the yield increases as the number of grains in the hill is increased. Two grains per hill gave 54 bushels of corn per acre, while three grains produced under otherwise similar circumstances 57 bushels. When four grains were left in the hill the yield was 58.9 bushels.

The most striking fact brought out in the table is the influence the fertility of the soil exerts upon the yield from different rates of seeding. On good land the largest yield was secured from leaving four stalks in a hill 3 feet 9 inches apart each way, giving a yield of 70.4 bushels per acre. On poor land the largest yield, 36.0 bushels, was gotten from thinning to two stalks per hill. On this land four stalks gave 6.6 bushels per acre less and more than half of this yield was unmerchantable corn or nubbins. One stalk in the hill lacked but one bushel per acre of producing as large a crop as four stalks on the poor land and almost every ear was of merchantable size.

In all cases the thicker the planting the larger the yield of stover and the greater the proportion of nubbins. Where the corn is grown for market it would be unprofitable to leave four stalks per hill since nearly one-fourth of the yield was nubbins. The expense of husking would be very much increased and the amount of merchantable corn would be slightly less than when three grains were planted per hill. If the ears and stalks are to be fed together either as ensilage or cured fodder, it appears that the thicker planting will give the largest return on good land in the average season.

INFLUENCE OF STAND.

It is often a question when a reasonably good stand has been gotten, whether it will pay to replant the missing hills. In case of poor stands whether it would not be better to plant the field again. These points were put to test in 1891 with the follwoing results:

TREATMENT.	Good ears per plot. Lbs.	Nubbins per plot. Lbs.	Corn per acre. Bu's	Stover per acre. Lbs.
85 per cent of stand—undisturbed	336	37	53.3	3435
85 per cent of stand, *replanted	316	46	51.8	4090
Entire plot planted anew	217	72	41.3	4120
94 per cent of stand—undisturbed	337	51	55.5	3635

*Missing hills replanted.

The results of this season seem to indicate that 85 per cent. of a perfect stand or 15 stalks missing out of 100, will give a better crop when left alone than when planted over or than when the missing hills and stalks are replanted. It will be seen, however, that 94 per cent. of a perfect stand gave 55.5 bushels of corn, and 3635 pounds of stover, while 85 per cent. of a perfect stand gave only 53.3 bushels, and 3435 pounds of stover per acre—a difference in favor of the more perfect stand of 2.2 bushels of corn and 200 pounds of stover.

CULTIVATION.

A number of experiments relating mainly to the depth of cultivation were carried on during the three years.

Deep and Shallow Culture.—To determine which of these two methods of tillage produced the largest yield, and under which system the moisture of the soil is best con-

served, the following experiment has been carried through three seasons:

TREATMENT.	1889.		1890.		1891.		AV.	
	Corn Per Acre Bu's.	Stover Per Acre Lbs.	Corn Per Acre Bu's.	Stover Per Acre Lbs.	Corn Per Acre Bu's.	Stover Per Acre Lbs.	Corn Per Acre Bu's.	Stover Per Acre Lbs.
Deep tillage	66.2	3240	46.8	2020	53.6	3570	55.5	2943
Shallow tillage	76.2	3560	51.1	2340	54.3	3570	60.5	3156
Deep tillage	65.5	3220	35.7	1630	53.8	3495	51.7	2782
Shallow tillage	84.0	4280	56.6	2070	57.3	3660	65.9	3337
Average deep tillage	65.8	3230	41.2	1825	53.7	3532	53.6	2862
Average shallow tillage	80.1	3920	53.8	2205	55.8	3615	63.2	3247
Gain from shallow tillage bushels	**14.3**	....	**12.6**	....	**2.1**	....	**9 6**	**385**
Gain from shallow tillage per cent	**21.7**	....	**30.6**	....	**4.0**	....	**17.9**	....

The deep tilling in these trials was done with the ordinary walking cultivator run four times at a depth of five or six inches. In the first cultivations the narrow shovels or bull tongues were used; afterwards the ordinary shovels. Care was taken to avoid as much as possible ridging or hilling.

The shallow tilling was done with an implement designed by Professor Sanborn and made by a local blacksmith. It is a modification of the principle of the Tower Cultivator, with a number of narrow knives running an inch or more beneath 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.

It will be observed that in every case shallow tillage

gave the largest yield. The gain from this method ranged from 2.1 to 14.3 bushels per acre, or from 4 to 30.6 per cent. In 1890, nearly one-third more corn was produced on the plots tilled shallow than on those receiving the ordinary deep tillage.

An average of the three years work shows a gain of 9.6 bushels per acre or 17.9 per cent. These results are corroborated by similar trials at the Experiment Stations in Illinois, Utah, Ohio, Pennsylvania, New York, and other States, besides the confirmation given shallow tillage by a large number of experienced and successful corn growers in Missouri.

EFFECT OF TILE DRAINAGE.

It is believed by many agriculturists that drainage would be especially beneficial on the stiff retentive clay soils of Missouri, even though they have reasonably good surface drainage.

To ascertain the correctness of this view, six one-tenth acre plots, with fair surface drainage, were devoted to a test of the value of tile drainage for our soil. Three were underdrained with three-inch tile, and three were left undrained. The two sets are separated by a plot not in the trial to avoid the influence of drainage upon the first of the undrained plots.

These plots 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 of the drained group 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; in 1890, Cuban Queen corn, in rows three feet nine inches apart each way with three plants in a hill; in 1891, sugar beets were grown in rows 18 inches apart, thinned to one plant every 9 inches in the row.

The yields of the different plots for the three years were as follows:

TREATMENT.	1889	1890—CORN		1891
	Mangels. yield per acre. Lbs	Grain per acre. Bu's	Stover per acre. Lbs.	Sugar beets per acre. Lbs.
Drained.....	20400	55.5	2260	9915
Drained.....	19940	51.3	1760	9090
Drained.....	18480	56.2	1920	9985
Undrained.....	18660	59.0	1920	10210
Undrained.....	16740	59.0	1890	9080
Undrained.....	16160	56.0	1690	8570
Average of Drained....	**19540**	**54.3**	**1966**	**9663**
Average of Undrained.	**17180**	**58.0**	**1833**	**9286**
Gained from Drainage.	**2360**	.....	**133**	**357**
Loss from Drainage.....	.....	**3.7**	.....	.....

In 1889 the drained plots gave 2360 pounds of mangels per acre, or 13.7 per cent more than did the undrained land. In 1890 the results were reversed with corn, when the undrained land gave the highest yield by 3.7 bushels per acre or 7 per cent. In 1891 when sugar beets were grown the gain from drainage amounted to but 377 pounds per acre or 4 per cent. The average gain from drainage per year for the three years is approximately 3.5 per cent. The gains thus far obtained are not sufficient to indicate the advisability of draining this class of lands.

Effect of Drainage on Soil Moisture.—During the growing seasons of 1890 and 1891 samples of the soil of each plot in this experiment were drawn each week for the determination of moisture.

Method of Sampling.—On the same day of each week five sub-samples from equally distributed points in each plot were taken to the depth of one foot by digging a pit fifteen inches deep with one perpendicular wall. With a sharp spade a slice or section the width of the spade one inch thick was cut from this wall and a section one inch wide was cut from this slice. Each of the five subsamples from each plot were therefore inch columns one foot long. They were immediately enclosed in dry glass jars sealed and delivered to the chemical laboratory. These subsamples were carefully mixed before the final sample for drying was drawn. That portion of the soil stirred by tillage was taken in all cases as a part of the sample.

Weekly samples were taken in 1890 for eleven weeks, from May 27 to August 6 inclusive, with the following results:

*MOISTURE IN DRAINED AND UNDRAINED SOIL. 1890.

DATE OF SAMPLING.	Water in Drained Soil Per Cent.	Water in Undrained Soil Per Cent.	Rainfall for Week. Inches.
May 27	22.930	22.720	1.79
June 3	20.580	20.530	.00
June 18	21.296	20.445	†2.05
June 25	20.228	18.875	1.35
July 9	14.237	15.170	†.42
July 17	19.367	19.048	2.09
July 24	20.565	20.756	2.46
July 31	16.721	15.106	.00
August 6	12.161	13.201	.12
Average	18.565	18.428	.93

*In 1890 the moisture was not determined in the soil of the separate plots.

†Two weeks.

The results for this season do not appear to follow any rule. It is probable that the differences in the individual plots or the errors in sampling were greater than the differ-

ence in water contents due to drainage or lack of drainage.

In 1891, weekly samples were drawn from each plot, for twenty-two weeks, from April 24 to October 2nd, beginning before the land was plowed and continuing until the beets were mature, with the results shown in the table below:

TABLE SHOWING PER CENT. OF MOISTURE IN SOIL TO DEPTH OF ONE FOOT.

DATE OF SAMPLING 1891.	DRAINED.				UNDRAINED.				Rain fall of week ending on date of Sampling
	Plot 88 Per Cent. Water	Plot 89 Per Cent. Water	Plot 90 Per Cent. Water	**Average of Drained Plots.**	Plot 92 Per Cent. Water	Plot 93 Per Cent. Water	Plot 94 Per Cent. Water	**Average of Undrained Plots.**	
April 24...	25.20	25.45	25.70	**25 45**	27.08	26.20	27.06	**26.78**	1.47
May 1.....	21.02	22.33	22.42	**21.92**	23.25	23.54	18.45	**21.75**	....
May 8.....	21.95	22.30	21.72	**21.99**	23.26	23.97	23.06	**23.43**	2.62
May 15....	.....	19.75	20.26	**20.00**	22.13	21.75	22.19	**22.02**	.27
May 22...	18.82	20.06	19.57	**19 48**	20.49	20.66	20.43	**20.53**	.64
May 29....	30.63	20.91	20.67	**20.74**	21.31	21.63	21.35	**21.43**	.71
June 5....	21.91	22.96	22.12	**22.33**	23.28	22.60	23.06	**22.98**	2.55
June 12...	22.80	23.43	22.75	**22.99**	22.85	22.80	22.75	**22.80**	1.08
June 26...	21.40	21.68	22.24	**21.77**	22.59	20.86	21.14	**21.53**	1.95
July 4....	22.57	22.01	21.59	**22.06**	22.78	22 08	21.01	**21 96**	1.21
July 11....	22.27	21.97	21.44	**21.89**	22.43	21.95	21.60	**21.99**	1.73
July 18....	19.81	20.96	19.46	**20.11**	20.85	22.16	20.93	**21 31**	.32
July 24....	20.13	20.88	19.19	**20.07**	19.58	20.47	20.20	**20.08**	.55
July 31....	19.02	20.62	18.93	**19.52**	19.68	21.25	18.43	**19.78**	1.60
August 7..	17.38	17.52	17.01	**17.30**	19.18	19.27	17.83	**18.76**	.42
August 14	22.63	22.75	22.59	**22.66**	23.68	23.12	22.92	**23.24**	.81
August 28	19.51	20.06	19.31	**19.63**	20.11	20.51	18.96	**19.86**	4.22
Sept. 4.....	16.54	16.91	18.14	**17.19**	17.84	18.58	15.33	**17.25**	.12
Sept. 15....	14.64	13.33	13.56	**13.84**	13.43	12.73	11.02	**12.39**	....
Sept. 18....	10.44	11.85	9.80	**10.69**	10.58	11.00	8.34	**9 97**	.07
Sept. 25....	9.89	9.08	9.11	**9.36**	8.40	8.62	8.26	**8.43**	....
October 2..	9.66	9.93	9.03	**9.54**	9.07	8.75	8.52	**8.78**	.34
Average ..	18.96	19.40	18.90	**19.11**	19.72	19.75	18.81	**19.41**	1.03

Averaging all plots of each set for the season there is practically no difference in the water content. The drained soil contained an average of 19.11 per cent. for the season, and the undrained soil showed an average of 19.41 per cent. an absolute difference of but .3 per cent. and a relative difference of 1.5 per cent.

Assuming that all plots receiving the same treatment contained the same amount of moisture and that the differences in water content of different plots in the same group are due to errors in sampling (which is not likely to have been wholly true) the maximum error in sampling amounts to 5.09 per cent. or a relative difference of 21.6 per cent. Had such discrepencies been of frequent occurrence the results would be worthless, but it will be observed that the maximum average error assumed to be due to the incorrectness of the samples is only .94 per cent. or a relative difference of 4.7 per cent.

While there is practically no difference shown in the water content of the drained and undrained soils, when the determinations of the entire season are averaged a close scrutiny of the detailed results clearly indicates that drainage did exert some influence on the soil moisture. They clearly show that the drained plots contained slightly *less* moisture than did the undrained ones when the water content was 20 per cent. or more and that they contained *more* moisture than the undrained plots when the water content fell below 15 per cent. During the first 18 weeks of these observations the water content was above 17 per cent. in both groups of plots and in 14 weeks it was above 20 per cent. Comparing the two groups for this period, extending from April 24 to September 4, the drained land shows an average of 20.95 per cent. of water and the undrained 21.53 per cent., an absolute difference of .58 per cent and a relative difference of 2.77 per cent. compared with a relative difference of 1.5 per cent. for the entire season. During the remaining four weeks of these observations almost no rain fell and there was a marked decline in the water content of

the soil. In this period, however, the undrained plots showed *less* moisture than the drained plots instead of more as in the preceding period. The average per cent. of water during the four weeks was: For drained soil 10.86 and for undrained soil 9.89, an absolute difference of .95 per cent. and a relative difference of 9.6 per cent.

It is manifest that these differences, however interesting they may be, had no appreciable effect upon the yield of the crops grown.

At no time was the difference great enough to be appreciable even to the closest observer, and the drained soil was not dry enough to cultivate appreciably earlier than was the undrained land.