SECOND ANNUAL REPORT

OF THE

EXPERIMENT STATION,

KANSAS STATE AGRICULTURAL COLLEGE.

MANHATTAN, KANSAS.

FOR THE YEAR 1889.

TOPEKA.
KANSAS PUBLISHING HOUSE: CLIFFORD C. BAKER, STATE PRINTER.
1890.

BOARD OF REGENTS.

HON. T. P. MOORE, *President,* Holton, Jackson Co.
HON. JOSHUA WHEELER, *Vice-President,* Nortonville, Jefferson Co.
HON. JNO. E. HESSIN, *Treasurer and Loan Commissioner,* Manhattan, Riley Co.
HON. THOMAS HENSHALL, Kansas City, Wyandotte Co.
HON. A. P. FORSYTH, Liberty, Montgomery Co.
HON. MORGAN CARAWAY, Great Bend, Barton Co.
PRES. GEO. T. FAIRCHILD, *(ex officio) Secretary.*

I. D. GRAHAM, *Assistant Secretary,* Manhattan.

COUNCIL OF THE STATION.

GEO. T. FAIRCHILD, A. M., CHAIRMAN, *President of the College.*
*E. M. SHELTON, M. Sc., DIRECTOR, *Professor of Agriculture.*
GEO. H. FAILYER, M. Sc., *Professor of Chemistry.*
E. A. POPENOE, A. M., *Professor of Horticulture and Entomology.*
W. A. KELLERMAN, PH. D., *Professor of Botany.*
———— ————, *Professor of Veterinary Science.*

I. D. GRAHAM, B. Sc, *Secretary.*

ASSISTANTS.

H. M. COTTRELL, M. Sc., *Agriculture.*
J. T. WILLARD, M. Sc., *Chemistry.*
F. A. MABLATT, B. Sc., *Entomology.*
WM. SHELTON, *Foreman Farm.*
S. C. MASON, *Foreman Gardens.*
W. T. SWINGLE, *Botany.*

The Station may be addressed at Manhattan, Kansas.

* Resigned January 1, 1890. C. C. Georgeson, M. Sc., installed Professor of Agriculture at this date.

KANSAS STATE AGRICULTURAL COLLEGE,
MANHATTAN, KAS., January 31, 1890.

To His Excellency Governor L. U. HUMPHREY:

DEAR SIR — I herewith transmit, as required by act of Congress approved March 7th, 1887, the second annual report of the Experiment Station of the Kansas Agricultural College, for the year 1889, including the financial statement to June 30, 1889.

Respectfully yours,

GEO. T. FAIRCHILD,
Secretary Board of Regents.

TABLE OF CONTENTS.

FINANCIAL STATEMENT.

REPORT OF THE TREASURER.

To the Board of Regents of the Kansas State Agriculturul College:

GENTLEMEN — Herewith is submitted my report of receipts and expenditures, on account of the Experiment Station, for the fiscal year ending June 30, 1889.

Received from the Treasurer of the United States.	$15,000
Paid approved vouchers, Nos. 1 to 322	15,000

Respectfully submitted. JOHN E. HESSIN, *Treasurer.*

MANHATTAN, KAS., July 1, 1889.

REPORT OF THE DIRECTOR.

To the Board of Regents of the Kansas State Agricultural College:

GENTLEMEN—The following statement of the financial affairs of the Experiment Station of the Kansas State Agricultural College, for the fiscal year ending June 30, 1889, is respectfully submitted.

The several items of the account herewith submitted are all covered by vouchers, which in every case have been approved by the disbursing officer, certified by the Director, and allowed by the President of the Board of Regents. The statement is made from the account of the Assistant Secretary of the Board, kept in an independent set of books, as provided in the act of Congress organizing the Experiment Station. Duplicate vouchers, covering every item of expense incurred during the year, are on file in the office of the Secretary of the College.

DE.

To appropriation for the year ending June 30, 1889, under act of Congress approved March 2, 1887	$15,000 00

CR.

June 30, By Salaries	$10,985 00
Labor	400 37
Apparatus	1,767 74
Supplies	551 60
Printing.	808 17

June 30, By Stationery	$132 35
Postage	14 29
Library	24 09
Traveling expenses	39 55
Freight	154 72
Building repairs	115 87
Photographs	3 25
Naming insects	3 00
Total	$15,000 00

Respectfully submitted. E. M. SHELTON, *Director*.

We, the Finance Committee of the Board of Regents of the Kansas State Agricultural College, having duly examined vouchers Nos. 1 to 322, for $15,000 received and expended on account of the Experiment Station during the fiscal year ending June 30, 1889, and having diligently compared the same with the books of the Secretary, hereby certify both books and vouchers to be correct according to the statements furnished by the Treasurer and the Director.

Respectfully submitted.

THOS. HENSHALL,
JOSHUA WHEELER,
MORGAN CARAWAY,
Committee.

REPORT OF THE COUNCIL.

To the Board of Regents of the Kansas State Agricultural College:

GENTLEMEN—We herewith present for your consideration and publication the Second Annual Report of the Kansas Experiment Station, covering in detail all general operations for the year 1889, and the statement of accounts to the close of the fiscal year ending June 30, 1889.

The organization of the Council has remained the same as in the previous year, except that the chair of Veterinary Science has been vacant since the resignation of Prof. R. F. Burleigh, August 31st. On the resignation of Prof. E. M. Shelton, December 31st, 1889, to accept the position of Instructor in Agriculture under the Government of Queensland, Australia, the office of Director is by act of the Board of Regents abolished, and the clerical duties heretofore connected with that office are given to the Assistant Secretary of the Board in the following terms:

"The Assistant Secretary of the Board of Regent shall be Secretary of the Council, whose duties shall be to keep the records of all meetings, receive and maintain all general correspondence with the Station, attend to the publication and distribution of all reports and bulletins under direction of the Council, certify to all bills and keep accounts of the same."

Hereafter, therefore, the above-named duties will be performed by Secretary I. D. Graham, B. Sc., while the Agricultural Department of the Station is in charge of Prof. C. C. Georgeson, M.Sc., successor to Prof. Shelton in the chair of Agriculture.

The efficient corps of assistants in the several departments has been changed but slightly. Mr. C. L. Marlatt, M.Sc., having resigned in January, 1889, to take a position in the Division of Entomology of the U. S. Department of Agriculture at Washington, Mr. F. A. Marlatt, B. Sc., has taken up the work in entomology with commendable earnestness and devotion.

The regular meetings of the Council have been held weekly during term time, and at convenient intervals during the summer vacation. Full consideration has been given to every experiment undertaken by any Department, and all expenditures have been made after estimates approved by the Council and allowed by the Board of Regents. The accounts kept by the Assistant Secretary of the Board have been submitted with the vouchers at each quarterly meeting of the Regents, and fully audited.

The first annual report, presented according to law to the Governor of the State on the 31st day of January, 1889, and immediately thereafter placed in the hands of the Gee. W. Crane Publishing Company for printing, was, on the morning of February 22d, entirely destroyed by fire. It became necessary to reproduce the copy for the printers, which labor, together with hindrances caused by the same fire in the work of the printers, delayed the issue until July. Three thousand copies have been as carefully distributed as possible, but the number is not sufficient to meet the demand of farmers in the State. It seems proper to call attention to the fact that several States have provided for printing the reports of their stations in large editions, for wide distribution. If this State is to reap the full benefit of Station work, some means for extended distribution of the reports will be needed beyond what the funds of the Station will allow.

Four bulletins, as the law requires, have been issued during the year, and seven thousand copies of each distributed. These are numbered and paged consecutively with those of last year, and bear the following titles: No. 6, “Silos and Ensilage;” No. 7, “Experiments with Wheat;” No. 8, “Preliminary Report on Smut in Oats;” No. 9, “ Experiment in Pig-Feeding.” The subject-matter of these bulletins is embodied in the reports of the several Departments presented herewith.

The Council have been gratified in the kindly appreciation of the Station work as exhibited in the reception given the report and bulletins, both within and without the State. The Secretary of the State Board of Agriculture, Hon. Martin Mohler, has aided materially by giving extended circulation to several of the bulletins through reprinting them in the monthly or quarterly reports of the Board of Agriculture. The Station is also under obligations to him for facilities afforded for printing its own issue of the same bulletins.

The several reports of the Departments of Agriculture, Chemistry, Horticulture and Entomology, and Botany, include full data of completed experiments, with brief reference to those still in progress. No report from the Veterinary Department appears, for the reason that up to the time when the chair of Physiology and Veterinary Science was vacated no experiments had been completed, and the general health of stock throughout the State had afforded almost no peculiar cases for investigation.

In the work of the Station, the Professors of Agriculture, Chemistry, Horticulture and Botany, have occupied fully one-half their time and energies, receiving one-half their salaries from the Station fund. The assistants in all departments, with the exception of Mr. Swingle, Assistant in Botany, have been paid entirely from the Station funds, and, with slight exceptions offset by other workers, have given their whole time to the Station. Mr. Swingle has, during the present College year, given all of his time in vacations and two-thirds of each day during term-time to the Station, receiving wages according to the time given. It is believed that the results show valuable returns for all the time employed.

In conclusion, the Council wish to express their conviction that the work of the Station is taking a larger place from year to year in the agricultural interests of the State. The plans for continued experiment are more extensive, and still more definite, while matters of detail are more successfully managed. They are satisfied that the consultations of the Council are an assistance to the several heads of departments in devising and explaining their work.

To this report we append a list of donations to the Station, and hereby express thanks to those who have thus favored the Station.

Respectfully submitted.

GEO. T. FAIRCHILD.
E. M. SHELTON.
GEO. H. FAILYER.
E. A. POPENOE.
W. A. KELLERMAN.

COLLEGE, December 31, 1889.

REPORT OF THE FARM DEPARTMENT.

E. M. SHELTON, M. Sc., *Professor of Agriculture.*
H. M. COTTRELL, *Assistant in Agriculture.*
WM. SHELTON, *Foreman of Farm.*

The work of the Department for the year has been directed along lines as indicated below:

Corn— Varieties and methods of planting, cultivating, and harvesting.
Wheat— Varieties, fertilizers, and methods of cultivation.
Forage Plants— Sorghums (saccharine and non-saccharine), millets, oats, etc.
Silos, and feeding value of silage.
Pig-feeding— To show influence of foods on character of growth.
Pig-feeding— To test stock from mature and undeveloped parents.
Steer-feeding— To show the cost of growth. (This experiment has not been completed.)

EXPERIMENTS WITH CORN.

TEST OF VARIETIES.

Sixty-five varieties of corn were grown on the College farm in 1889. The varieties planted for ensilage are described under the head of "Forage Crops." Forty-seven varieties planted for yield of grain were grown in field 2. The soil in this field is a sandy loam, "second bottom," uniform in character and surface. The land has been in cultivation many years, and produced a crop of millet in 1888. It was plowed in November, 1888, and thoroughly harrowed both with spring-toothed and smoothing harrows in the spring before the corn was planted. The field was marked off in rows 3½ feet apart and four rows given to each variety. The length of rows used in this trial was 155.57 feet; each variety, therefore, occupied one-twentieth of an acre. The corn was planted April 18, 1889, with a one-horse corn drill. The planting was made too early in the season, germination was slow owing to cold weather, and a poor stand was secured of many varieties. This was especially noticeable of those varieties grown in the South. Wherever a poor stand occurred the spot was replanted and a perfect stand was secured in this way of all varieties. May 12th the first good rain of the season fell. Before this time the growth of the corn had not been thrifty, being checked by frosts the first week in May and by dry weather. After this date all varieties grew without check until ripe. The corn was cultivated three times during the season. After cultivating once all varieties were thinned out to a uniform stand of 9 stalks per each 12 feet of row in all the varieties. Some of the varieties would undoubtedly have given a better yield if planted closer, while others would have yielded more if the stalks had been farther apart. It was difficult to determine just what distance would be the best for each variety, and it was thought best, all things considered, to plant all varieties alike. The season was very favorable to the growth of corn; rain fell whenever needed and in sufficient quantities. The corn was husked October 1st to 12th, and the weight of each variety taken. The product of each variety was then stored in a small bin by itself, where it was kept dry and given free ventilation. December 10th the corn was re-weighed. At this date the ears of all the varieties were thoroughly dry. The shrinkage from husking until December 10th varied greatly with the variety. The greatest shrinkage was with the Conscience, amounting to 30 per cent.; while 12 of the early varieties did not show any shrinkage at all. The yield in the following table is calculated on the weight of the dry corn December 10th. The date given in the column “When ripe” is the date when the husks became dry, the kernels hard, and the leaves beginning to turn but still green enough to be cut for fodder.

VARIETIES OF CORN.

Number of plat.	Varieties.	Time of germinating, days.	Per cent. of stand.	When in tassel.	When in milk.	When ripe.	Height of stalk, feet.	Height of ear from ground, feet.	Yield of plat, ear corn, lbs.	Yield per acre, ear corn, bu.	Per cent. of nubbins.	Weight shelled corn in 1 bu. (70 lbs.) ear corn, lbs.
	White.											
1	Beard's Pearl White	9	75	July 5	July 25	Aug. 24	8½	4½	218	62	39	60.2
2	Conscience	14	47	" 17	Aug. 12	Sept. 12	11	6	227	65	24½	60.2
3	Cook's	11	70	" 2	July 22	Aug. 24	9	4	245	70	18	58.1
4	Cranberry White	10	84	" 7	" 23	" 30	9	4½	226	65	29	60.2
5	Champion White Pearl	11	72	" 1	" 22	" 30	9	4½	250	71	28	60.9
6	Early White Dawn	10	78	June 30	" 16	" 22	7½	3½	230	66	30	60.2
7	Hickory King	13	53	July 15	Aug. 8	Sept. 3	11	5	267	76	26½	63
8	Johnson's Mammoth Early White	15	32	" 10	July 31	Aug. 30	9	4½	214	61	31	60.2
9	Mason's Flour	12	62	" 3	" 19	" 23	8	3¾	238	68	36	57.4
10	Mammoth White	14	53	" 5	" 27	" 25	9	4	272	78	30½	58.1
11	Mosby's Prolific	13	54	" 17	Aug. 8	Sept. 10	12	6½	354	101	28½	61.6
12	Maryland White	12	75	" 12	July 30	Aug. 30	10	5	278	79	27½	57.4
13	Normandy Giant	12	70	" 12	Aug. 1	Sept. 3	10½	5½	406	116	12½	57.4
14	Naylor's Improved	13	62	" 10	July 27	Aug. 25	9½	5	335	96	33	60.9
15	Pride of the South	12	75	" 18	Aug. 5	Sept. 5	11	6	225	64	24	60.9
16	Parrish White	13	67	" 16	" 5	Sept. 5	11	6½	307	88	35	59.5

17	Piasa King	11	69	July 16	Aug. 5	Sept. 10	10½	6	269	77	30	61.6
18	Shannon's Big Tennessee White	14	49	" 16	" 5	" 5	11	6	246	70	31	58.8
19	St. Charles	12	71	" 14	July 31	" 3	10	5½	342	98	31	59.5
20	Wisconsin White	10	80	June 27	" 15	Aug. 12	7	2¾	167	48	40	58.8
	RED OR MIXED.											
21	Calico King	13	59	July 16	Aug. 5	Sept. 1	11	6	307	88	29	59.5
22	Brown Beauty	10	76	" 8	July 22	Aug. 30	10	4½	271	77	36½	60.9
23	Piasa Pet	13	64	" 16	Aug. 5	Sept. 5	11	6½	358	102	17	60.2
24	King Philip	11	79	" 8	July 22	Aug. 22	9	4½	254	73	23½	58.8
25	Red Dent	12	74	" 12	" 25	" 27	10	5	379	108	28½	57.4
	YELLOW.											
26	Big Buckeye	11	71	July 6	July 23	Aug. 22	10	5	240	69	38	58.8
27	Clarage Yellow	11	73	June 29	" 20	" 20	9½	4½	192	55	34	58.8
28	Chester County Mammoth	13	61	July 5	" 24	" 28	9	4½	211	60	34	60.2
29	Early Golden Lenawee	14	59	June 24	" 15	" 10	7	2½	129	37	44	58.8
30	Early Yellow Hathaway	10	65	June 25	" 16	" 12	8	3	181	52	45½	58.8
31	Early California	10	90	July 1	" 22	" 24	9¾	5	284	81	24	60.2
32	Eclipse	11	90	" 5	" 22	" 24	10	5	247	71	34½	61.6
33	Farmer's Favorite Golden Dent	15	75	" 10	" 30	Sept. 3	10½	5	225	64	26½	58.8
34	Glick's Yellow	14	76	" 5	" 25	Aug. 28	10	5	246	70	30	58.1
35	Golden Beauty	15	47	" 6	" 25	" 28	9½	5	241	69	37	58.1
36	Leaming	11	86	" 7	" 22	" 22	9	4½	244	70	20	59.5
37	King of the Earliest	10	93	June 25	" 16	" 15	7	2¾	133	38	55	60.9

VARIETIES OF CORN — CONCLUDED.

Number of plat	VARIETIES.	Time of germinating, days	Per cent. of stand	When in tassel.	When in milk.	When ripe.	Height of stalk, feet	Height of ear from ground, feet	Yield of plat, ear corn, lbs.	Yield per acre, ear corn, bu.	Per cent. of nubbins	Weight shelled corn in 1 bu. (70 lbs.) ear corn, lbs.
38	Mammoth Cuban	10	90	July 5	July 19	Aug. 22	8½	4	243	69	21½	59.5
39	Murdock's 90 Day	10	86	" 7	" 23	" 24	10¼	5⅛	273	78	18	60.2
40	North Star	10	90	June 24	" 15	" 10	6½	2¾	116	33	44½	60.9
41	Prairie King	11	84	July 3	" 17	" 22	9	4½	231	66	25	59.5
42	Pride of the North	11	84	June 25	" 16	" 12	7	2¾	113	32	48	60.9
43	Piasa Queen	13	83	July 12	Aug. 5	Sept. 1	10	5½	249	71	22	59.5
44	Riley's Favorite	11	86	" 3	July 18	Aug. 20	9½	4½	221	63	37	60.2
45	Shannon's Big Tennessee Yellow	13	64	" 16	Aug. 5	Sept. 10	11	6½	241	69	29½	59.5
46	Woodworth's Yellow	12	71	June 26	July 17	Aug. 12	8	3	142	41	34	57.4
47	College Yellow	12	73	July 11	" 25	" 28	9½	4¾	252	72	20	59.5

Seed for the above plats obtained from the following sources:

Plats 17, 21, 22, 23, 32 and 43 from E. P. Kellenberger, Godfrey, Ill.
Plats 1, 6, 10, 26 and 27 from A. W. Livingston's Sons, Columbus, Ohio,
Plats 7, 13, 36, 40 and 42 from F. Barteldes & Co., Lawrence, Kas.
Plats 4, 16, 20 and 46 from J. C. Vaughan, Chicago, Ill.
Plats 8, 15, 18 and 45 of M. W. Johnson Seed Co., Atlanta, Ga.
Plats 31, 37, 38 and 44 of Jas. W. Bouk, Greenwood, Neb.
Plats 28, 33 and 35 of Peter Henderson & Co., New York.
Plats 24, 25 and 47 of Farm Department, College.
Plats 29 and 30 of D. M. Ferry & Co., Detroit, Mich.
Plats 19 and 39 of Plant Seed Co., St. Louis.
Plats 11 and 14 of W. S. Dept. of Agriculture.
Plat 34 of Hon. G. W. Glick, Atchison, Kas.
Plat 41 of Trumbull, Reynolds & Allen, Kansas City.
Plat 12 of J. M. Thorburn & Co., New York.
Plat 9 of J. B. Quimby, Wakefield, Kas.
Plat 5 of J. C. Suffern, Voorhies, Ill.
Plat 3 of W. S. Delano, Lee Park, Neb.
Plat 2 of Alexander Drug & Seed Co., Augusta, Ga.

The table shows that the per cent. of stand secured with the different varieties varied greatly. King of the Earliest showed the highest germination — 93 percent.; Johnson's Mammoth Early White, the lowest, only 32 per cent. of the kernels planted germinating. As has been previously explained, the blank places were replanted, and a perfect stand secured of all the varieties. This is the only advantage that the corn in this trial had over field corn as ordinarily grown, and the large yields secured with some of the varieties must be considered as due solely to the season and the variety. For convenience, two systems of classification of varieties will be used in discussing the results shown by this experiment—one as to color of kernel, and the other as to time of maturity. The following table shows the more important variations shown by the varieties when grouped under these classes:

	Yield per acre, bushels	Time required in germination, days	Per cent. of stand	Height of stalk, feet	Height of ear from ground, feet	Per cent. of nubbins
Average of white varieties	76	12	65	10	5	29
Average of red and mixed varieties	90	12	70	10	5	27
Average of yellow varieties	60	12	77	9	4.5	33
Average of early-maturing varieties	55	10.9	78	8	3.6	36
Average of medium-maturing varieties	74½	11.9	70	9	4.6	33
Average of late-maturing varieties	82	12.9	59	11	5.9	26

This table shows that the average yield of the yellow varieties was the lowest; the average of the white varieties came next in order, and the average of the red and mixed varieties is the greatest. Many of the white varieties were from Southern seed, and not adapted to this climate. The average of the white varieties tested that are adapted to this locality was greater than that of the red and mixed sorts. Another season may change the relative positions of these three classes. There is a marked difference between the groups when classed according to time of maturity. The average yield of the medium-maturing varieties was more than 9 per cent. less, and that of the early-maturing varieties 33 per cent. less than the average yield of the late varieties. The time required in germination by the medium-maturing varieties was 1 day more and that required by the late varieties 2 days more than the time required by the early varieties. The per cent., of stand was the highest with the early varieties and lowest with the late varieties. Other interesting facts are brought out by the table, but do not require discussion.

VALUE OF VARIETIES.

In considering the value of the different varieties, it must be remembered that the remarks apply only to results obtained this year. Future trials may change the estimate made of some of the varieties. *The figures following the name of a variety indicate the yield per acre in bushels of that variety.* The first varieties to mature were the Early Golden Lenawee 37 and North Star 33, both ripe August 10th. They were followed two days later by Early Yellow Hathaway 52, Wisconsin White Dent 48, Woodworth's Yellow 41 and Pride of the North 32, and five days later by King of the Earliest 38. Riley's Favorite 63 and Clarage Yellow 55 ripened 10 days after North Star. King Philip (College) 73, Leaming 70, Big Buckeye 69, Mammoth Cuban 69, Early White Dawn 66, and Prairie King 66, were ripe 12 days after North Star, and Mason's Flour 68, 13 days. The average yield per acre of the Lenawee and North Star is 35 bushels, of the varieties ripening 2 days later 43 bushels, 10 days later 59 bushels, and 12 days later 69 bushels per acre. A very few days added to the growth of an early variety gives a considerable increase in the yield. In general it may be stated that it is the most profitable to plant the largest latest-maturing variety that will give a sure crop in the locality where grown. Each farmer must decide whether an early, medium or late-maturing sort best fills this requirement on his own farm. The value placed upon the varieties given above has been determined chiefly by the yield of grain. The habits of growth of Mason's Flour corn make it a very desirable variety for fodder where an early-maturing sort is wanted. Its stalks are slender and very leafy, the leaves extending nearly to the ground. It will bear thick planting, and in most seasons could be planted as a second crop after wheat.

The medium-maturing varieties taken in the order of yield are: Naylor's Improved 96, Early California 81, Maryland White 79, Mammoth White 78, Murdock's 78, Brown Beauty 77, Champion White Pearl 71, Eclipse 71, Cook's 70, Glick's Yellow 70, Golden Beauty 69, and Chester Co. Mammoth 60. From our experience this year we would place the value of these varieties very nearly in the order named. Early California is especially adapted for fodder where a medium-maturing sort is desired. It grows to a fair height, with slender, leafy stalks.

The following are the most valuable late varieties tested: Normandy Giant 116, Piasa Pet 102, Mosby's Prolific 101, St. Charles 98, Parrish White 88, Calico King 88, Piasa King 77, Hickory King 76, and Piasa Queen 71. All these kinds are valuable and well worth planting. To this list may be added Farmer's Favorite 64. This variety is not a heavy yielder, but the corn is very good in quality, large, long ears with few nubbins, and it does well on poor soils and in dry seasons.

SELECTION OF EARS FOR SEED.

If a considerable number of ears of any variety of Dent corn be examined, it will be noticed that a variable number of rows of kernels are found on ears even of the same variety. The number of rows on different ears varies from 12 to 40; the usual number is from 12 to 20, on medium-sized varieties. For several years a medium-sized yellow Dent variety of corn has been planted for the main crop on the College Farm. The number of rows per ear varies from 12 to 22. In the spring of 1889 a number of choice ears of each of these variations in this variety were selected, and seed from these different-rowed ears planted in adjoining plats in field B. There were 4 rows in each plat, the rows 40 rods long. The plats were cultivated four times, all plats being treated exactly alike. At husking-time 115 feet in length along each plat was measured off and the corn husked for examination, with the results as given in the table.

No. of plat.	Number rows on ears used for seed in planting plat.	Yield of plat.			Yield per acre.		
		Good ears, lbs.	Nubbins, lbs.	Total yield, lbs.	Good ears, bu.	Nubbins, bushels.	Total yield, bu.
1....	12-rowed ears..........	162½	52	214½	62.8	20.1	82.9
2....	14-rowed ears..........	128	49	177	49.5	18.9	68.4
3....	16-rowed ears..........	132½	62	194½	51.2	24.0	75.2
4....	18-rowed ears..........	143	41	184	55.3	15.9	71.2
5....	20-rowed ears..........	134	78	212	51.8	30.1	81.9
6....	22-rowed ears..........	72	73	145	27.8	28.2	56

Most of the ears from plat 1 were 12-rowed The ears were long and slender, and very distinct in size and shape from the ears grown on the other plats. The ears from plats 2 to 5 were alike in shape, being thick and rather short. They varied on all these plats from 12 to 22 rows per ear. The ears from plat 6 were short, poorly filled out at tip, and mostly nubbins. As will be seen in the table, the 12-rowed ears gave the highest yield per acre, and the 22-rowed ears the lowest yield. Further trial will be necessary to determine whether this rule is constant or only accidental, varying with the soil and season. The fact remains, however, that there is a considerable difference in the yield from seed of the different-rowed ears of the same variety of corn. It would be an easy matter for any farmer when planting corn to make a trial of this kind with his own variety of corn, and the results of the trial given above seem to show that such a test would be well worth the trouble.

DISTANCE TO PLANT CORN.

The first question that arises in planting corn, after the ground is prepared, is, what distance should there be between the rows, and how far apart should the stalks stand in the rows? A variation in these two particulars makes a vast difference in the yield of corn obtained; but what these distances should be has not been determined by accurate experiment. The proper distances to plant corn, both between the rows and between the stalks, will probably vary considerably with the character of the soil and the variety of corn planted. The trial herein detailed was made on a clay-loam upland of moderate fertility. The field has been in cultivation for several years, and the area selected for this experiment has never been manured. This kind of soil and the cropping without manure are both conditions common to Kansas farms, and the land was selected for this reason. The variety of corn planted was a medium-sized yellow Dent, described under trial of varieties as College Yellow. The accompanying plan of the experiment will need but little explanation.

PLAN OF EXPERIMENT.

	No. of row.	LENGTH OF ROWS 150 FEET. Distance between stalks in row.
ROWS $2\frac{1}{2}$ FEET APART.	34	16 inches.
	33	12 inches.
	32	8 inches.
	31	4 inches.
	30	16 inches.
	29	12 inches.
	28	8 inches.
	27	4 inches.
	26	16 inches.
	25	12 inches.
	24	8 inches.
	23	4 inches.
	22	Odd row.
ROWS 3 FEET APART.	21	16 inches.
	20	12 inches.
	19	8 inches.
	18	4 inches.
	17	16 inches.
	16	12 inches.
	15	8 inches.
	14	4 inches.
	13	16 inches.
	12	12 inches.
	11	8 inches.
	10	4 inches.
	9	Odd row.
ROWS $3\frac{1}{2}$ FEET APART.	8	16 inches.
	7	12 inches.
	6	8 inches.
	5	4 inches.
	4	16 inches.
	3	12 inches.
	2	8 inches.
	1	4 inches.

The corn was planted so as to test the effect of varying the distance between the rows and the stalks in the row. To accomplish this object the rows were laid out in three series, the rows of the first series 3½ feet apart, the rows of the second series 3 feet apart, and the rows of the third series 2½ feet apart. The stalks in the first row of each series were 4 inches apart, in the second row 8 inches apart, in the third row 12 inches apart, and in the fourth row 16 inches apart; this arrangement of distances between stalks repeated for all the rows of each series. Where two series of rows joined, an "odd row" occurred that was nearer to the adjoining row on one side than it was on the other. The yield of these "odd rows" is not given in the tables. The land selected for this experiment was in ensilage corn, in 1888. It was plowed in November, 1888, and thoroughly harrowed in the spring. The corn was planted April 25,1889, with a one-horse corn drill, set to drop a kernel every 2 inches or less. After cultivating the corn once, the stalks were thinned out so that they stood at the exact distances apart shown in the plan. The corn was cultivated three times. All the rows were cut September 11, and each row shocked by itself. The corn was husked October 26, and the weight of corn and fodder of each row taken. It would require too much space to give the yield of each row separately in the table, but the average yield of all rows planted alike in each series is given, and a summary of the yield of all plats.

No. of rows planted	TREATMENT.	AVERAGE YIELD OF ROW.				AVERAGE YIELD PER ACRE.			
		Sound ears, lbs.	Nubbins, lbs.	Total yield corn, lbs.	Fodder, lbs.	Sound ears, bu.	Nubbins, bu.	Total yield corn, bu.	Fodder, tons.
	ROWS 3½ FEET APART.								
2	Stalks 4 inches apart in row	8.75	53	61.75	75	10.37	62.80	73.17	3.12
2	Stalks 8 inches apart in row	19.75	36	55.75	51.5	23.4	48.59	71.99	2.14
2	Stalks 12 inches apart in row	36.25	26	62.25	42	42.95	30.82	73.77	1.75
2	Stalks 16 inches apart in row	27.25	21.5	48.75	36.5	32.28	25.48	57.76	1.52
	ROWS 3 FEET APART.								
3	Stalks 4 inches apart in row	5.67	43.00	48.67	79	7.84	59.47	67.31	3.82
3	Stalks 8 inches apart in row	5.33	33.67	39.00	51	7.38	46.56	53.94	2.47
3	Stalks 12 inches apart in row	18.17	18.33	36.50	36.7	25.13	25.35	50.48	1.77
3	Stalks 16 inches apart in row	13.50	17.33	30.83	29.33	18.67	24.06	42.73	1.42
	ROWS 2½ FEET APART.								
3	Stalks 4 inches apart in row	2.67	29.50	32.17	67.67	4.43	48.94	53.37	3.93
3	Stalks 8 inches apart in row	2.50	21.17	23.67	47.0	4.15	35.33	39.48	2.22
3	Stalks 12 inches apart in row	7.67	21.33	29.00	28.0	12.72	35.39	48.11	1.61
3	Stalks 16 inches apart in row	8.50	16.17	24.67	23.33	14.10	30.69	44.79	1.35

SUMMARY.

No. of rows used	TREATMENT.	YIELD OF ROW. Sound ears, lbs.	YIELD OF ROW. Nubbins, lbs.	YIELD OF ROW. Total yield corn, lbs.	YIELD OF ROW. Fodder, lbs.	YIELD PER ACRE. Sound ears, bu.	YIELD PER ACRE. Nubbins, bu.	YIELD PER ACRE. Total yield corn, bu.	YIELD PER ACRE. Fodder, tons.
2...	Rows 3½ ft. apart, stalks 4 in. apart in row....	8.75	53.00	61.75	75.00	10.37	62.80	73.17	3.12
3...	Rows 3 ft. apart, stalks 4 in. apart in row.....	5.67	43.00	48.67	79.00	7.84	59.47	67.31	3.82
3...	Rows 2½ ft. apart, stalks 4 in. apart in row....	2.67	29.50	32.17	67.67	4.43	48.94	53.37	3.93
2...	Rows 3½ ft. apart, stalks 8 in. apart in row....	19.75	36.00	55.75	51.50	23.40	48.59	71.99	2.14
3...	Rows 3 ft. apart, stalks 8 in. apart in row.....	5.33	33.67	39.00	51.00	7.38	46.56	53.94	2.47
3...	Rows 2½ ft. apart, stalks 8 in. apart in row....	2.50	21.17	23.67	47.00	4.15	35.33	39.48	2.22
2...	Rows 3½ ft. apart, stalks 12 in. apart in row...	36.25	26.00	62.25	42.00	42.95	30.82	73.77	1.75
3...	Rows 3 ft. apart, stalks 12 in. apart in row....	18.17	18.33	36.50	36.70	25.13	25.35	50.48	1.77
3...	Rows 2½ ft. apart, stalks 12 in. apart in row...	7.67	21.33	29.00	28.00	12.72	35.39	48.11	1.61
2...	Rows 3½ ft. apart, stalks 16 in. apart in row...	27.25	21.50	48.75	36.50	32.28	25.48	57.76	1.52
3...	Rows 3 ft. apart, stalks 16 in. apart in row....	13.50	17.33	30.83	29.33	18.67	24.06	42.73	1.42
3...	Rows 2½ ft. apart, stalks 16 in. apart in row...	8.50	16.17	24.67	23.33	14.10	30.69	44.79	1.32

An inspection of the above tables shows that the greatest total yield of corn and fodder was obtained when the stalks stood 4 inches apart in rows 3½ feet apart. The yield on these rows was, omitting unimportant fractions, 73 bushels of corn and 3 tons of fodder per acre, but only 14 1/3 per cent. of the corn was of marketable size. The largest yield of corn from any distance of planting was 73.77 bushels per acre, raised on rows 3½ feet apart with stalks 12 inches apart in the rows; 58 per cent. of the ears from this planting were marketable corn. The season was favorable to close planting, as sufficient rain fell whenever needed, but the land was of poor quality. The usual practice on the College farm, based on years of general observation, has been to plant corn in rows 3½ feet apart with stalks 16 inches apart in the rows; but we have made no accurate experiments heretofore to determine the proper distance. The table shows that the highest yield of fodder, 3.93 tons, was raised on rows 2½ feet apart, stalks 4 inches apart in rows.

Where grain alone is desired, the wider planting will always give the greatest yield of marketable corn. The yield of fodder from the rows with stalks 4 inches apart was more than double the yield from the rows with stalks 12 or 16 inches apart, while its value for feed was much more than twice that of the fodder from the wide planting.

The valuable portion of the feed when corn is cut for fodder is contained in the leaves and ears; the stalk is worthless. Thick planting checks the rank growth of stalks, and increases the value of the fodder by increasing the proportion of leaves and grain. The ears from the thick planting are small and easily eaten by cattle, without needing to be broken, crushed, or ground. Corn-fodder from corn grown in this way should always be fed without husking. A further discussion of the value of close-planted corn for feed will be given in the experiment of Harvesting for Corn and Fodder.

LISTING AND SURFACE PLANTING.

A test of the value of these methods of planting corn was made in field D. The soil is a clay loam upland of moderate fertility, and the area selected has a very considerable slope to the south, so much fall in fact as to make a severe test of listing from washing. The field was in corn the previous year. Eight plats were laid off, each plat 395 feet long and 14 feet wide. Alternate plats, beginning with plat 1, were plowed, harrowed, and marked off in rows 3½ feet apart, and the corn planted with a one-horse drill. The even-numbered plats were planted with a 14-inch lister in rows 3½ feet apart. The lister was run midway between the rows of corn grown the previous year. This method of listing is generally known as "splitting the rows." A medium-sized variety of yellow Dent corn was used, and single kernels dropped 16 inches apart in the rows on all plats. May 24 and 31, and June 18, all plats were cultivated with a two-horse cultivator, and the corn given level cultivation. The corn from all the plats was husked October 21, 1889, with the results as given in the following table:

No. of plat.	METHOD OF PLANTING.	Yield of plat, ear-corn, lbs.	Yield per acre, ear-corn, bu.
1....	Surface	705	79.3
2....	Listed	770	86.6
3...	Surface	780	87.8
4....	Listed	790	88.9
5....	Surface	775	87.2
6....	Listed	805	90.6
7....	Surface	785	88.3
8....	Listed	825	90.8

SUMMARY.

No. of plats.	METHOD OF PLANTING.	Average yield of plat, ear-corn, lbs.	Average yield per acre, ear-corn, bu.
1, 3, 5, 7..	Surface	761¼	85.65
2, 4, 6, 8..	Listed	797½	89.22

The table shows a small gain in yield for the listed corn; the average of all the plats showing a gain of 3.57 bushels per acre in favor of planting with the lister —a gain of 4.16 per cent. The season has been very favorable to surface-planting, as the rainfall has been abundant. In 1888, with an insufficient rainfall, the listed corn showed a gain of nearly 15 per cent. over surface-planted. The increase in yield does not represent the whole gain made by planting corn with a lister. The labor and time required to plant an area with corn are greatly lessened by this method. Listed corn stands drouth much better than surface-planted, and requires less cultivation. Listed corn does not blow down nearly as much in the fall when subjected to heavy winds as does surface-planted.

METHODS OF CULTIVATING CORN.

To aid in determining how much cultivation is profitable in raising a crop of corn, an experiment was undertaken in field B. Twelve plats were laid off, each plat 530 feet long and 24 feet wide. There were 7 rows to a plat. The corn was planted April 19 with a one-horse corn drill, set to drop a kernel every 20 inches. Plats 1 to 5 were planted with yellow corn, and plats 6 to 12 with the St. Charles white corn. The arrangement of plats and the method of cultivation adopted for each plat is shown in the table.

All plats were cultivated May 25 with a two-horse cultivator. The plats receiving ordinary cultivation were cultivated June 4, 15 and 27 with a two-horse cultivator. In the last cultivation, the cultivator was set to run deep and "hill up" the corn as much as possible. The plats receiving surface cultivation were cultivated June 4, 15 and 27 with Tower's surface cultivator, an implement so constructed as to pulverize the surface of the ground but working only to a depth of 2 to 3 inches.

The plats receiving excessive cultivation were cultivated June 4, 15, 26 and July 6 with a one-horse, five-toothed cultivator, set to run shallow.

No. of plat	TREATMENT.	Yield of plat, ear-corn, lbs.	Yield per acre, ear-corn, bus.
1	Ordinary cultivation	1,115	74.71
2	Surface cultivation	1,000	67.10
3	Excessive cultivation	842	56.50
4	Ordinary cultivation	975	65.42
5	Surface cultivation	965	64.75
6	Excessive cultivation	1,010	67.77
7	Ordinary cultivation	1,035	69.45
8	Surface cultivation	995	66.76
9	Excessive cultivation	1,055	70.79
10	Ordinary cultivation	1,095	73.47
11	Surface cultivation	1,155	77.50
12	Excessive cultivation	1,350	90.59

SUMMARY.

Number of plats.	TREATMENT.	Yield of plat, ear-corn, lbs.	Yield per acre, ear-corn, bus.
1, 4, 7, 10	Ordinary cultivation	1,055	70.76
2, 5, 8, 11	Surface cultivation	1,028¾	69.03
3, 6, 9, 12	Excessive cultivation	1,064¼	71.41

The summary shows that there was but little difference in the yield obtained from the corn having different methods of treatment. Practically the same results have been obtained in similar experiments tried in many different seasons, and also in the general experience on the College farm. Moderate cultivation, such as will keep the ground free from weeds, seems to be all that is required by the corn plant when grown on good soil in an ordinary season. The general experience seems to show that a greater amount of tillage may be profitable in a dry season or on poor land.

HARVESTING FOR FODDER AND CORN.

In 1888 a series of experiments were made to test the effect both on yield of fodder and corn of harvesting the crop at different stages of growth.* The trials were made with several varieties of corn, and in two different soils, and every test showed a remarkable loss in cutting corn before the ear was hard and the leaves beginning to turn. This trial of the effect of cutting corn at different stages of growth was repeated in 1889, with slight modifications of plan only. Four varieties of Dent corn were planted, side by side, in field D, April 27, 1889. There were 16 rows planted to each variety except Brown Beauty, of which only 15 rows were planted. The plan of cutting adopted was as follows: Row 1 of each variety was cut while the grain was in the milk, row 2 while the grain was in the dough, row 3 when the grain was hard, the husk dry, but the leaves yet green. This is the usual stage for cutting fodder in this State. It is the stage called ripe, in the table. Row 4 was left standing. This arrangement of cuttings repeated for the 16 rows of each variety. The corn was shocked as soon as cut. The rows were 310 feet long and 3 1/2 feet apart. The corn on all the rows was husked and the product of each row weighed separately, October 19, as shown in the table.

DATE OF CUTTING.	CONDITION OF GRAIN.	NO. OF ROW	YIELD OF PLAT, LBS.				YIELD PER ACRE.			
			Good ears	Nubbins	Total corn	Fodder	Good ears, bushels	Nubbins, bushels	Total corn, bushels	Fodder, tons
CALICO KING.										
Aug. 21,	Thick milk,	1	.....	54½	54½	125	....	32.29	32.29	2.59
		5	11	53½	64½	123	6.52	31.70	38.22	2.57
		9	.....	51	51	127	....	30.22	30.22	2.63
		13	15½	40½	56	65	9.18	24.00	33.18	1.35
Aug. 28,	Dough.....	2	23½	58	81½	170	13.92	34.37	48.29	3.52
		6	24	52	76	110	14.22	30.81	45.03	2.28
		10	31	51½	82½	127	18.37	30.51	48.88	2.63
		14	24	53½	77½	125	14.22	31.70	45.92	2.59

*See First Annual Report Kansas Exp. Sta., pp. 42-54.

DATE OF CUTTING.	CONDITION OF GRAIN.	NO. OF ROW	YIELD OF PLAT, LBS. Good ears	Nubbins	Total corn	Fodder	YIELD PER ACRE. Good ears, bushels	Nubbins, bushels	Total corn, bushels	Fodder, tons
			CALICO KING — *concluded.*							
Sept. 4,	Ripe	3	Lost.	Lost.	Lost	Lost.	Lost.	Lost.	Lost.	Lost.
		7	54	44½	98½	195	32.00	26.37	58.37	4.04
		11	38½	54	92½	130	22.81	32.00	54.81	2.69
		15	35	59½	94½	110	20.74	35.25	55.99	2.28
Not cut,	Ripe	4	76	29	105	.....	45.03	17.18	62.21	.....
		8	85	40	125	.....	50.36	23.70	74.06	.....
		12	97	22	119	.....	57.47	13.04	70.51	.....
		16	75½	28½	104	.....	44.73	16.89	73.77	.....
			PIASA PET.							
Aug. 21,	Thick milk,	1	2	63	65	100	1.19	37.33	38.52	2.07
		5	.....	55½	55½	125	....	32.88	32.88	2.59
		9	.....	61	61	95	....	36.14	36.14	1.97
		13	10	71	81	173	5.93	42.07	48.00	3.58
Aug. 28,	Dough	2	26	70½	96½	150	15.41	41.77	57.18	3.10
		6	8½	68	76½	125	5.04	40.29	45.33	2.59
		10	14	77½	91½	120	8.30	45.92	54.22	2.48
		14	34½	77	111½	145	20.44	45.62	66.06	3.00
Sept. 5,	Ripe	3	52	56½	108½	115	30.81	33.48	64.29	2.38
		7	21	99	120	140	12.44	58.66	71.10	2.90
		11	45	56	101	100	26.66	33.18	59.84	2.07
		15	62	60	122	170	36.74	35.55	72.29	3.52
Not cut,	Ripe	4	118	25	143	.....	69.92	14.81	84.73	.....
		8	96	45½	141½	.....	56.88	26.96	83.84	.....
		12	65½	34	99½	.....	38.81	20.15	58.96	.....
		16	127	38½	165½	.....	75.25	22.81	98.06	.....

DATE OF CUTTING.	CONDITION OF GRAIN.	NO. OF ROW.	YIELD OF PLAT, LBS. Good ears	Nubbins	Total corn	Fodder	YIELD PER ACRE. Good ears, bushels	Nubbins, bushels	Total corn, bushels	Fodder, tons
BROWN BEAUTY.										
Aug. 21,	Thick milk,	1	36½	34	70½	90	21.63	20.15	41.78	1.86
		5	56	36	92½	85	33.18	21.33	54.51	1.76
		9	47½	45½	93	75	28.14	26.96	55.10	1.55
		13	34	39½	73½	90	20.15	23.41	43.26	1.86
Aug. 28,	Hard dough,	2	65	26½	91½	105	38.51	15.70	54.21	2.17
		6	67½	23½	91	103	39.90	13.92	53.82	2.13
		10	72	34	106	95	42.66	20.15	62.81	1.97
		14	58½	17½	76	75	34.37	10.37	44.74	1.55
Sept. 4,	Ripe	3	79	16	95	90	46.81	9.48	56.29	1.86
		7	85	22	107	95	50.36	13.04	63.40	1.97
		11	86	21	107	80	50.96	12.44	63.40	1.66
		15	72½	12½	85	83	42.96	7.41	50.37	1.72
Not cut,	Ripe	4	77	15½	92½	.....	45.62	9.18	54.80	.....
		8	84	18	102	.....	49.77	10.67	60.44	.....
		12	90	16	106	.....	53.33	9.48	62.81	.....
PIASA QUEEN.										
Aug. 21,	Thick milk,	1	11½	75½	87	120	6.81	44.73	51.54	2.48
		5	6	77½	83½	105	3.56	45.92	49.48	2.17
		9	4½	74½	79	85	2.67	44.14	46.81	1.76
		13	6	82	88	90	3.56	48.59	52.15	1.86
Aug. 28,	Dough.....	2	67½	45½	113	105	39.99	26.96	66.95	2.17
		6	42	40	82	80	24.89	23.70	48.59	1.66
		10	55½	58	113½	105	32.88	34.37	67.25	2.17
		14	40	80	120	90	23.70	47.40	71.10	1.86

DATE OF CUTTING.	CONDITION OF GRAIN.	NO. OF ROW.	YIELD OF PLAT, LBS.				YIELD PER ACRE.			
			Good ears	Nubbins	Total corn	Fodder	Good ears, bushels	Nubbins, bushels	Total corn, bushels	Fodder, tons
			PIASA QUEEN — *concluded.*							
Sept. 5,	Ripe	3	90½	34	124½	120	53.62	20.15	73.77	2.48
		7	103	35	138	135	61.03	20.74	81.77	2.79
		11	87	34½	121½	90	51.55	20.44	71.99	1.86
		15	70½	55	125½	110	41.77	32.59	77.62	2.28
Not cut,	Ripe	4	116	15	131	.....	68.73	8.89	77.62	.....
		8	122	18	140	.....	72.29	10.67	82.96	.....
		12	110	20½	130½	.....	65.18	12.15	77.33	.....
		16	105	25	130	.....	62.51	14.81	77.32	.....

SUMMARY.

No. of rows used.	VARIETIES.	CONDITION OF GRAIN.	AVERAGE YIELD PER ACRE.			
			Good ears, bushels	Nubbins, bushels	Total corn, bushels	Fodder, tons
4	Calico King	Milk	3.93	29.80	33.48	2.29
4	Calico King	Dough	15.18	31.85	47.53	2.76
3	Calico King	Ripe	25.18	31.21	56.39	3.00
4	Calico King (stalks not cut)	Ripe	49.40	17.70	67.10	.....
4	Piasa Pet	Milk	1.78	37.10	38.88	2.55
4	Piasa Pet	Dough	12.30	43.40	55.70	2.79
4	Piasa Pet	Ripe	26.66	40.22	66.88	2.72
4	Piasa Pet (stalks not cut)	Ripe	60.22	21.18	81.40	....
4	Brown Beauty	Milk	25.78	22.96	48.66	1.76
4	Brown Beauty	Dough	38.86	15.04	53 90	1.96
4	Brown Beauty	Ripe	47.77	10.59	58.36	1.80
3	Brown Beauty (stalks not cut)	Ripe	49.57	9.78	59.35	.....
4	Piasa Queen	Milk	4.15	45.85	50 00	2.07
4	Piasa Queen	Dough	30.37	33.11	63.47	1.97
4	Piasa Queen	Ripe	51 99	23.48	76.29	2.35
4	Piasa Queen (stalks not cut)	Ripe	67.18	11.63	78.81	.....

SUMMARY-CONCLUDED.

No. of rows used....	VARIETIES.	CONDITION OF GRAIN.	AVERAGE YIELD PER ACRE. Good ears, bushels.....	Nubbins, bushels.....	Total corn, bushels.....	Fodder, tons..
16	Average of all varieties..........	Milk	8.91	33 93	42.76	2.17
16	Average of all varieties..........	Dough.....	24.18	30.85	55.15	2.37
15	Average of all varieties..........	Ripe	37.90	26.38	64.48	2.47
15	Av. of all varieties (stalks not cut).	Ripe	56.59	15.07	71.66	.....

The above tables show a uniform increase in the yield of corn as the growth progressed from the milk stage until the ears were ripe and the stalks dead. The averages of all varieties show that the loss in yield of corn sustained by cutting when the corn was in the milk was 40 per cent., the loss in cutting when in the dough was 23 per cent., and the loss in cutting when the corn was ripe was 10 per cent. The corn cut when ripe was left standing as long as possible and yet make good fodder. The husks were dry and the ears beginning to turn. To further test the question, a series of cuttings were made in field 5 with King Philip corn. A portion of the field was laid off in plats of two rows each. The rows were 3½ feet apart and 311.14 feet in length, each plat containing one-twentieth of an acre. The plan of cutting adopted in this field differed somewhat from that just detailed. In this field rows 1 and 2 were cut while the grain was in the milk, rows 3 and 4 left standing, rows 5 and 6 cut when in the dough, rows 7 and 8 left standing, and rows 9 and 10 cut when the grain was ripe. This arrangement of cuttings was repeated throughout the whole number of rows selected for the experiment. A glance at the table will show what treatment was given each row. The corn was shocked as soon as cut, each pair of rows being shocked together, and all the plats husked October 26th, with the results as given in the table.

KING PHILIP.—FIELD 5.

FIRST OUTTING, AUGUST 28. GRAIN IN MILK.

NO. OF ROW.	YIELD OF PLAT, LBS. Good ears.	Nub-bins.	Total corn.	Fodder.	YIELD PER ACRE. Good ears, bu.	Nub-bins, bu.	Total corn, bu.	Fodder, tons.	QUALITY OF CORN.
1 and 2.......	48	61	109	245	13.7	17.4	31.1	2.45	Very poor.
13 and 14......	75	33	108	200	21.4	9.4	30.8	2.00	Poor.
25 and 26......	60	55	115	245	17.1	15.7	32.8	2.45	Poor.
37 and 38......	97	32	129	230	27.7	9.1	36.8	2.30	Poor.
49 and 50......	91	48	139	305	26.0	13.7	39.7	3.05	Very poor.

KING PHILIP — CONCLUDED.

SECOND CUTTING, SEPTEMBER 4. GRAIN IN DOUGH.

NO. OF ROW.	YIELD OF PLAT, LBS.				YIELD PER ACRE.				QUALITY OF CORN.
	Good ears.	Nub-bins.	Total corn.	Fodder.	Good ears, bu.	Nub-bins, bu.	Total corn, bu.	Fodder, tons.	
5 and 6.......	95	33	128	230	27.1	9.4	36.5	2.30	Fair.
17 and 18......	127	23	160	235	36.3	6.6	42.9	2.35	Fair.
29 and 30......	117	33	150	215	33.4	9.4	42.8	2.15	Fair.
41 and 42.....	158	34	192	280	45.1	9.7	54.8	2.80	Good.
53 and 54......	158	43	201	330	45.1	12.3	57.4	3.30	Poor.
THIRD CUTTING, SEPTEMBER 13. GRAIN RIPE.									
9 and 10......	162	19	181	285	46.3	7.4	53.7	2.85	Good.
21 and 22......	166	30	196	190	47.4	8.6	56.0	1.90	Good.
33 and 34......	125	25	150	150	35.7	7.1	42.8	1.50	Good.
45 and 46......	194	34	228	230	55.4	9.7	65.1	2.30	Very good.
57 and 58......	212	53	265	305	60.6	15.1	75.7	3.05	Good.
STALKS LEFT STANDING.									
3 and 4.......	145	29	174	......	41.4	8.3	49.7	......	Good.
7 and 8.......	123	51	174	......	35.1	14.6	49.7	......	Fair.
11 and 12......	140	33	173	......	40.0	9.4	49.4	......	Good.
15 and 16......	156	37	193	......	44.6	10.6	55.2	......	Good.
19 and 20......	186	29	215	......	53.1	8.3	61.4	......	Good.
23 and 24......	146	13	159	......	41.7	3.7	45.4	......	Good.
27 and 28......	178	32	210	......	50.9	9.1	60.0	......	Good.
31 and 32......	190	13	203	......	54.3	3.7	58.0	......	Very good.
35 and 36......	198	32	230	......	56.6	9.1	65.7	......	Very good.
39 and 40......	237	19	256	......	67.7	5.4	73.1	......	Very good.
43 and 44	218	54	272	......	62.3	15.4	77.7	......	Good.
47 and 48......	234	39	273	......	66.9	11.1	78.0	......	Good.
51 and 52......	279	39	318	......	79.7	11.1	90.8	......	Very good.
55 and 56......	274	33	307	......	78.3	9.4	87.7	......	Good.
59 and 60......	279	58	337	......	79.7	16.6	96.3	......	Very good.

SUMMARY.

No. of double rows used.	CONDITION OF GRAIN.	AVERAGE YIELD PER ACRE.			
		Good ears, bushels.	Nubbins, bushels.	Total corn, bushels.	Fodder, tons.
5..	In milk	21.2	13.1	34.3	2.45
5..	In dough	37.4	9.5	46.9	2.58
5..	Ripe	49.1	9.2	58.3	2.32
15..	Ripe stalks, not cut	56.8	9.7	66.5	......

The effect of cutting at different stages of growth with the King Philip corn is the same as that shown in the experiment in field D, varying only in the per cent. of loss. The loss made by cutting this variety when in the milk, as shown by the summary, was 48 per cent., the loss by cutting when in the dough 29 per cent., and the loss by cutting when ripe was 12 per cent. As in the trial in field D, there was but little difference in the yield of fodder produced by the different cuttings. The quality of the fodder was the same in both fields. That cut when the grain was in the milk was of fair quality, but considerably damaged by weather; the fodder cut when the grain was in the dough was of the very best quality; while that made from cuttings when the grain was ripe was of fair quality, but not nearly so good as from the dough cutting. The fodder cut when the grain was ripe was as good as most of the fodder put up in this State. Our feeding trials given under the head of "Silos and Silage" show that from 40 to 60 per cent. of such fodder is uneaten when fed to stock. While the fodder from the stalks cut when the grain was in the dough was of the best quality, no farmer could afford to cut corn in this stage of growth with the certainty of a loss of one-fourth or more in the yield of grain. The figures giving the per cent. of loss of corn do not show all the loss made by cutting the stalks. Besides the loss in yield, there was a loss from cutting in the quality of the corn. In the trial in both fields, the corn cut when in the milk gave few good ears, and the kernels were badly shrunken. The corn cut when in the dough had some solid ears, but must of the ears had shrunken kernels, loose on cob. The ears from corn cut when ripe were good, but the kernels were rather loose. The ears on the stalks left standing were solid, and the kernels firm on cob.

The table on the following page, compiled from the first annual report of this Station, shows the results obtained in 1888 with King Philip corn.

Condition of grain when cut.	Yield of corn per acre, bushels.	Yield of fodder per acre, tons.	Loss in cutting before corn was ripe, per cent.
In milk	29.69	2.03	51.50
In dough	40.96	1.95	33.50
Ripe, stalks drying	61.44	2.15	....

An extensive trial was made the same year with several other varieties, but as the work shows like results, it will be unnecessary to give them here. As has been mentioned before, all the rows were cut in the trials of 1888, and it is not known what would have been the gain had the corn been left standing.

These trials have been made in two very different seasons, in fields that differ considerably as to character of soil, and in each year with several varieties of corn (8 varieties in 1888, 5 varieties in 1889), and all show like results—a serious loss in the yield of corn whenever the stalks are cut for fodder. Even when the stalks are left, before cutting, until the husks are dry and the leaves begin to turn, there is still a loss of from 10 to 12 per cent. in the yield of corn over that left standing.

Considering all the facts shown in this experiment and in the experiment with corn planted at different distances, the inference seems plain that we must plant corn with the sole object of raising grain, or with the sole object of raising feed. Plant the corn intended for a yield of grain in rows not less than 3½ feet apart, and give the stalks plenty of room in the row, using the largest latest variety that will mature on the farm where the crop is raised. Plant the corn intended for feed in rows 2½ or 3 feet apart, leave single stalks 4 to 8 inches apart in the rows, and use for seed some tall, leafy-stalked variety, such as Mosby's Prolific, Mason's Flour, Early California, or Farmers' Favorite; cut the stalks when the grain begins to harden, set in large shocks, and feed without husking; all loss from extra handling will thus be avoided, the expense of raising and handling will be reduced to the lowest point, and a large amount of most excellent feed produced. It is doubtful if there is any way in which good land can be made to produce as much feed as when planted with corn handled in this way, unless it is when corn is planted and the crop stored in a silo.

EXPERIMENTS WITH WHEAT.

The position of wheat-raising in Kansas agriculture has always been a peculiar one; almost from the first, the acreage has been subject to wide fluctuations, unknown in the case of other staple grains, and due largely to the changing opinions of farmers themselves. In Kansas, as in every other country where it is successfully grown, wheat is a favorite crop with the pioneer. In the central portions of the State, in the '70s, wheat was the universal crop; for various reasons the great wheat fields gave place to even larger corn fields, and a system of mixed farming. The short crops of '85, '86 and '87 intensified the general prejudice against wheat-raising, until in many of the counties of the State, like Riley, wheat has ceased to cut any considerable figure as an agricultural product. Lately, many signs of returning interest in wheat-raising are visible; the crop of last year was a very large one, and as the prices were good, it was highly remunerative; as a result, farmers talk of" going into wheat" very much as they did in '75 and '76. Almost certainly the assessors' returns for another year will show a very large increase in the area of wheat sown the present fall. All this seems to me a good deal unfortunate. Wheat is undoubtedly, taking the years together, a very profitable crop in Kansas when grown in connection with other crops, and as part of a system. It is equally true that to cultivate it as a specialty is to certainly invite all the disasters that twelve years ago resulted from the excessive wheat-raising.

THE ARGUMENT FOR WHEAT-RAISING IN KANSAS.

Few will question that Kansas soils, in general, are preeminently "wheat" lands. It may well be doubted if another State in the Union can show so large a proportion of its soils that are well adapted to the cultivation of the great staple. Moreover, wheat is, in many respects, well suited to the peculiarities of our climate. The usual abundant rains of early spring and summer come in ample time to mature the crop, while by its time of ripening it escapes the July drouth and the hot winds which often work so much damage to late-growing crops like corn.

The records of the College farm, for the last sixteen years, show conclusively enough that wheat is a profitable crop in Kansas. During this time I find that our average yield, including three total failures, has been 18¼ bushels per acre, which has been sold at the average price of eighty cents per bushel. To further show the success with which wheat is grown under the most unfavorable circumstances, I may here mention the case of the experimental acre, referred to in previous publications of this Station.* This acre was first sown to wheat in the fall of 1880, and has been seeded to the same crop every year since, without the addition of fertilizer or renovating treatment of any kind. Although the crop failed from winter-killing during two years (1886 and 1887), the average yield of wheat for eight years, including the two failures, has been 25.1 bushels per acre. Considering that this acre of land, from the Kansas standpoint, is quite below the average of fertility, the facts of this experiment show a wonderful natural adaptation of the soil and climate of this section to the wheat plant. Wheat-

*See Bulletin No. 4, page 44.

raising upon a large scale and carried on as a specialty deserves condemnation in Kansas, as elsewhere; but when the crop is grown as a part of a system in alternation with corn, oats, grass, and other crops, it is almost certainly a profitable one to the farmer. It is one of the few crops that give returns in actual cash, and this cash comes at a season when ordinarily there is little upon the farm that is salable. The indications now are, that Kansas farmers will again "go into wheat" extensively, and invite the disasters which have before followed the special cultivation, on a large scale, of this cereal. One of the most discouraging facts to those who are striving for real and substantial progress in agriculture is the almost constant need of attacking old fallacies in practice which it had been thought were safely disposed of years, perhaps generations, before.

THE CHINCH-BUG ARGUMENT.

But the objection constantly raised to wheat-growing in connection with other crops, in Kansas, is that wheat by its early growth furnishes shelter and support to chinch-bugs early in the season; and that these pests pass directly from the wheat to adjoining fields of corn and oats, which are likely to be more or less seriously damaged thereby. The reply to this familiar argument is, so far as my experience and observation have gone, that this danger from chinch-bugs has been greatly overestimated. During the sixteen years of my superintendence of the College farm, in every one of which a wheat crop has been sown, we have never lost a corn crop from the action of chinch-bugs. In a few cases, always in seasons of drouth, some damage has been done corn and oats by the bugs, but the action of these insects has always been to *emphasize the effects of drouth.* Chinch-bugs have never damaged our crops seriously in "good years."

PASTURING WHEAT.

An effort was made to repeat the experiment of last year, having for its object to test the influence of close pasturing growing wheat, by cattle. An accurately measured half-acre was fed off closely during the fall months. this half-acre was pastured, by a considerable herd, at different times, the total grazing amounting to 161 hours by a single animal. The wheat upon this pastured area seemed not to suffer much from the increased demands upon it; it was slightly shorter than the unpastured portion of the field, and the time of blossoming and ripening seemed to have been somewhat checked, although not enough to influence the time of harvesting. Comparing this pastured half-acre with an adjoining half-acre, unpastured, we find that the pastured area gave a yield of 11.23 bushels of grain and 1,156 pounds of straw, while the unpastured area gave 13.3 bushels of grain and 1,302 pounds of straw. These figures seem to show a loss for pasturing. The difference in yield, however, is clearly chargeable to another cause — the unpastured area had better soil and a thicker and more even stand to begin with than that which was pastured. This deference is amply sufficient to explain the variation in yield of the two areas. This fact serves further strikingly to illustrate the difficulty experienced everywhere in using a few large plats to test a given point.

GENERAL PLAN OF THE EXPERIMENT WITH VARIETIES.

Outside of the crop grown in ordinary field culture, nineteen varieties were this year grown in small plats with the view to testing their fitness for this soil and climate. These varieties were selected, in part, because they were new to the agriculture of the section, but chiefly because many of them seemed to possess qualities which especially adapted them to this locality. Generally, the plats used were one-twentieth of an acre in area, although in some cases, on account of the difficulty in obtaining seed in proper quantities, smaller areas were used.

All were sown at the same time, September 18th, and in adjacent plats, except Maryland Track, the seed of which was not received until well along in October. The soil upon which the varieties were grown was a strong and fairly rich clay. All passed through the winter without much damage from freezing. All suffered a good deal in early May from lack of proper rains, and later the mature chinch-bugs, which were found in considerable numbers in every plat, did some damage, of which it is difficult to speak with accuracy. Arnold's Hybrid, Golden Drop, Red May, Purple Straw, Ontario Wonder and McCregan were the chief sufferers. The Maryland Track, above referred to, was grown at a considerable distance from the others, and upon a soil very different chemically and physically from that which bore the other sorts mentioned. The table on the following page gives in convenient statistical form the general facts of this experiment.

VARIETIES.	Date of ripening....	YIELD PER ACRE.		Weight of struck bushels, pounds...	Straw (pounds) to bushel of grain....	REMARKS.	SEED FROM—
		Grain, bushels..	Straw, pounds ..				
Extra Early Oakley....	June 18,	31.83	2,080	58	65.34	Red; large berry, fair quality, shrunken..	R. T. Pierce, Monaskon, Va.
Arnold's Hybrid.......	" 20,	26.18	2,518	58	96.18	Dark amber; of good quality............	Philip Bork, Tiffin, Ohio.
Curwell..............	" 20,	39.23	2,354	60	60.00	Red; large berry, full and plump.........	R. T. Pierce.
Buckeye..............	" 20,	25.03	2,139	57	85.45	Red; coarse and badly shrunken.........	J. C. Suffren, Voorhies, Ill.
Badger................	" 20,	20.33	1,180	58	58.04	Red; poor quality, badly shrunken.......	Philip Bork.
Golden Drop..........	" 25,	19.16	1,850	58	96.55	Red; fair quality, somewhat shrunken....	F. Barteldes & Co., Lawrence, Kas.
Purple Straw Red	" 20,	20.13	1,890	58	93.84	Red; good quality, somewhat shrunken...	Mark W. Johnson & Co., Atlanta, Ga.
Ontario Wonder.......	" 22,	19.13	2,040	56	106.56	Red; kernels very unequal in size........	Jas. Riley, Thorntown, Ind.
McCregan............	" 20,	21.52	2,914	....	135.40	Red; of poor quality...................	Philip Bork.
Nigger................	" 20,	22.70	1,990	....	87.66	Red; poor quality, badly shrunken.......	J. C. Suffren.
Hybrid Mediterranean.	" 23,	25.66	2,220	59	86 51	Red; excellent quality, plump	F. Barteldes & Co.
Red Fultz.............	" 23,	31.33	2,720	58	86.81	Red; somewhat shrunken................	Mark W. Johnson & Co.
Red Russian..........	" 26,	32.00	2,880	58	90.00	Red; shrunken, inferior quality..........	Samuel Wilson, Mechanicsville, Pa.
Reliable..............	" 24,	27.66	3,140	59	113.52	Dark amber; large berry, full and plump..	Samuel Wilson.
Red May.............	" 20,	31.50	2,710	59	86.03	Red; plump, of excellent quality.........	Mark W. Johnson & Co.
Zimmerman	" 20,	31.54	.....	60	......	Red; undistinguishable from Red May...	College Farm.
Tasmanian Red.......	" 22,	27.84	2,042	58	73.34	Red; poorly filled.......................	J. C. Suffren.
Tuscan Island..... ..	" 24,	30.83	3,150	59	102.17	Red; fair quality	Samuel Wilson.
Maryland Track.......	" 29,	24.33	3,940	56	161.94	Red; coarse, poor, badly shrunken.......	P. S. Hargett, Frederickstown, Md.

The testing of varieties is perhaps the most unsatisfactory work that comes to the experimenter. The experience of a single season is almost entirely worthless, because whatever results are obtained, where a long list is under examination, they are very likely to be contradicted by the experiences of another year. This tendency is made almost a certainty by the fact that but a very small number (usually only one) of small plats can, from the nature of the experiment, be used for each sort tested. On this account, the experience of years usually involves contradictions of soils, as well of seasons. It is only by 'striking a balance" of many of these opposing results that we get at an approximation to the truth. The reader is therefore cautioned against considering the facts of our table as being anything more than suggestively useful.

RED MAY, AND ZIMMERMAN.

For many years the main crop of the College farm has been one of the two sorts named in this caption. Both sorts, if they are separable, are extensively grown under these names throughout the State, and their reputation for earliness, productiveness and general suitableness to the conditions of Kansas agriculture is excellent. We have grown them side by side during the present and previous seasons, but by no fixed and definite characters have we been able to separate them. They ripen at the same time, have equal lengths of straw, and in form of head, arrangement of spikelets, color and texture of grain and general average of yield, they exhibit no noticeable differences. I am inclined to think that the Little May, Big May, Red May, Zimmerman, and perhaps others, are but local names for one and the same variety which quite likely shows slight variations, due to local causes. This wheat, call it by what name you choose, possesses many admirable qualities; it stools enormously under favorable conditions, ripens early, yields heavily, of excellent flouring wheat, and endures hot, dry weather wonderfully well. Its weak point, perhaps, is a susceptibility to winter-killing, from which it often suffers severely.

THE BEST SORTS.

The wheats that are really successful in Kansas, for a series of years, so far as my observation has extended, are reds, soft or hard, and all agree in the possession of the qualities, earliness, hardiness, and compactness of habit. The early-ripening sorts are liable to escape our too-fervent suns of late June and the ravages of the first brood of chinch-bugs; while their compact habit and abundant stooling furnish the dense, moist shade, which repels the mature "bugs" by which alone these varieties are likely to be damaged.

FERTILIZERS AND METHODS OF CULTIVATION.

Forty-five plats were laid off in field No. 6 for the purposes of the experiment here detailed. The soil used was a strong clay loam, of quite ordinary fertility. It bore a crop of millet in the summer of 1888, and for three years previously it had been occupied by a light stand of alfalfa. The plats were arranged side by side in a single extended series. Each plat was 147x14 ft., 9.72 in. (one-twentieth acre). The ground, beginning with plat No. 1, rose gradually until plat 20 was reached, and as gradually declined from plat 20 to 40. As might be expected, the fertility of the land diminished in direct proportion to the increase of its altitude. The plats were all plowed, and plats 10, 12, 14 and 16 subsoiled during the last week in August. The seeding was done on September 22d, a roller-drill with eight-inch drill spacings having been used, except with plats 17 to 24, which were seeded with a drill which placed the rows of wheat ten inches apart.

All the fertilizers applied in the fall were sown broadcast, and harrowed in just before the time of seeding. The barn-yard manure had a most unfortunate effect: it loosened the upper soil, thus permitting it to dry out to such an extent that a large proportion of the wheat never germinated. On this account a poor stand was made on the manured plats. The salt applied in the spring, April 4th, was sown broadcast on the growing wheat. The variety of wheat used in this experiment was the Zimmerman, above alluded to. The "nothing" plats referred to in the table which follows, and elsewhere, are those which received no special treatment.

In the subjoined table the essential facts of the experiment are given in easily accessible form:

No. of plat	TREATMENT.	YIELD OF PLAT, LBS.		Weight of struck bushel, lbs.	YIELD PER ACRE.		Pounds of straw to bushel of grain
		Grain	Straw		Grain, bushels.	Straw, pounds.	
A	Nothing	143	247	63	47.66	4940	104
B	Salt, 300 lbs. per acre, applied in spring	140	250	63	46.66	5000	107
C	Nothing	145	255	63	48.33	5100	106
D	Salt, 300 lbs. per acre, applied in spring	145	265	63	48.33	5300	110
1	Nothing	129	196	63	43.00	3920	91
2	Salt, 300 lbs. per acre, applied in fall	92	143	63	30.66	2860	93
3	Nothing	81	109	64	27.00	2180	81
4	Salt, 300 lbs. per acre, applied in fall	74	106	62	24.66	2120	86
5	Nothing	83	107	63	27.66	2140	77
6	Salt, 300 lbs. per acre, applied in fall	91	139	62	30.33	2780	92
7	Nothing	105	130	63	35.00	2600	74
8	Salt, 300 lbs. per acre, applied in fall	100	145	62	33.33	2900	87
9	Nothing	107	143	64	35.36	2860	80
10	Subsoiled	89	131	64	29.66	2620	88
11	Nothing	92	128	64	30.66	2560	84

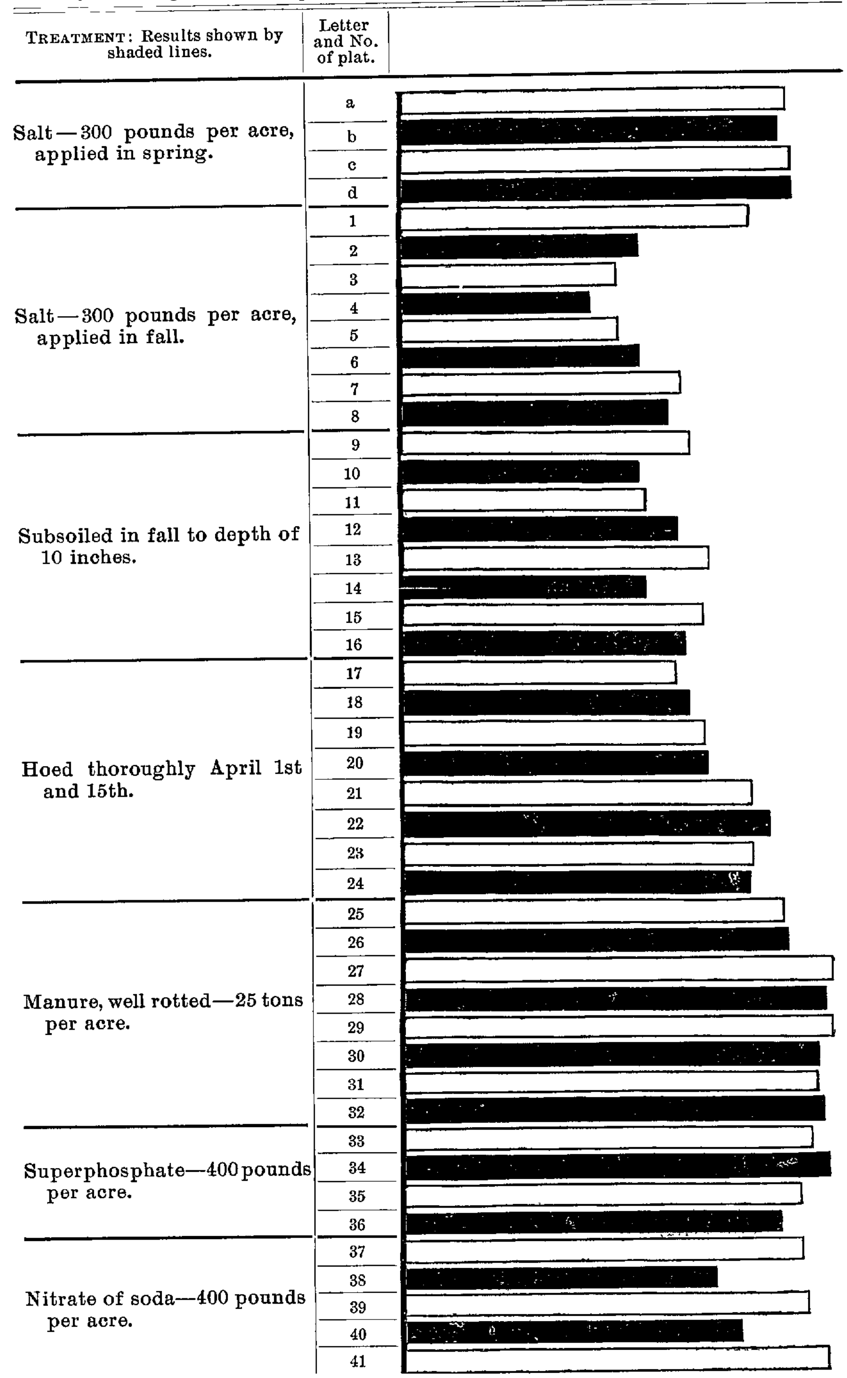
No of plat	TREATMENT.	YIELD OF PLAT, LBS.		Weight of struck bushel, lbs.	YIELD PER ACRE.		Pounds of straw to bushel of grain
		Grain	Straw		Grain, bushels.	Straw, pounds.	
12	Subsoiled	102	168	64	34.00	3360	99
13	Nothing	114	156	64	38.00	3120	82
14	Subsoiled	92	133	64	30.66	2660	87
15	Nothing	112	143	64	37.33	2860	77
16	Subsoiled	106	159	63	35.33	3180	90
17	Nothing	102	143	64	34.00	2860	84
18	Cultivated	107	163	63	35.66	3260	91
19	Nothing	112	158	63	37.33	3160	85
20	Cultivated	114	181	63	38.00	3620	95
21	Nothing	131	189	63	43.66	3780	87
22	Cultivated	135	215	63	45.00	4300	96
23	Nothing	131	194	63	43.66	3880	89
24	Cultivated	130	210	62	43.33	4200	97
25	Nothing	141	229	63	47.00	4580	97
26	Manure, 25 tons per acre	141	229	63	47.00	4580	97
27	Nothing	160	250	64	53.33	5000	94
28	Manure, 25 tons per acre	157	243	63	52.33	4860	93
29	Nothing	161	239	63	53.66	4780	89
30	Manure, 25 tons per acre	155	245	63	51.66	4900	95
31	Nothing	154	236	64	51.33	4720	92
32	Manure, 25 tons per acre	158	247	64	52.66	4940	94
33	Nothing	153	267	63	51.00	5340	105
34	Super-phosphate, 400 lbs. per acre	160	285	63	53.33	5700	107
35	Nothing	152	273	62	50.66	5460	108
36	Super-phosphate, 400 lbs. per acre	140	260	62	46.66	5200	111
37	Nothing	150	265	63	50.00	5300	106
38	Nitrate of soda, 400 lbs. per acre	119	221	62	39.66	4420	111
39	Nothing	153	247	63	51.00	4940	97
40	Nitrate of soda, 400 lbs. per acre	127	243	62	42.33	4860	115
41	Nothing	160	265	63	53.33	5300	99

SUMMARY.

	Yield of plat, pounds.		Weight of struck bushel..........	Yield per acre.		Straw (pounds) to bushel of grain...
	Grain.... ...	Straw.........		Grain, bushels...	Straw, pounds...	
Salt, applied in spring, Plats B and D....	142.5	257.5	63.0	47.5	5150	108
Nothing plats adjacent above............	139.0	232.6	63.0	46.3	4652	100
Differences—Gains and losses*......	3.5	24.9	0.0	1.2	498	8
Salt, applied in fall, Plats 2, 4, 6 and 8...	89.3	133.3	62.0	29.8	2666	89
Nothing plats adjacent above............	101.0	137.0	63.0	33.6	2740	81
Differences—Gains and losses.......	-11.7	-3.7	-1.0	-3.8	-74	8
Subsoiled Plats 10, 12, 14 and 16.........	97.3	147.8	64.0	32.4	2956	91
Nothing plats adjacent above............	105.4	142.6	64.0	35.1	2852	81
Differences—Gains and losses.......	-8.1	5.2	0.0	-2.7	104	10
Cultivated Plats 18, 20, 22 and 24........	121.5	192.3	63.0	40.5	3846	95
Nothing plats adjacent above............	123.4	182.6	63.0	41.1	3652	89
Differences—Gains and losses.......	-1.9	9.7	0.0	-.6	194	6
Manured Plats 26, 28, 30 and 32..........	152.8	241.0	63.0	50.9	4820	95
Nothing plats adjacent above............	153.8	244.2	63.0	51.3	4884	95
Differences—Gains and losses.......	-1.0	-3.2	0.0	-.4	-64	0
Super-phosphate, Plats 34 and 36........	150.0	272.5	62.5	50.0	5450	109
Nothing plats adjacent above............	152.0	268.3	63.0	50.6	5366	106
Differences—Gains and losses.......	-2.0	4.2	-.5	-.6	84	3
Nitrate of soda, Plats 38 and 40..........	123.0	232.0	62.0	41.0	4640	113
Nothing plats adjacent above............	154.0	259.0	63.0	51.4	5180	101
Differences—Gains and losses.......	-31.0	-27.0	-1.0	-10.4	-540	12

*The minus sign (–) preceding a number indicates a loss for the particular method.

GRAPHIC PRESENTATION OF THE RESULTS OF THE EXPERIMENT.— The shaded spaces stand for the plats receiving the special treatment named in the left-hand column; the unshaded represent the "nothing" plats. The yield of grain per acre is indicated by the length of each space.



AN EXPLANATION OF RESULTS.

The above experimental facts show strikingly that the better class of Kansas soils, when well farmed, *during favorable seasons,* require little in the way of artificial stimulation. There are several facts, however, which have doubtless influenced the results here given, the exact amount of whose influence it has been impossible to ascertain. Thus there was a considerable sprinkling of chinch-bugs in most of the plats, but especially where the growth of the wheat plants was thin and feeble. The mildew also put in appearance in several plats, doing some damage, without doubt, in every case. Many of the plats "lodged" badly, particularly those to which the yard manure, super-phosphate and nitrate were applied. That the loss from this cause was considerable, can hardly be questioned.

SALT AS A FERTILIZER.

In our experiment, salt was applied at the rate of 300 lbs. per acre, to certain of the plats in the spring and to the others in the fall season. I have reason to believe that this 300 lbs. per acre is nearly the largest amount that can be applied without danger from the destructive sterilizing influence of the mineral. Certainly a dose applied at the rate of 450 lbs. per acre has proved quite destructive to vegetation in the case of certain small plats where it was tried. Great expectations have been raised regarding the influence of salt upon Kansas crops. That these hopes are for the most part extravagant and not likely to be realized in practice, I am fully persuaded. The recent discovery of salt in great abundance in several sections of the State has quite likely made "the wish the father of the thought," in the case of these extravagant expectations. In the experiments under examination it will be noticed that the plats treated with salt, taken as a whole, show no increase of grain, and only a very slight gain in straw, over the unsalted. In my experiment of last year, on the other hand, an average gain of nearly five bushels of grain and 800 lbs. of straw was recorded for the slated plats. These facts are in direct accord with previous experiences had with this fertilizer. Upon certain soils and during particular seasons salt has proved valuable, but quite as often it has been inert and worthless as a fertilizer. This fact doubtless explains why salt, which has been used as a fertilizer in all ages and countries, has yet no permanent place among the generally recognized manurial agents.

It is proper here to mention some of the known and established facts regarding salt and its use as a manure. Salt does not enter into the composition of plants as a necessary element: that is, plants may be grown and brought to perfection in a soil which contains none or only a very small proportion of this mineral. If salt then is beneficial to a crop, it must be due to the fact that it acts upon the necessary elements of plant-growth by which these are made more available to the plants. Salt has generally proved much more beneficial to inland than coastwise countries, and its influence has been shown most markedly with cereal crops.

In the columns of the public press of the State much has been said of late of the effect of salt in warding off the attacks of chinch-bugs. Our experiments of the last two years give no support to this widely-current notion. During the year the unanimous reports of visitors, and of those whose duty it was to closely observe every fact in connection with these experiments, has been to the effect that the salted plats were suffering more than the unsalted from the attacks of these pests. The salt has this undoubted effect: it made a brighter, cleaner straw, which was noticeable in the haulm weeks after the grain had been cut.

Although the subsoiling in the case of this experiment was done upon land that theoretically ought to be greatly benefited by the process, it was of no benefit whatever; nor, I may add, has it ever been markedly beneficial when tried upon the College farm, where trials of subsoiling have been made by the dozen. The plats cultivated, *i. e.*, lightly hoed twice, were also plainly not benefited by the extra labor put on them. The yard manure, super-phosphate and nitrate of soda were certainly not beneficial in any case. They each stimulated the wheat plants — the present season most unnecessarily — giving an enormous growth of weak straw, which lodged so badly that it was impossible to gather it in harvesting. The result is seen either in slight losses, as where the yard manure or super-phosphate was used, or a very large loss, as in the case of the plats receiving the dose of nitrate.

SALT APPLIED TO OATS.

To further study the influence of salt as a fertilizer, an experiment was tried this year with oats, similar to that made with wheat as detailed above, For this purpose six plats each 2x8 rods (one-tenth acre) were used. These plats were all sowed with oats at the rate of two and a half bushels per acre, March 23d, The day following, salt at the rate of 300 pounds per acre was applied to each alternate plat in the series. The only differences noticed immediately afterwards in the salted and unsalted plats was a peculiar dryness of the soil of the salted plats, even directly after rains, and the bright color of the straw grown on the salted areas, before referred to in the case of the experiment with wheat. The crop of the experimental plats suffered a good deal from rust, the bushel only weighing twenty-eight pounds. The following are the essential facts of this experiment:

No. of plat.	TREATMENT.	YIELD OF PLAT, POUNDS.		Weight of struck bushel.	YIELD PER ACRE.	
		Grain.	Straw.		Grain, bushels.	Straw, pounds.
1	Nothing	112	198	28	34.3	1,980
2	Salt, 300 lbs. per acre	126	234	28½	39.3	2,340
3	Nothing	112	208	28	34.3	2,080
4	Salt, 300 lbs. per acre	127	263	27½	39.7	2,630
5	Nothing	124	246	27	38.7	2,460
6	Salt, 300 lbs. per acre	124	236	28	38.7	2,360
	Average of salted plats	125.6	244.3	28	39.2	2,443
	Average nothing plats	116	217.3	27½	36.3	2,173
	Differences, gains and losses	9.6	27	½	2.9	270

This oat experiment again illustrates the uncertainty of salt when used as a fertilizer. The figures show a gain for the use of salt of less than three bushels of grain and 270 lbs. of straw per acre. Even if this difference is to be credited directly to the use of the salt — which may well be questioned—the transaction was a most unprofitable one, considering the values involved.

LISTING WHEAT.

The question whether the advantages claimed for the methods of listing the corn crop have not an application in wheat culture, has long seemed to me worthy of experimental examination. If corn by being planted at the bottom of a deep furrow germinates more surely and better withstands the effects of drouth, thus making sure a larger yield, why may not as much be expected of wheat when treated in like manner? Moreover, the method of listing might be expected to have the additional advantage in the case of wheat that it would almost certainly enable wheat so planted to pass even the severest winters uninjured by winter-killing. Who has not noticed in fields of wheat, more or less completely destroyed by winter-freezing, that every plant fortunate enough to have root in some dead-furrow or other depression in the field has almost certainly passed the rigors of winter unharmed? If we put the entire crop beneath the surface, why may it not altogether escape winter-killing? seems at least a reasonable question.

To test this question, three small double-shovels — miniature listing-plows —were secured to the frame-work of a “Buckeye” one-horse drill, in such a manner as to make a six-inch-deep furrow in advance of the three discharge spouts of the drill. The implement thus “improved” put the seed wheat in furrows eight to ten inches deep and about fourteen inches apart. The seed thus planted sent its shoots above-ground a day or more in advance or seed sown near by upon the surface. The listed wheat made a ranker and more luxuriant growth, the plants having a much better color than those which grew upon the surface, where the seed had been sown at the same time in the familiar manner. The listed wheat rapidly covered the ground with its dense verdure; in color, height, and apparent vigor, it seemed from the first superior to that which had been seeded upon the surface. Of course, last winter furnished no test for the main question involved in listing — whether the new method of seeding would enable winter wheat to withstand freezing; so I have no report to make on this point. Our listed wheat seemed to show a tendency to lodge, which quite likely it would not show in less stimulating seasons than that of 1889. This experiment has seemed to me to involve a question of very great importance to Kansas wheat-growers, but I am compelled to await another season's experience before speaking more accurately and positively of the merits of the methods of listing as applied to wheat.

FORAGE CROPS.

Twenty-four varieties of forage crops were planted in adjacent plats in field 4. The field had been in corn the previous year. The land was plowed May 4, 1889, harrowed and cross-harrowed with smoothing harrow, and the seeds planted in rows three feet apart May 6 and 7. Plats 1 to 16 were planted to varieties of non-saccharine sorghums, the seed put in with a one-horse corn drill. Plats 17 to 24 were planted with the following crops, put in in the order named: Serradella, Teosinte, New Golden Wonder millet, Pearl millet, Soja beans, and three varieties of cow peas.

All plats were cultivated May 31, June 21, and July 5, with a one-horse cultivator, and the weeds were cut out with a hoe as found necessary.

Cow Peas (Dolichos Chinensis.)— Three varieties were planted — the Whippoorwill and Clay, seed from F. Barteldes & Co., and the Unknown, seed from the U. S. Department of Agriculture. The plants of all three varieties grew vigorously. The vines began to run June 20, and before the season closed covered the ground with a dense mass of vines 2 feet thick.

The Clay and Unknown varieties proved to be identical. They bore but few pods, and these were killed by frost before reaching maturity. The Whippoorwill vines bore a considerable number of pods, which ripened by September 27. The pods were 7 to 8 inches long, and well filled with speckled beans. They were gathered by hand and threshed, giving a yield of 7 bushels per acre. Our stock will not eat the vines either green, cured, or made into ensilage. The yield of beans does not pay for raising. This crop possesses no value for Kansas farmers unless possibly when used as a green manure.

Serradella (Ornithopus sativus.)— Seed from V. H. Hallock & Son, Queens, N. Y. The plants came up well, made a very slow growth until hot weather, when most of them died. The few that lived began blossoming July 6, and the blooming continued until cut off by frost. The plants did not reach a height of more than 2 inches at any time during the season, and never covered one-fourth of the ground. This is the poorest forage crop ever grown on the College farm.

Pearl Millet (Pennisetum spicatum.)— Seed from Barteldes. The seed failing to germinate, the plat was replanted June 1, and a poor stand secured. The early growth was very weak, the plants not growing more than one-half as fast as sorghum. After hot weather began, the plants made a wonderfully rapid growth. The plants grow 7 to 8 feet high, with stout, short-jointed and very leafy stalks, and stool prolificly, as many as fifteen full-sized stalks growing from a single seed. This plant is not worth a further trial. It is very difficult to secure a stand, the early growth is so feeble that it is hard to keep the plants from being killed by weeds, and when grown the forage is not as valuable as that from the sorghums.

Soja Bean (Glycine hispida).— Seed from T. W. Wood & Sons, Richmond, Va. Growth vigorous throughout the season, from the time the plants first appeared above ground until they were killed by frost. The plants grow erect, averaging 4 1/2 feet in height. The stalk is strong and woody, and has numerous branches covered with heavy foliage. The branches and upper part of the main stem are thickly studded with clusters of pods—from 2 to 5 pods growing in a cluster, each pod containing 2 beans. The plants were killed by frost before the beans had matured. The crop was harvested November 14, and yielded at the rate of 17 bushels of beans per acre. This plant has many valuable qualities, and deserves further trial with home-grown seed.

Teosinte (Euchlœna luxurians).— Seed obtained from Barteldes. Single seeds were dropped 10 to 12 inches apart in the row. They germinated well, and the plants made a good growth. The plants did not reach maturity, not even blossoming, but continued to grow until harvested. The plant resembles corn: the stalks are slender and very leafy, the leaves narrower than those of corn. This plant stands drouth better than corn, but not so well as some of the sorghums. From 12 to 50 stalks grew from each seed, and reached an average height of 8 1/2 feet. The plat was cut October 2d and yielded at the rate of 31 3/4 tons green forage per acre. This fodder was greatly relished by cattle, and eaten up clean. No attempt has been made here to cure the fodder; we have always fed it green. As a green crop a very large yield can be secured, and it seems to make good feed although so immature. The crop promises to be a valuable one to feed in late summer and fall when the pastures fall short.

Golden Wonder Millet.— Seed from Emerson Seed Co., Omaha, Neb. The plants grew to a height of 4 1/2 feet. The stalks are rather coarse, leaves large, and heads very long—from 10 to 14 inches in length. Headed out July 5th. This variety is not profitable when grown in drills and cultivated, but when sown broadcast is among our best hay plants. (See report on millets.)

Non-Saccharine Sorghums (Sorghum vulgare).— A little more than one-fourth of an acre (.256) was planted with each variety mentioned in the table below, except Red Kaffir corn and Egyptian Rice corn; an area of one-tenth acre was planted with the Red Kaffir corn, and nine-hundredths acre to rice corn. African millet and Yellow Millo maize failed to germinate, and the plats were replanted May 30th. Rural Branching sorghum was replanted June 6th, for the same reason. After this second planting a fair stand was secured of all the varieties. June 21st the sorghum disease made its appearance and attacked all the plats. White Millo maize, Kaffir corn and Red Kaffir corn were uninjured. Three-fourths of the plants of Yellow Millo maize, one-half of Rural Branching sorghum and Brown Dhoura, one-third of African millet and one-fourth of Rice corn were killed by this disease. The south half of the Brown Dhoura plat was almost entirely destroyed, while the north half was uninjured. The rows ran north and south. The yield given in the table for this variety is for the uninjured portion. In 1888 Rural Branching sorghum was uninjured by the blight, although every plant of another variety in an adjoining plat was killed and Kaffir corn was seriously injured; this year the damage is reversed. All the varieties were cut and shocked October 3d to 7th. As soon as well cured, the stalks were topped and the heads threshed. The following table gives the results:

VARIETIES.	Yield dry forage per acre, tons	Yield seed per acre, bushels	Weight of seed per struck bushel, lbs.	When headed out.	Height of stalk, feet	Amount injured by sorghum blight.
White Millo maize	15	57	60	Aug. 20	11½	Uninjured.
Rural br'nching sorghum,	6	29½	60	Aug. 25	10½	One-half plants killed.
African millet	6½	36½	60	Aug. 20	11½	One-third plants killed.
Brown Dhoura	13½	40	53	Sept. 1	11½	One-half plat killed; yield is for uninjured portion.
Yellow Millo maize	5½	10	53	Aug. 30	10	Three-quarters plants killed.
Kaffir corn	7	60	60	Aug. 15	6¾	Uninjured.
Red Kaffir corn	9	71	61	Aug. 15	7¾	Uninjured.
Rice corn	....	....	59	Aug. 1	5½	One-quarter plants killed.

White Millo Maize seed from Barteldes, *African Millet* seed from Barteldes, and *Rural Branching Sorghum* seed from Thorburn, seem to be identical in every respect. The plant stools well, is tall and slender, with leafy stalk moderately thick at butt. The stalk is very juicy, and the juice moderately sweet. The heads grow erect, in compact panicles, and are from 8 to 12 inches in length, well filled with large white seeds. Average height of stalk 11 1/2 feet. A full stand was secured of White Millo maize. This gave a yield of 15 tons dry forage per acre. The yield of threshed seed was 57 bushels per acre. This variety requires a full season in which to mature.

Kaffir Corn.— Seed from Barteldes. The plant grows short and stocky; short-jointed stalk and broad leaves. The stalk is very pithy, and has almost no juice when ripe. The heads grow erect, in rather loose panicles, from 10 to 12 inches in length, bearing large white seeds. Average height of stalk, 6 3/4 feet. The plat yielded at the rate of 7 tons dry forage per acre. The yield of seed was 60 bushels per acre. This variety is earlier than White Millo maize. This variety has one serious fault: the seeds shell very easily, and with only ordinary care in handling there is considerable loss from this cause.

Red Kaffir Corn.— Seed from U.S. Department of Agriculture. This plant grows taller than Kaffir corn; the stalks are more slender, very juicy, and The juice slightly sweet. The heads are long and narrow, averaging in length from 12 to 16 inches. The seed is light red or amber-colored, and slightly smaller than the seed of the common Kaffir corn. It weighed 60 pounds per struck bushel. Average height of stalk, 7 3/4 feet. The yield was at the rate of 9 tons dry forage per acre. The seed yielded 71 bushels per acre. This variety matures early and seems to be superior to the common Kaffir corn in almost every respect.

Brown Dhoura.— Seed from M. W. Johnson Seed Co., Atlanta, Ga., and Yellow Millo maize, seed from Barteldes, seem to be the same. The plant grows tall, with large, leafy and juicy stalks. The juice is slightly sweet. The heads are short and thick, weigh from one-half to three-fourths of a pound each, and grow on a short goose-neck. The seed is light yellow and larger than that of the other varieties. Most of the Yellow Millo maize was killed by sorghum blight. The south half of the Brown Dhoura was almost entirely killed by this disease, while the north half was uninjured and a full crop obtained. The uninjured part of the Brown Dhoura plat yielded at the rate of 13 1/2 tons dry forage per acre. The yield of seed was 40 bushels per acre. The seed was light, weighing only 53 pounds per struck bushel.

Egyptian Rice Corn.— Seed from Barteldes. This is an old, well-known sort. The plants grew to an average height of 5 1/2 feet, with small stalks that bore but few leaves. Seed head large, and hangs down on a short goose-neck; the seed is large, white and sweet. The plat was seriously damaged by the sorghum disease. As soon as the seeds began to harden they were attacked by English sparrows, and most of them taken before they became ripe enough to harvest. No estimate could be made of the yield. This variety, even at its best, is inferior to the other varieties in almost every respect, and has the same fault as the Kaffir corn — the seeds shell off too easily.

These non-saccharine sorghums resist drouth well, and will give a good crop of both grain and forage in a season that is too dry for corn. In 1887 the corn on the College farm was a total failure, owing to drouth, while African millet and Kaffir corn both furnished good crops. These varieties are well adapted to poor soils. Where seed is chiefly desired, Red Kaffir corn ranks first with the common, Kaffir corn a close second. Where forage and seed are both wanted, White Millo maize is preferable. It has given this year double the amount of forage that we raised from Kaffir corn, and nearly as much seed. The forage is much better than that from Kaffir corn. Kaffir corn stands the wind better on account of its shorter and thicker stalk.

Brown Dhoura has not received sufficient trial to warrant a conclusion on its merits.

The accompanying engraving shows the comparative size of the heads of the best varieties, the scale shown on the picture is in inches.

Chinese Varieties. —Seed of eight varieties of Chinese non-saccharine sorghums, numbered 1, 5, 18, 27, 30, 42, 43 and 58, respectively, was received from the U. S. Department of Agriculture, and planted in plats adjoining those of the varieties described above. No. 1 proved to be Brown Dhoura. The others were new varieties, that proved to be very inferior sorts. They were considerably injured by the sorghum blight.

MILLETS.

Eleven varieties of millet were sown broadcast in adjoining plats in field 6, May 11, 1889. Each plat contained one-twelfth of an acre. Three pounds of seed were sown on each plat and covered with a smoothing harrow. Broom corn millet seed, from the Emerson Seed Co., Omaha, Neb., and white and red French millets, seeds from Thorburn, failed to grow. The other varieties appeared above ground May 19th, except Pearl millet, which did not appear until May 24th. The land had been heavily manured in the fall and fall-plowed. The millets made a good growth, and so did the weeds. The plats became so weedy that it was impossible to ascertain the yield of the different varieties. The following notes were taken:

German Millet seed from Barteldes, *Italian Millet* seed from the Higganum Mfg. Corp., New York, *Texas Millet* from Hallock, and *Texas Millet* from Waxahachie, Texas, all proved to be the well-known German millet (Setaria Italica). The plants grew 4½ feet in height, and headed out July 30th, 80 days after sowing. The plants possessed the usual characteristics of this variety — stem coarse, leaves broad and numerous, and heads large.

Common Millet.—Seed from Barteldes. Grew 3 feet in height, and headed out July 10, 60 days after sowing.

Hungarian.—Seed from Barteldes. Grew to a height of 3½ feet, and headed out July 5, 55 days after seeding. Hungarian and common millet have very like habits of growth. The leaves of both are abundant and smaller than those of the German, and the stalk is not so coarse. In a favorable season the German will greatly outyield these varieties, but it is considerably later, and is frequently destroyed by chinch-bugs and drouth after the earlier varieties have been harvested and made a good crop.

New Golden Wonder Millet.— Seed from Emerson Seed Co. A new variety advertised as a cross between sorghum and millet. The plants grew to a height of $5^1/_2$ feet, and headed out July 5, 55 days after seeding. The stalk is coarse, the leaves broad — broader than those of the German millet — and the heads long, averaging 10 to 12 inches in length. Some of the heads were smutted. This variety has not been tried before at this station. It promises to be a valuable acquisition. It is ready to cut as early as the common millet, and will yield as much or more forage than the German — two very desirable qualities.

Pearl Millet.— Sown broadcast. A total failure. The early growth of the plants was so slow that the plat became covered with a heavy growth of weeds.

KOHL - RABI.

This plant is a bulb-stalked cabbage, a native of Germany, where it is much cultivated both for forage and as an article of human diet. The stem of the kohl-rabi above ground is swollen into the form and proportions of a handsome, symmetrical tuber. This tuber in composition closely resembles the ruta-baga, having, however, a much larger proportion of the plastic or nitrogenous element than the swedes possess. The interior or flesh of the kohl-rabi closely resembles in appearance, texture and flavor the inside of the stalk of the cabbage.

In May, 1887, about one-half ($^{54}/_{100}$) acre was planted to kohl-rabi. The seed was drilled in rows three feet apart — three and a half would have been better—one of the common hand-drills having been used for the purpose. The seed " came up " promptly, and as soon as the rough leaves had reached the size say of a dessert spoon, the plants were thinned out, leaving one plant to each twelve or fourteen inches of row space. After that, two or three cultivations and a light hoeing put the crop in shape to be " laid by. " The season of 1887 was one of drouth and disaster all over the West. Every grain crop upon the College farm except oats, which yielded a bare half-crop, was that year a complete failure. From about the middle of June until the first week in August less than one and a half inches of rain fell, and this came in the shape of insignificant showers which barely sufficed to lay the dust. The behavior of the kohl-rabi during this drouth period fully confirms the statement that " the kohl-rabi is the bulb of dry summers." Our cabbage bulbs did not make any extraordinary growth during this time of drouth and terrific heat, but they lived without much apparent discomfort, making bulbs the size of the clenched fist, while corn in the same field was burned up before it was half grown. As soon as the rains of August set, in the kohl-rabi made an extraordinary growth. Bulbs of six and eight pounds soon became common, and late in October we harvested from this fraction of an acre ($^{54}/_{100}$) 205 bushels of handsome bulbs, and several wagon-loads of tops which, without weighing, were hauled to the cattle and greedily consumed by them.

Our crop of kohl-rabi was wintered in a shallow pit; the bulbs were first covered with a coating of eight inches of dry straw, and later in the season this was covered with about the same thickness of earth. In this condition the kohl-rabi remained until the following spring—some were kept until late in May — when they were taken out in perfect condition and fed to milch cows and calves, which ate them with evident relish.

The present season (1889) kohl-rabi has been cultivated on the College farm, on two detached pieces of ground aggregating something like one acre. The smaller of these ($^{36}/_{100}$ acres) gave us 273 bushels (60 lbs.) of bulbs, a yield which rates at 758 bushels, or 22 $^{79}/_{100}$ tons per acre. The bulbs ran from six to twelve pounds each, although a single specimen three weeks before harvesting weighed an even twenty pounds.

In conclusion, let me say to intending cultivators of kohl-rabi: Get for the use of this crop clean, rich ground; plant at ordinary corn-planting time, and keep clean. While I cannot guarantee a crop of bulbs in every case, I am confident that with no other Western farm crop are the chances for success greater than with kohl-rabi. Of the two kinds, purple and green, sold in the market for stock purposes, the purple is greatly the better, giving larger and handsomer bulbs, apparently of better quality than the "white," the name under which the seed of the green variety is commonly sold. In seeding, avoid the hand-drill; it always wastes two-thirds of the seed that it sows, and does its work poorly. I plant by hand preferably, and thereby save seed sufficient to pay the laborer, and get a better stand than can be had with the drill. Two to four seeds thrust into the moist earth by the thumb and forefinger, at intervals of ten to twelve inches, is almost certain to give an even stand in the best possible shape for the subsequent operations of thinning and hoeing.

Following is a brief statement of the cost of seed and labor of raising this 273 bushels of bulbs on .36 of an acre of land:

	LABOR—HOURS.		
	Students.	Men.	Teams.
Plowing, harrowing, and rolling	....	5	5
Planting	12	....	......
Hoeing (three times) and thinning	29	....	......
Cultivating (three times)	6	....	3
Harvesting, weighing, and pitting	27	....	5
Total	74	5	13

Charging the student-labor at 10 cents and the men 12½ cents per hour (the prices actually paid), and allowing 10 cents per hour for the use of the team, we have, with the 75 cents paid for seed, a total cost for the crop, excluding rent of land, of $10.08. This makes the cost of each bushel of our kohl-rabi a trifle more than three and one-half (3.69) cents. The amount of labor used in growing this crop was doubtless excessive.

The advantages which this crop possesses are: insects do not injure it, drouth does not prevent its growth, and it keeps longer after being harvested than other root crops, and a stand is easily secured.

VARIETIES OF ENSILAGE CORN.

Thirteen varieties of corn recommended for making ensilage were planted in continuous plats in field B. The plat for each variety was 207.43 feet long by 21 feet wide, and contained one-tenth of an acre. The ground was plowed November, 1888, and thoroughly harrowed just before planting. The corn was planted April 24, 1889, in rows 3½ feet apart with a one-horse corn drill, set to drop one kernel every 4 to 6 inches. July 17, all varieties were thinned to 1 stalk each 12 inches. The plants of all varities appeared above ground May 8, germination having been slow, owing to drouth. May 25 and June 5, all plats were cultivated with a two-horse cultivator; June 17, with a surface cultivator, and June 26 with a one-horse cultivator. All the varieties, except Early Sanford, were cut August 29 and weighed green. Early Sanford was cut August 16. The table on the following page gives many of the facts noted during the season.

VARIETIES.	Yield per plat, green lbs.	Yield per acre, tons.	When tasseled.	When in milk.	Height stalk, feet.	Height ear from ground, feet.	Average weight green plant, lbs.	Average number ears per stalk.	GREEN PLANT. Per cent. leaves.	GREEN PLANT. Per cent. stripped stalk.	GREEN PLANT. Per cent. husked ears.	Condition of grain.	Seeds obtained from—
Blunt's Prolific Ensilage	2620	13.1	July 20	Aug. 9	10	4¾	2.20	1.10	28½	53	18½	Thick milk.	Parker & Woods.
Bullock's White Prolific	3215	16.0	July 23	Aug. 12	10	5	1.88	.84	26½	59½	14	Thick milk.	College.
Brazilian Flour Corn	3460	17.3	Aug. 1	Aug. 25	10	4¾	2.20	.92	45	45¼	9¾	Milk	Barteldes.
B. & W.	3265	16.3	July 24	Aug. 12	10½	5¼	2.12	.98	32	49	19	Milk	Cornish, Curtis & Green.
Conscience	3180	15.9	July 24	Aug. 12	10¼	5	2.20	.86	31¾	50	18¼	Milk	Alexander Drug and Seed Store.
Parker & Woods's Perfect Ensilage	3040	15.2	July 19	Aug. 5	10	4½	2.00	.84	28½	46½	25	Milk	Parker & Woods.
Red Cob Ensilage	3395	16.9	July 19	Aug. 5	9¼	5	2.67	.94	27½	50½	12	Milk	D. M. Ferry & Co.
Sanford's Early	1800	9.0	July 1	July 15	6	2	1.72	1.28	35	45	20	Milk	Parker & Woods.
Shoe Peg	3540	17.2	July 24	Aug. 12	10½	5½	2.76	.94	40	41½	18½	Milk	T. W. Wood & Sons.
Sheep's Tooth	2880	14.4	July 19	Aug. 5	9	4	2.38	.90	38½	56	25½	Dough	D. M. Ferry & Co.
Southern Horse Tooth	4720	23.6	Aug. 1	Aug. 25	13	6½	4.40	.84	31	56¼	12¾	Milk	Peter Henderson & Co.
Thoroughbred White Flint	2685	13.4	July 12	Aug. 1	8	3	1.44	.78	27	47¼	25¾	Hard dough,	J. M. Thorburn & Co.
White Flat Ensilage	3325	16.6	July 25	Aug. 12	10	5¼	2.44	1.36	26¾	49¾	24½	Hard dough,	Parker & Woods.

The ideal variety of corn for ensilage is one that has a tall, slender, short-jointed stalk, well eared, and bearing an abundance of foliage. The leaves and ears should make up a large percentage of the total weight, and the yield per acre should be heavy. The lower leaves should keep green until the crop is ready to harvest, and it is desirable to have the plant stool well and throw out tall, grain-bearing suckers. For this State an ensilage variety should mature late — the later the better, as a long-growing, late-maturing sort will furnish much more feed, from a given area, than one that ripens early.

No one variety that has been tried here possesses all these qualities. Among those that approach nearest are the Southern Horse Tooth, Shoe Peg, Brazilian Flour corn, Bullock's White Prolific, B. & W., and Red Cob Ensilage. The Southern Horse Tooth will give the greatest yield of any variety tried here. It resists drouth well, as shown in our trial of 1888, and will give a large yield in almost any season. The objection to this variety is that it has a very coarse stalk. This fault may be overcome somewhat by close planting. The Shoe Peg yields well, and has a smaller stalk than the Horse Tooth, but does not stand drouth as well as the latter. Brazilian Flour Corn, as grown this year, approached very near to the perfect standard. It gave a good yield of the very best quality. In 1888 it suffered severely from drouth, and did not yield over half a crop. There is little choice between Bullock's White Prolific, B. & W., and Red Cob Ensilage — all are desirable varieties. They have been tried for a number of years in a great variety of soils and seasons, and have given general satisfaction.

NOTES ON HABITS OF GROWTH.

Blunt's Prolific. — Suckers very little; stalk thick, short-jointed, and well leaved. Many stalks bear two ears. Rather a poor yielder.

Brazilian Flour Corn.— Stalks small, long-jointed, moderately well eared; leaves narrow, but longer than those of the other varieties. Suckers profusely; usually 5 full-size stalks grow from each seed. It makes ensilage of the best quality, and this year gave a yield above the average. In 1888 this variety did not yield half a crop, owing to drouth.

B. & W. — Stalks and leaves large, suckers moderately; is short-jointed and fairly well eared. Lower leaves wilt less than those of most varieties. In another field it gave a yield of 17 tons per acre. This is a standard variety.

Bollock's White Prolific.—Stalks slender and well leaved; plants sucker well; poorly eared. Lower leaves wilt considerably. A good yielder. Yield in another field, 25.3 tons per acre.

Conscience.— Stalk thick, joints long, leaves large, plants sucker well, lower leaves wilt considerably, ears very large.

Parker & Wood's Perfect Ensilage.—Fair-sized stalks, short-jointed and well leaved; lower leaves wilt considerably; yield fair.

Red - Cob Ensilage.— Stalk slender, rather short, well eared, moderately leaved out; a good yielder.

Sanford's Early.— A flint variety, not adapted to this climate.

Shoe Peg.— Stalk slender, short-jointed, poorly eared, leaves abundant; yields well, and makes a good quality of ensilage. Yield in another field, twenty-one tons per acre. A very desirable variety.

Sheep's Tooth.— Stalk short and thick, short-jointed and leafy; suckers moderately; lower leaves do not wilt. Too small and matures too early for this State.

Southern Horse Tooth.— Stalks tall and coarse. Many stalks measured 16½ feet in length. Suckers numerous and large; lower leaves wilt but little. The latest and largest variety grown on the College farm. Yields well on a great variety of soils. In field 6, a considerable area was planted to this variety, and the corn allowed to ripen. It gave a yield of seventy-one bushels corn per acre.

Thoroughbred White Flint.— Stalks slender, leafy, well eared; ears large; suckers profusely, many of the suckers bearing ears. Quality of forage very good; yield under the average. May prove a desirable variety when acclimated.

OATS.

In the spring of 1889 seven varieties of winter oats were sown in field 6. The varieties were attacked by rust just before harvest and so badly injured that no conclusion could be drawn from the yield of grain.

Accurate notes of the habits of growth of each variety were kept. Three of the varieties possess such habits of growth as seem to make them especially valuable for sowing for pasture. *Gray Winter,* seed from T. W. Woods & Sons, Richmond, Va., and *Virginia Winter,* seed from D. Landreth & Sons, Philadelphia, seem to be identical. The early growth is vigorous. The plants stool more than most varieties of oats, and have spreading habits of growth. The leaves are narrow.

Blue Grazing Winter, seed from M. W. Johnson Seed Co., Atlanta, Ga., has a vigorous early growth. The plants stool very profusely, and have a peculiar curly, matted habit of growth, covering the ground with a dense mass of narrow-bladed foliage.

These three varieties of oats ripen late, and sown thickly would furnish a large amount of valuable pasturage. They will stand considerable frost, and if sown early in the fall could be used with profit for fall pasture. In most seasons in this section they would furnish feed until the 1st of January. This kind of fall feed is highly appreciated by stock of all kinds, and where used is found to considerably lessen the amount of other feed required.

SILOS AND SILAGE.

The question of fodder-making from corn is intimately associated with that of silaging. If it can be shown that corn forage is equal in value to corn after siloing—that the fodder can be made and handled as cheaply and fed as economically as silage made from the like material — then it is futile to make further argument for the silo; for silaging is an expensive process, and one that goes naturally with intensive farming and accumulated capital in farming. It seems necessary, therefore, in the outset, to consider the question of

FODDER-MAKING

As preliminary to a statement of facts and experiments bearing on the question of silos and silage.

Every practical man familiar with the facts understands that corn fodder in Kansas is a very different thing from the article of the same name raised in New England and the Middle States. Here, the corn plant in all its parts reaches a development quite unknown in regions of shorter summers and poorer soils. Moreover, the proportion of leaves and blades (edible fodder) is doubtless much less with the Kansas corn than with the small-growing eastern sort, due to the habit of the plant in part, and to the whipping action of the blades in our prairie winds. Kansas corn–fields are weak in the fodder product for other reasons: the ripening period is a very brief one, allowing very little time in which to cut and shock the corn. The subsequent tying and shocking of the bundles of fodder at the time of husking is always, except on “wet days,” a difficult task, due to the nearly always dry and brittle condition of the stalks, and to their bulk. Even when all this has been done with the most pains-taking care, a very large proportion of the valuable corn-blades will be found to have been crushed and broken and scattered about the base of the shocks, from which it can scarcely be recovered. When we attempt to gather the remnant of our fodder, now literally “stalks,” into shape such as to make it water-proof, either by close shocking, stacking, or hauling to the barn, we encounter difficulties, growing out of the coarse, bulky character of the materials, that we have never been able to overcome.

For these reasons chiefly, and because of the cost of cutting up the corn and the added cost of husking from the shocks, we have ceased, upon the College farm, to attempt further to grow corn and fodder in the same field. The same facts have compelled us to look to the silo as a means of utilizing the wealth of vegetation which is otherwise largely wasted in our cornfields.

WASTE OF FODDER IN FEEDING.

After we have cut our corn in the best possible state, shocking it carefully and husking with equal care, there is still a very great waste in feeding it, that few farmers estimate. For three years we have, during a considerable portion of each "feeding" season, fed a number of cows, greater or less, upon corn fodder alone, and in various conditions, *i. e.*, chopped into different lengths and fed whole, and mixed with grain in various proportions. Below is given in tabular form our more recent experiments to test this question of the amount of corn fodder "wasted" or rejected by the animals before which it was placed.

The effort has been made to give results in whole numbers; to this end unimportant fractions have everywhere been discarded:

TABLE NO. 1.

Period covered by experiment.	No. of cows fed...	Daily feed of cow, lbs.........	Amount fed, lbs...	Total waste, lbs...	Length of cut of fodder, inches...	Per cent. of waste...........	Remarks.
1887. December 22–28,	4	20	480	134	¼	28	Fine fodder of excellent quality.
Dec. 28–Jan. 3..	4	20	480	124	½	26	Fine fodder of excellent quality.
1888. January 7–13...	4	20	480	125	1	26	Fine fodder of excellent quality.
February 1–7...	4	20	480	127	2	26	Fine fodder of excellent quality.
February 14–18,	4	19	300	121	*	40	Coarse fodder of good quality — wasted in handling.
February 18–21,	4	20	240	66	2	27½	Fodder of excellent quality.
February 21–24,	4	20	240	64	*	27	Fodder of excellent quality.
February 24–27,	4	18	220	59	1	27	Early-cut fodder, excellent quality.
Feb. 28–Mar. 2..	4	19	230	56	½	24	Early-cut fodder, excellent quality.
March 2–5......	4	19	230	39	¼	17	Early-cut fodder, excellent quality.
March 6–9......	4	16	192	24	¼	12½	Selected fodder — butts removed; fed mixed with corn-meal.
March 9–16.....	4	17	336	47	¼	14	Good fodder, fed with corn-meal.
March 16–19....	4	16	192	8	¼	4	Poor fodder — often mouldy.
1889. March 2–16.....	4	19	538	221	2	41	Fine fodder of excellent quality.
March 5–12.....	4	20	552	214	1	39	Fine fodder of excellent quality.
March 19–26....	4	17	484	113	½	23	Fine fodder of excellent quality.
Mar. 29–Apr. 5..	4	20	560	159	¼	28	Fine fodder of excellent quality.
March 16–23....	4	19	544	156	½	29	Fine fodder, same as above, except that it was *unhusked*.
Mar. 30–Apr. 2..	....	....	900	533	1	59	Ordinary coarse fodder.

* Uncut.

SUMMARY.

Condition of fodder.	Amount fed, lbs.	Total waste, lbs.	Per cent. of waste.
Fodder uncut	540	185	34
Fodder cut in two (2) inch lengths	1,258	414	32
Fodder cut in one (1) inch lengths	2,152	931	43
Fodder cut in one-half (½) inch lengths	1,738	449	26
Fodder cut in one-fourth (¼) inch lengths	1,462	340	23
Fodder cut in one-fourth (¼) inch lengths and fed with meal	528	71	13
Total fodder of all lengths	7,678	2,390	31

This table is interesting and instructive, albeit to some extent misleading, because of the impossibility of stating the exact quality and condition of the fodder.

The table seems to show that the shorter the lengths into which fodder is chopped, the smaller the proportion rejected by the animals; and this, I believe, is generally true of fine fodder of the first quality. That it is not true of all classes of fodder is shown by many of the feeding periods of the table, in which the fodder cut in shortest lengths shows the largest proportion of waste. Moreover, in an experiment made in 1886 we demonstrated that the finer the fodder was cut up the larger the proportion of waste; but in this case the fodder used was coarse and uniformly poor. I am abundantly satisfied from accurate experiments made to test the point, and from a large general experience, that the chief, almost only, value of cutting fodder is found in the fact that such chopped fodder can be placed in the manger and generally handled much more conveniently than the unchopped.

The addition of meal to the cut fodder diminished the waste greatly without a doubt, although it may well be questionable whether cattle are benefited by consuming a large amount of indigestible, woody fiber to which they have been tempted by a very small amount of adhering meal.

The striking fact is that even with the very excellent fodder used in this experiment, and fed as it was in a tight manger, the cattle rejected thirty-one (31) per cent. of all placed before them. Consider for a moment what would likely — certainly, I may say—be the case with ordinary, coarse fodder fed on the ground in the field or yard and often necessarily in the mud !

THE LOSS OF CORN IN FODDER–MAKING.

There is yet another phase of the fodder question that must not be lost sight of. If we make fodder of any real value the corn must be cut up while it is yet green. At what stage of ripeness the corn plant yields the best and largest amount of fodder has not yet been definitely determined, but all agree that the corn plant must be "green" at the time of cutting. Now the experiments of last season, made at this station,* seem to show as conclusively as one trial can show anything, that the loss of corn when cut even slightly green is very great.

It was distinctly shown that in *nearly every case* adjacent rows, cut at intervals of seven to twenty days, gave variations, with only two or three exceptions in seventy-odd cases, almost exactly proportionate to the difference in the time of cutting; the largest yield of the best quality of corn, going with the row cut latest. Indeed, we are plainly taught here that corn continues to improve in weight until the very last—after the blades of the plant have been dried up, and quite likely blown away, and seemingly until the juices of the stalks have been completely sucked up. It is hard to resist the conviction that this cannot be a mere coincidence; that, in short, these figures point to a real principle in the growth of the crop which the farmer cannot afford to ignore. . . . Considering then all the facts—the great labor of husking corn from the shock as compared with "picking" it from the standing stalks, the great difficulty in tying, hauling and stacking or otherwise securing the fodder crop, and the great waste of fodder in the field and ultimate loss in feeding (which we have demonstrated time and again to amount to twenty to sixty per cent. of the stalks) — it is perfectly clear to me that we must raise corn for corn, with no thought of fodder, and corn again which has no higher purpose than the production of fodder. We must, in short, have two corn-fields on every farm, receiving radically different treatment, to correspond with the different purposes for which they are cultivated.

This seems to me to state with sufficient fullness the argument against the attempt to get grain and fodder from the same field. The great Kansas staples, corn and sorghum, are unsurpassed fodder plants when grown and harvested with the single object of making "hay," I have come to think, after three years of careful experiment with the silo upon the College farm, that it is a necessary part of the machinery of the corn-field. The argument for this view is given in what follows.

SPECIAL VALUE OF THE SILO TO KANSAS.

Corn and sorghum are, and are likely to remain to Kansas farmers, the principle sources of stock food. With either of these crops cultivated for the sole purpose of fodder-making, and considering them from the standpoint of bulk or quality, two or three times as much stock food can be produced as from an equal area of timothy, clover, orchard grass, or millet. That bulky foods like corn and sorghum may be harvested easiest, cured best and with least loss, and handled with the least waste, when their destination is the silo, and when there are stored in the smallest space, are facts that go without argument with me. Moreover, a crop of rich corn fodder

See page 42, *et seq.*, First Annual Report Kansas Experiment Station.

or sorghum is always a possibility in Kansas. In 1874 a magnificent crop of fodder corn bearing ten bushels of nubbins to the acre was consumed by grasshoppers because we had no silo in which to store it. In the drouth year of 1887 our crop of sorghum was an excellent one. Last season (1888) we grew a good crop of fodder bearing thirty-five (35) bushels of corn to the acre, the seed of which was planted on July 6th. In this section of the State, an excellent crop of fodder may be grown after the wheat crop has been harvested, where the seed has been listed in upon wheat-stubble ground.

THE EXPENSIVENESS OF ENSILAGE as compared with the common method of fodder-making in the field is often urged by those unfamiliar with it. A comparison of the successive steps necessary in both methods does not, however, show a heavy balance of labor against the silo. In both methods the corn must be cut up and hauled to the barn or feeding-place, and the cutting into half-inch lengths is as necessary to one process as to the other. The silaging, too, saves the expensive process of husking from the shock, and the subsequent hauling, shelling and grinding of the corn. In the single item of husking, the silo saves to its owner much more than the increased cost of hauling the green fodder. The overwhelming argument for the silo, in Kansas, is that it furnishes the means by which the greatest of all forage plants, corn and sorghum, may be cut up, cured, and fed in such time and manner as give to the farmer all of value that there is in them. Of course other crops, the grasses, clovers, alfalfa, the non-saccharine sorghums, millet and forages in general, may be used as silage material, but in Kansas corn and sorghum are, and are likely to remain, well-nigh the only silage materials.

THE SILO.

The silo is simply a more or less completely air-tight and cold-proof room or compartment of any nature. It will be made large or small, according to the size of the herd to be fed from it. A large silo is more economically constructed than a small one, and other things being equal, a smaller proportion of spoiled silage will be taken from a large silo than from a small one. Nevertheless I should on no account advise the erection of very large silos, simply because an accident to a large silo means a very large loss in its contents, and besides, a large surface of silage exposed to the atmosphere will in this climate, unless fed out promptly, mould and spoil, often considerably. However large the herd, I should not care to make the silo larger in superficial area than say 35x15 feet. If larger than this, I should certainly divide the silo by one or more cross-partitions. A few figures giving results obtained at the Station during the last year may prove suggestively useful to the farmer who is thinking of his first silo. However, we give fair warning that such figures, if taken literally, are most delusive. For example, our herd would quite likely have eaten very much more silage than they did had the season been a cold one, or the grain ration less, or had the cattle been larger or less comfortably housed.

DAILY CONSUMPTION OF SILAGE.

Our silo No. 2 is, inside, 18¼ feet by 13¼ feet, and 22 feet high. It was filled-eight days having been occupied in the process—with 80 tons of corn silage, omitting a small fraction here as elsewhere. Two days after the filling it had settled two feet. The average weight of each cubic foot of the contents of this silo at that time was a small fraction under 34 pounds. Our herd to which silage was fed numbered 56 head, all females, of four breeds, and ranging from yearling to aged cows. The average daily feed to these cattle, most of which had a small daily grain ration, was nearly 34 pounds, or almost exactly a cubic foot of silage as it rested in the silo shortly after filling.

Prof. Samuel Johnson, in the April bulletin of the Michigan Station, estimates that cows of 1,000 pounds will consume a daily ration of 60 pounds of silage. This is considerably more than we have been able to feed. With us only large cows, and those of which extra service at the pail, or in suckling calves, was demanded, consumed a daily feed of 60 pounds of silage and an added grain ration. From outside sources of information, the discussions had at farmers' institutes and the like, as well as from our own experiments, I am inclined to think that the estimate of the consumption of silage per head of cattle, here given at one cubic foot per day, is, with a good quality of silage, and considering herds made up of large and small animals, a very safe basis for an estimate of the size of the proposed silo.

LOCATION OF SILO.

If in the possession of a barn of suitable size, I should prefer a silo erected inside this building to an independent structure, by reasons of cheapness in construction and its usual convenience to the animals to be fed from it. Where the silo occupies a portion of the barn, it should be made to extend the full height of it—from the floor of the basement or cellar to the purline plates. A silo located in a dry bank or bluff-side, such that a portion of its height greater or less was beneath the ground, would be most advantageously situated, provided the silage could be withdrawn at the lowest point of the silo. Such a silo would have very decided advantages over one built wholly above ground; it would admit of easier filling, and at a moderate height above ground would give great depth to the silo, which is always an advantage. A silo having a cellar from which the silage must necessarily be hoisted, is wholly inadmissible. The "cellar" portion of the building will ordinarily be constructed of masonry. This should, however, be given a thick coat of cement or plaster, so that the silage is nowhere brought in contact with the stone or brick of the wall.

Our experience with a stone silo has been most disastrous. During the two years we used a silo of exposed stone masonry, our loss of silage must have been nearly or quite fifty per cent. of its contents. Even where this stone work was brushed over with a thick paste of cement and lime, there was found six inches to a foot thick of rotted silage in contact with the masonry. Afterwards the stone work was sheathed over with inch stuff, leaving a two-inch air-space between the sheathing and wall. The same silo since has preserved its contents without loss.

Great care should be taken that the location of the silo is such that feeding from it may be done with the least possible outlay of labor. If located in the barn, the silo should be placed as near as possible to the cattle stalls; if outside, it should be given a position adjoining the feed-yard or shed, as the case may be. Where the herd is fed in shed or barn, the stalls are likely to be arranged in double tiers, the tiers separated by an alley toward which the cattle are headed. In this case, the silo should be placed adjoining the end of the shed in such manner that the door of the silo will open into this common alley.

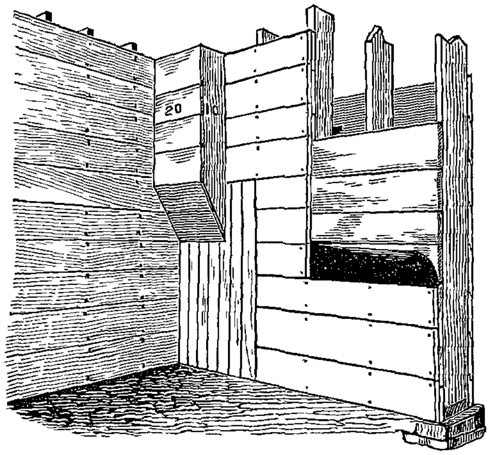
CONSTRUCTION OF THE SILO.

The foundation of the silo walls may be a wooden sill slightly imbedded in the ground, but for obvious reasons such a foundation will rarely be used. In making silos as in many other cases the cheapest method is often a very dear one in the end. I advise farmers generally to be extremely shy of the cheap and easy methods of making silage which I see occasionally recommended by amateurs. *A nearly air-tight and cold-proof room* must be had, and any silo that comes short of this is sure to give the owner a large annual crop of mouldy, spoiled silage.

Our practice has been to build a light stone foundation-wall, one about ten (10) inches in the ground, rising no higher than the surface, and about twelve (12) inches thick at the top. At intervals of about eight (8) feet a bolt of half or three-eighths-inch iron, threaded at the top and provided with a burr, is built in the masonry. This bolt is made to project above or out of the foundation-wall about three inches. A foot-wide, two-inch plank which has been previously tarred and bored to match the projecting bolts, is satisfactory as a sill. This is driven down over the bolts to the top of the wall, the corners are halved together and strongly spiked, the burrs are turned down, and the foundation of our silo is laid.

With a silo twelve (12) feet high, joists 2"x8" set upright every sixteen (16) inches are heavy enough; with a higher wall than this I should use 2x10 joists in every case. The walls of the silo must be made strong enough to bear without deflection the great pressure put upon them. If the Wall yields to the pressure, the silo takes air, and the result is a mass of spoiled silage, greater or less according to the amount exposed. With the joists erected and securely “toe-nailed” to the sill, and secured by a strong plate at the top, the work of finishing the silo is of the simplest character.

The cut represents a part of the interior and cross-section of one of the walls of the College silo No. 3, recently finished. In this silo the exterior wall-shell is composed of shiplap; the inner is made up of two thicknesses of stock-boards, with one thickness of tarred paper intervening. In selecting materials for the silo wall, care should be taken to avoid pieces with knotholes, and those much warped or twisted. In boarding up the inner wall-shell we have found it cheapest in the end to bring the stock-boards to a straight edge with the plane before attempting to nail them up. The tarred paper we put up in horizontal strips, allowing the strips to lap three inches. We have used ten-penny wire nails in sheathing the silo-wall, although quite likely 8s would answer the purpose. The two courses of boards should be made to break joints much more completely than is shown in the cut. The top of the silo, to prevent spreading, ought always to be stayed by a number of cross-ties of plank or wire cable, extending from one plate to the other. The roof of the silo may be made of any materials that will exclude the rain.



THE SILO FLOOR.

Do not attempt to floor the silo with boards or plank. The best and cheapest material for the floor of the silo is common clay, which after having been evenly spread to the depth of three inches should be moistened and worked (puddled) and smoothed with the hoe. One of our silos has a cement floor, the other is floored with clay. For aught that is appreciable to the senses the clay floor is fully equal to the much more expensive one made of cement.

THE COST OF THE SILO.

Will of course largely depend upon local values of the labor and materials employed in its construction. I am abundantly satisfied that it will be unsafe to calculate the cost of the silo in Kansas upon a lower basis than $2 to the ton of its contents.

SILAGE MATERIALS.

Any material of value in the condition of hay or fodder is probably suitable for silage. Clover, timothy, alfalfa, millet, Hungarian, cow-peas and many other forages have been tested and found satisfactory in the condition of silage. Nevertheless, for reasons stated before, the coarse-growing fodder plants, like corn and sorghum, are sure, in Kansas and generally throughout the West, to be the principal if not the only silage crops.

GROWING THE SILAGE CROP.

So far as the corn crop is concerned the tendency in recent years has been strongly in the direction of thinner planting for silage. By many it is maintained that ensilage corn should be planted precisely as though the object was to procure the largest yield of grain of the best quality. I am inclined to think that a like rule holds with ensilage sorghum, and that it should be planted in such a manner as to insure the maximum development of sugar and seed. We plant ensilage corn in drills three and one-half feet apart, with plants occupying in the rows eight to twelve inches of space. The corn is cultivated and kept clean, precisely as corn is ordinarily managed during the growing period. With sorghum designed for the silo we should plant in drills three and one-half feet apart, and grow individual plants in the rows at intervals of six to ten inches. Upon good soil and with fair treatment, corn raised as above will yield twelve to sixteen tons of silage per acre, while the yield of sorghum will often reach twenty tons.

HARVESTING THE CROP.

The tendency has in recent years been markedly towards harvesting corn designed for the silo at an advanced stage of ripeness.

In Kansas it will not be safe to follow eastern practices in this respect. Here the intense heats and other special climatic influences push the corn crop, when once on the down grade towards ripeness, at a constantly accelerating speed; so that often only a few hours separates the grain which is only "glazed" and that which is ripe to flintiness, and dead and dry in leaf, stem, and seed. Moreover, after the corn plant begins to dry up and "fire," the winds act upon the blades and tender parts of the plant most wastefully. For these reasons, and considering the accidents and hindrances likely to arise after the work of filling the silo has fairly begun, this work ought not to be much delayed after the corn is in the early "dough" state.

The simplest and, on most accounts, best method of harvesting corn for the silo is the common plan of cutting the corn with the corn-knife and gathering it in armfuls, carrying each armful as fast as cut directly to the wagon-rack.

It is often necessary to cut the corn and leave it in bunches on the ground hours or even days before hauling. The sweetest and best sample of silage that I have yet seen was made from rather green sorghum which had been cut and left in hundred-pound heaps on the ground during three to five very hot days, before hauling to the silo.

FILLING THE SILO.

Whether the silo should be filled at a continuous operation, or by periods allowing one or two days of rest to follow each day's work of filling, is one of the mooted questions in silage-making. It is argued that the method of slow filling permits free access of air to all parts of the mass of silage, and consequent rapid oxidation and great increase of temperature. This high temperature (140° Fahr. and upwards) destroys the germs of acetic fermentation, it is claimed, and thus we have as a result of the slow filling, "sweet ensilage." By others, this theory, and the facts on which it is based, are disputed, and the claim is put forward that sweet ensilage is due to the condition in which the corn crop is harvested for the silo — well-ripened fodder giving the sweet article of silage, while the green, watery and succulent corn develops a high degree of acidity. In our experience with both plans of filling, the slow method has given what seemed the sweeter silage. I admit, however, that our experience on this point is far from conclusive. It certainly ought not to be a difficult matter for those who have made a study of bacteriology to determine whether a temperature of 140° Fahr —beyond which we have never known the temperature of the silo to rise —is really destructive of vinegar germs.

For practical men this fact remains: we may fill the silo rapidly, or by the slow method, as suits our convenience, with the assurance that no great harm will result in either case. We have used in filling our silo a "13-A" Ross feed-cutter having a twenty-four (24) foot elevator. This machine is operated by a ten (10) horse-power engine, which is greatly more power than is really needed. We have usually cut our silage into half-inch lengths, although for aught I know results have been just as satisfactory when the cut was made at one inch, except that the silage cut into inch lengths would not pack quite as closely in the silo as when the materials were cut in smaller pieces.

We have tried treading and packing the silage as the filling progressed, afterward weighting the mass heavily with rocks, and we have filled the same silo without treading, or subsequent pressure of any kind. In the latter case, the silage kept as well and came from the silo, it seemed to me, in much better order than that which had been thoroughly tramped and weighed. In filling, the stream of silage should fall at as nearly as possible the center of the silo, and it is wise to level the mass frequently, treading down the sides and corners, that settling may go on evenly.. After the silo is full it may be covered with almost any material that will tend to exclude the air. We have found nothing better than a layer of tarred paper, covered about eighteen (18) inches deep with green, fine grass, like the aftergrowth of orchard grass, or prairie grass. This caution deserves the attention of every owner of a silo: do not, on any account, after the silo has been sealed up, disturb this covering or the inclosed silage until you wish to feed it. I have had occasion in a number of cases to break the natural seal of the silo, and always have lost heavily, as a result, in spoiled silage.

EMPTYING THE SILO.

The operation of feeding from the silo is usually performed from the door, as shown in the cut. In feeding it is well to remember that if a silage surface is left exposed to the atmosphere for a number of days, it moulds quite rapidly and not infrequently a considerable loss results. On this account I prefer to feed from the top of the silage, so that more or less of the entire surface can be fed every day. To accomplish this purpose I planned in the new silo (No. 3) the shoot, shown in the cut, over the door of the silo. This consists simply of a 2"x10" spiked on edge securely to the silo, twenty inches from the corner. Twenty-inch pieces of shiplap lightly tacked to this projecting plank connect it with the adjacent wall, thus forming a 10"x20" shoot which passes through the inner door of the silo.

This shoot has been used in emptying silo No. 3 to our entire satisfaction. The silage kept without moulding as well in contact with the shoot as that from any other portion of the silo. In other words, the shoot did not promote decomposition of the contact ensilage in the least. Every man having a practical acquaintance with the subject will recognize the importance of removing the ensilage, beginning at the top of the mass, and we can think of no means by which this can be accomplished so satisfactorily as by the device here figured, or something like it.

STATION EXPERIMENTS WITH SILAGE, 1888-9.

In the late summer and fall of 1888, beginning August 13, we put away in two silos a total of one hundred and fifteen (115) tons of silage, placing thirty-five (35) tons in silo No. 1, and eighty (80) tons in silo No. 2. A record was made of all silage placed in the silos, but weighing of silage taken from the silo was only made in the case of silo No. 2. It should be said that all of this 115 tons, except sixteen tons of odds and ends obtained from various forage experiments, was had from a corn-field of eight and one-half (8.35) acres nearly. The results of this experiment, including the feeding of the silage and the various determinations made by weighing, are given in concise form as follows:

1. Eight and one-half acres of corn gave 98.8 tons of silage, an average yield of 11.83 tons per acre. The maximum yield of a measured acre was 16.1 tons.

2. The 115 tons of silage fed by us in the winter of 1888-9 carried 56 head of cattle 123 days, an average daily feed — with small-grain ration — of 34 lbs., or one cubic foot of silage.

3. Of the 80 tons placed in silo No. 2, 10,347 lbs., or 6.47 per cent., spoiled. This loss was chiefly caused by the yielding of the silo walls. The amount rejected by the cattle, due almost wholly to over-feeding, was 1,296 lbs.—less than 1 per cent. of the 80 tons. The loss by evaporation was 7 per cent.

4. The cost of labor in cutting the corn, hauling it fifty rods to the silo, and storing it therein, was 62 cents per ton. This does not include any charge for use of machinery or power. This cost has been greatly reduced in 1889.

5. Assuming that one acre of corn produces 24,000 lbs. of silage, each animal consuming 34 lbs. daily, and deducting 10 per cent. for waste, we find that one acre of corn put in the form of silage will carry, with a small-grain ration, three cattle during the feeding season of 195 days, with 80 days' feed to spare.

6. Best results will be had when silage is fed with hay or other dry fodder. Silage of itself is not a sufficient food where much is expected of cattle.

PITTING GREEN CORN.

An interesting experiment in preserving green corn in a trench-like excavation made in the soil of the corn field, was made this year with very satisfactory results. With team and scraper an excavation was made, which, when completed, was some thirty (30) feet long, fifteen (15) broad, and two-and-one-half (2½) feet deep. Early in October corn which had been considerably frosted was placed in this pit, care having been taken to arrange the stalks evenly in two tiers, placing tops and butts alternately right and left, so as to keep the corn-pile level. Then a heavy iron roller was kept in constant motion upon two rows of plank, which were shifted with the roller back and forth from one side or end of the stack to the other, to be out of the way of the stacking. All told, some ten (10) tiers—it was not weighed—of corn were placed in the pit. The filling occupied portions of three (3) days, and at the end of that time the stack was not much above the surface of the ground. The stack was then covered with straw to the depth of four (4) inches; the scraper was set at work again, until the stack was covered with earth to the depth of twenty (20) inches. (This doubtless was two or three times as much earth as need to have been used for this purpose.)

On opening the pit for the first time — late in December— its contents were found to be the very perfection of ensilage. The ears of corn were soft as when put in the pit, and nearly as sweet; the stalks and blades were juicy, and bad only a faint suggestion of acidity. Certainly no silage made upon the College farm the present season will equal in quality that taken from this "hole in the ground." Of waste by rotting, there seems to have been absolutely none.

It seems to me, that in this experiment there is the suggestion of a truth that might be given a very wide practical application. Upon a dry knoll, or in a sandy, friable soil, a silo with capacity for a hundred tons of stalks might be dug at very slight expense, and might be filled without the need of expensive machinery of any kind.

STEAMING SILAGE.

In view of the fact that practical men generally agree that silage materials should go into the silo in a condition of abundant moisture (succulence), while scientists tell us that the filling should be done slowly in order to allow the development of great heat—sufficient to destroy the bacteria of acetic fermentation—it has seemed that both objects might be satisfactorily accomplished by steaming the mass of ensilage either during or immediately after filling the silo. To test this question, a small silo—one having capacity for three or four tons of silage—was constructed in the experiment barn, in the fall of 1888. This silo, except in the matter of size, was made precisely as that described in the foregoing pages. It was connected with the boiler by means of a half-inch steam pipe, which discharged steam into the space beneath a perforated false bottom, at a point near the middle of the silo floor. Live steam at a pressure of sixty (60) pounds was applied to the ensilage as soon as the silo had been filled, and this pressure was maintained until the steam escaping from the top of the mass told us that it was thoroughly cooked. Three trials of steaming were made, as follows:

EXPERIMENT No. 1.— In November the silo was filled with frosted sorghum cut in half-inch lengths, steamed, as above indicated, and promptly covered in with tarred paper and a tight-fitting board cover, which again was covered with eight inches of earth. At the expiration of about three months the contents of the silo were examined, when the mass was found to be in very bad condition. A large part—practically all, for the sound silage could hardly be separated from the spoiled—was mouldy and had a rank, rotten smell.

EXPERIMENT No. 2.— The silo was filled in June, 1888, with very succulent clover, which was cut and steamed as before, and afterwards covered in carefully. An examination of this clover ensilage, made three months after filling, showed the entire contents of the silo to be a disgusting mass of rotten clover.

EXPERIMENT No. 3.— In this experiment, green corn cut and stowed away in the silo as usual, was employed. The trial was made early in the season of 1889, and the silo was uncovered and examined about two months after it had been filled. As with the sorghum and clover, the great mass of ensilage thus treated, was mouldy, musty, and in a state of incipient rottenness, and wholly unfit for cattle food.

These facts seem to me to settle the question of steaming ensilage, so far as the practical man is interested in the subject. In every case tried by us, steaming seemed to give the ensilage a long start in the direction of rottenness.

FEEDING EXPERIMENT.

Shorts-Bran and Corn Meal Compared, as Food for Young Pigs.

The original idea of the experiment, the subject-matter of this article, was that two equal lots of young pigs should be fed in such manner as best to show the influences of common nitrogenous and carbonaceous foods upon both quality and quantity of the meat produced. In truth, the experiment just concluded is, in its essential features, with the single exception (the age of the pigs), a repetition of that made by me one year ago, (see Report of Secretary State Board of Agriculture for April, 1889,) in which only matured hogs were employed. In that experiment five hogs were given an exclusive diet of shorts and bran in equal parts, while five others received corn meal alone, containing about one-half the nitrogen of shorts-bran.

The results of careful slaughtering and subsequent examination showed no perceptible difference in the amount of lean meat in the two sets, or in its arrangement with the fat (marbling), although the general character of the meat of the corn-fed pigs was clearly better than that made from shorts-bran. The corn-fed series made a quicker, larger and more profitable gain of fatter meat than the others; their bones were as strong, and in the amount of blood and development of vital organs they were at least equal in all respects to the lot fed bran-shorts.

PLAN OF THE EXPERIMENT.

The experiment herein detailed was planned as follows:

1st. Ten *young* pigs, uniform in character, thrifty and vigorous, should be used.

2d. These to be fed in two equal sets — one receiving shorts and bran combined in definite proportions; the others corn meal alone or in combination with condimentary and other foods likely to add to the palatableness of the corn without increasing the proportion of nitrogen in the total feed.

CHARACTER OF THE PIGS.

The ten (10) pigs employed in this experiment were all purely-bred pedigreed Berkshire of the highest breeding. Their ages, sex, and, to some extent, relationship, are shown in the subjoined groupings.

The pigs having a common date of farrowing are of course of the same litter:

No. 1. Sow, " 3. Sow, " 5. Sow, " 6. Sow, " 10. Sow,	Farrowed March 28, 1889.
" 2. Sow, " 4. Barrow, " 9. Barrow,	Farrowed April 8, 1889.
" 7. Sow, " 8. Sow,	Farrowed April 28, 1889.

The litters of March 28th and April 28th had a common sire, while the dams of the three (3) litters were closely related.

From weaning-time to the time of the commencement of the experiment, the pigs were fed on shorts, bran, milk and corn in no very definite proportions. All were healthy, vigorous and well grown when put into the experiment pens.

DETAILS OF THE EXPERIMENT.

As in all previous pig-feeding experiments made in this department, each pig was given the exclusive use of a pen, an arrangement absolutely necessary to a knowledge of the behavior of individual animals. The pens, however, were only in use during the night-time. It seemed to us in the outset essential that these young and growing pigs should have every inducement to take ample exercise. To accomplish this, it was necessary that they should consort freely and have abundant range.

While in the outset the carrying out of this plan seemed beset with practical difficulties, these quickly vanished when brought to the test of experience. The practice was to gather the pigs to their several pens in the evening, where they were fed and allowed to remain over night. In the morning all were fed and afterwards driven promiscuously into a yard, a half-acre or more in extent, where they remained until evening. No difficulty was experienced in identifying each pig by punch-marks and nicks made in their ears. At first, extra help was required to drive the animals to the piggery, and in assigning each to its proper quarters; but this difficulty was not lasting. The animals, as evening approached, came regularly to the piggery, where it was an easy task for one man to assign each pig to its own pen.

THE FEED AND FEEDING.

As before intimated, pens 1 to 5 inclusive, were fed shorts-bran — always cooked in equal proportions — and pens 6 to 10 inclusive, cooked corn meal with certain variations and additions to be noticed hereafter. The addition of bran to the shorts doubtless made a more appetizing and easily-digestible food than shorts or bran alone would, and seemed to warrant an addition to the corn meal of the second set.

Knowing the keen liking of swine for animal food of all kinds, an addition of five per cent. *(5%)* of tallow was made to every feed of corn given in the course of the experiment.

Later on, (September 24th—November 5th,) the corn-fed pigs were given equal parts of corn and potatoes. From the first the feed of both series was thoroughly cooked to the condition of a mush or pudding, as the case might be. Occasionally the feed was given in a raw state, but in every case of the use of raw feed the failure in the appetites of the pigs became so quickly apparent that the trial was never persisted in beyond a few days or a week at furthest. These subsidiary trials, the use of fat, raw food and cooking, had but one object: to put the food in such shape as to secure for it the *largest possible consumption* by the pigs.

Although I have no facts more accurate than those coming as matters of experience and general observation, it seems clear now that every variation in the foods, beyond the use of fats and cooking, was attended by a loss. The potatoes were of undoubted value, considered either as an appetizer or true food.

The mixture of shorts and bran was evidently much more satisfactory to the pigs than either taken alone. When clear shorts was used cooked, the result was a sticky, pasty mess that seemed much less satisfactory to the pigs than when bran and shorts in equal portions were employed. Clear bran again, used only a few days, excited the disgust of the pigs to such an extent that it was quickly discontinued. In the tables following, no attempt has been made to indicate the variations made from the conventional feed, as stated above, except in the case of potatoes; the figures in *bold-faced type* refer to the mixture consisting of equal parts, by weight, of corn meal and potatoes.

The feed was cooked as needed at intervals of two or more days, depending somewhat upon the state of the weather as to temperature.

A given amount of food was weighed out, and this was cooked with water sufficient to make a "mush" of the desired consistency (five parts of water to one of meal or shorts-bran). The pigs were fed at morning and evening, great pains having been taken to give each animal all that he would eat without waste. Water was supplied by the brook which ran through the yards occupied by the pigs every day of the experiment. It is a plain inference from the condition of the pens occupied by the two sets, that the shorts-bran series drank greatly more water than their fellows of the other lot: the gutters from the pens occupied by the former flowing almost steadily, while those of the latter were as constantly dry. In this respect the experiment tallies exactly with that of one year ago. Both lots received whatever salt they required, and an abundance of cob-charcoal — of which they were greedy consumers — was regularly supplied them.

The following table, taken from the Annual Report of the Connecticut Experiment Station for 1887, sufficiently indicates the nature of the foods used in this experiment:

	Total dry matter.	Albuminoids or protein.	Crude fat.	Nitrogen, free extract.	Fiber.	Ash.
"Western corn"	80.90	8.30	3.70	66.00	1.75	1.20
Shorts	87.26	13.83	4.14	57.59	7.45	4.25
Bran	87.62	15.36	3.83	53.50	9.34	5.59
Potatoes	21.90	2.19	.10	18.19	.54	.88

It is plain from this tabular statement that for equal amounts of feed consumed in the two sets, the corn-fed pigs got less than one-half of the nitrogen contained in the food of the companion lot.

The subjoined tables give the essential facts of the experiment in statistical form. The figures indicating quantities, refer to pounds and decimals thereof in every case:

TABLE NO. 1.

SHOWING THE WEEKLY GAIN AND WEIGHT OF EACH PIG AT BEGINNING OF EXPERIMENT AND AT ITS CLOSE; GAIN OF EACH PIG, AND TOTAL GAIN; GAIN PER CWT. OF EACH PIG, AND AVERAGE GAIN PER CWT.

	FEED: SHORTS-BRAN (lbs.).						FEED: CORN MEAL (lbs.).					
	No. 1...	No. 2...	No. 3...	No. 4...	No. 5...	Total...	No. 6...	No. 7...	No. 8..	No. 9...	No. 10..	Total...
Wgt. of pig at beginning of exp., Aug. 13, 1889......	76	66	64	50	83	339	78	60	47	52	108	345
Gain Aug. 19..	10	6	11	5	7	39	8	6	6	6	7	33
" " 26..	3	4	3	4	8	22	7	2	3	1	4	17
" Sept. 2..	10	10	7	9	12	48	3	6	4	8	11	32
" " 9..	2	5	7	5	2	21	10	1	2	3	6	22
" " 16..	14	11	11	9	11	56	6	5	9	6	4	30
" " 23..	3	2	7	10	9	31	5	6	1	7	12	31
" " 30..	5	9	10	6	8	38	2	7	9	7	8	33
" Oct. 7..	17	13	14	10	15	69	10	7	17	12	8	54
" " 14..	3	4	3	9	7	26	10	6	0	10	10	36
" " 21..	7	10	17	9	14	57	12	9	7	2	13	43
" " 28..	22	16	13	16	21	88	18	10	10	21	19	78
" Nov. 4..	9	9	7	9	10	44	10	8	6	7	15	46
" " 11..	14	15	18	15	21	83	10	5	8	9	3	35
" " 18..	12	2	8	6	6	34	11	13	2	5	17	48
" " 25..	18	16	12	11	17	74	14	12	10	10	13	59
Weight at end of experiment......	225	198	212	183	251	1069	214	163	141	166	258	942
Gain...... ..	149	132	148	133	168	730	136	103	94	114	150	597
Gain per cwt..	196.0	200.0	231.2	266.0	202.4	.....	174.2	171.6	197.8	219.2	148.1	....
Average gain per cwt.....	215.3					.....	173.0					....

TABLE NO. 2.

SHOWING THE FEED CONSUMED EACH WEEK BY EACH PIG, AND THE TOTALS FOR EACH PIG AND SET.

(The figures in bold-faced type stand for a mixture of feed, consisting of corn meal and potatoes in equal parts.)

	FEED (lbs.): SHORTS-BRAN.						FEED (lbs.): { CORN MEAL. CORN MEAL AND POTATOES.					
	No. 1...	No. 2...	No. 3...	No. 4...	No. 5...	Total...	No. 6...	No. 7...	No. 8...	No. 9...	No. 10..	Total...
1st week..	20½	16	21½	15½	27½	101	22	13½	13½	14	24½	87½
2d " ..	29	21½	28	21	33½	133	27½	12	11	12½	29	92
3d " ..	30	28	28	26	35	147	30	17	14	17	30	108
4th " ..	34	31½	33	30½	36	165	26½	18	14½	18	34	111
5th " ..	35	32	35	32	38	172	28	17½	15	17½	32	110
6th " ..	28	28	27	32	33	148	20	16	18	20	32	106
7th " ..	43	43	43	38	48	215	**42**	**32**	**32**	**36**	**48**	**190**
8th " ..	49	49	49	48	54	249	**55**	**42**	**41**	**49**	**61**	**248**
9th " ..	36	38	38	39	44	195	**67**	**54**	**50**	**57**	**70**	**298**
10th " ..	54	51	50	53	63	271	**63**	**46**	**44**	**62**	**76**	**291**
11th " ..	55	55	55	55	68	288	**67**	**58**	**58**	**66**	**91**	**340**
12th " ..	62	62	62	62	77	325	**77**	**63**	**61**	**72**	**100**	**373**
13th " ..	69	63	69	68	86	355	47	38	38	43	54	220
14th " ..	64	59	64	60	79	326	42	37	29	40	61	209
15th " ..	64	53	64	54	77	312	41	41	30	38	57	207
Feed consum'd by each pig...	672½	630	666½	634	799	.....	655	505	469	562	799½	.....
Feed consum'd by each set .	3,402						2,990½					

TABLE NO. 3.

SHOWING THE COST, IN POUNDS OF FEED, OF ONE POUND OF INCREASE WITH EACH PIG EACH WEEK OF THE EXPERIMENT; AND THE LIKE COST OF THREE GROUPS OF EACH SET, AND BOTH SETS.

(The figures in bold-faced type stand for a mixture of feed, consisting of corn meal and potatoes in equal parts.)

	FEED (lbs.): SHORTS-BRAN.						FEED (lbs.): { CORN MEAL. CORN MEAL AND POTATOES.					
	No. 1	No. 2	No. 3	No. 4	No. 5	Average feed for 1 lb. of increase of three groups	No. 6	No. 7	No. 8	No. 9	No. 10	Average feed for 1 lb. of increase of three groups
1st week	2.05	2.66	1.95	4.20	3.92		2.75	2.25	2.25	2.33	3.50	
2d "	9.66	5.37	9.33	6.50	4.18		3.92	6.00	3.66	12.50	7.25	
3d "	3.00	2.80	4.06	3.43*	2.91	3.99	10.00	2.83	3.50	2.12	2.72	3.72
4th "	17.00	6.30	4.71	6.40	1.80		2.65	18.00	7.25	6.00	5.66	
5th "	2.50	2.90	*3.18	3.55	3.43		4.66	3.50	1.66	2.91	8.00	
6th "	9.33	14.00	3.85	3.20	3.74		4.00	2.66	18.00	2.85	2.66	
7th "	8.26	4.81	4.30	6.33	6.00		**2.10**	**4.57**	**3.55**	**5.14**	**6.00**	
8th "	2.88	3.76	3.50	4.80	3.60		**5.50**	**6.00**	**2.41**	**4.08**	**7.62**	
9th "	12.00	9.50	1.26	4.33	6.28		**6.70**	**9.00**	**No Gain.**	**5.70**	**7.00**	
10th "	7.77	5.10	2.94	5.88	4.50	4.79	**5.25**	**5.11**	**6.28**	**31.00**	**5.84**	**6.00**
11th "	2.50	3.44	4.23	3.43	3.23		**3.72**	**5.80**	**5.80**	**3.14**	**6.66**	
12th "	6.88	6.88	8.85	6.88	7.77		**7.70**	**7.87**	**10.16**	**10.17**	**18.00**	
13th "	4.92	4.20	3.83	4.53	4.09		4.70	7.60	4.75	4.77	1.80	
14th "	5.33	29.50	8.00	10.00	13.16	5.25	3.54	2.84	14.50	8.00	3.58	4.47
15th "	3.55	3.31	5.33	4.90	4.52		2.92	3.41	3.00	3.80	4.38	
Am't of feed for 1 lb. of increase of each pig........	4.51	4.77	4.50	4.76	4.16		4.81	4.90	5.04	4.93	5.33	
Average amount of feed for 1 lb. of increase........	4.66						5.00					

SUMMARY,

SHOWING THE GENERAL RESULTS OBTAINED IN THE TWO SERIES.

	Total feed. (lbs.)	Average daily feed per pig. (lbs.)	Average daily gain per pig. (lbs.)	Feed consumed for each pound of increase. (lbs.)	Total gain. (lbs.)	Gain per cwt. of pig. (lbs.)
Pens 1, 2, 3, 4, and 5— Feed: Shorts-bran...	3,402	6.48	1.39	4.66	730	215.33
Pens 6, 7, 8, 9, and 10—						
Feed: Corn meal..	1,250½	3.96	0.97	4.08	597	173.62
Feed: Corn meal.. and	870	4.14	1.38	6.00		
Feed: Potatoes...	870	4.14				

The results obtained with the young pigs employed in this experiment are in striking contrast in many respects with those obtained a year ago with mature hogs fed and treated in all essential respects as the subjects of the experiment under consideration have been. We reported of the experiment of a year ago, that "The corn-fed lot ate the largest daily ration (by 11½ per cent., nearly), made the largest average daily gain (by 9 per cent., nearly), and the largest gain per cwt. of pig (by 10 per cent., nearly); but the amount of food required to make a pound of increase was less (by nearly 2 per cent.) with the shorts-bran-fed series than with the pigs fed corn alone."

The present experiment in its results runs counter to that of one year ago in every one of the above particulars. The shorts-bran-fed pigs (see summary above) consumed daily much more than those fed on corn alone, made the largest gain per cwt. of pig; but, again, exactly contradicting the record of one year ago, the amount of feed required to make one pound of increase was smaller where that feed was corn meal than where shorts-bran was used. Even with these young pigs fed for nine (9) weeks upon an exclusive diet of corn meal, plus five (5) per cent. of tallow, larger gain was realized than was given by an equal amount of the shorts-bran mixture.

Those people who tell us over and over again, with almost painful iteration, of the dangers that lurk in the shadow of the corn-crib, may study with great advantage the groupings under table No. 2. We here see, in the case of every comparison (see first and third groups) of the pure corn and shorts-bran diet, that in the important particular — the amount of food required to produce a pound of gain — the advantage was in favor of the corn diet, in the one case considerably, and in the other markedly. But the most striking fact is seen in the comparison of the two sets during the time in which one was fed the shorts-bran mixture, and the other equal parts of corn meal and potatoes. Turning to the summary again, we are shown that 8.28 pounds of the mixed corn and potatoes, containing nearly one-half water, and in dry substance about 5.24 per cent. of albuminoids to about 44 (43.99) per cent. of starch and fat, gave almost exactly the same increase as that yielded by 6.48 pounds of shorts-bran having only 12½ per cent. of water, its dry substance containing 14.59 per cent. of albuminoids to 59.53 per cent. of starch and fat.

What the corn-potatoes mixture should have done to have been only equal, weight for weight of dry substance, to the highly albuminous shorts-bran, may be made clear by a simple computation:

.219 = Dry sub., potatoes.	.8726 = Dry sub., shorts.
.809 = " " corn.	.8762 = " " bran.
2) 1.028	2) 1.7488
.514 = Dry sub., mixture.	.8744 = Dry sub., mixture.

.514X8.28 (daily feed of corn and potatoes) = 4.255 = Daily feed of dry sub.
.8744X6.48 (daily feed of shorts-bran) = 5.665 = Daily feed of dry sub.

5.665 : 4.255 :: 1.39 : 1.04.

The reader will remember that the starchy corn-potatoes mixture actually gave 1.34 pounds of increase, instead of the 1.04 pounds it should have given, to have been precisely equal in feeding quality to the shorts-bran.

Much is said by scientific writers in the agricultural publications of the day, of the importance of a ration that is properly "balanced" in its chemical constituents. I have no doubt that a certain considerable latitude in food elements is necessary in particular cases—the food of young and rapidly-growing animals, perhaps—although I am confident that the practical man may generally, with perfect safety, disregard the chemical refinements of the "proper nutritive ration." Profit in the production of the staple results of feeding, the world's supply of meat, milk and its products, wool, and laboring animals, will ever depend, not upon the nice adjustments of chemical elements, but upon practical skill in selecting, preparing and combining foods in such manner as to insure the largest consumption and most complete digestion and assimilation.

APPEARANCE AND BEHAVIOR OF THE PIGS.

The two sets differed in appearance in one particular only: the corn-fed lot had plainly the glossiest and seemingly most abundant hair. So noticeable was the distinction of the two sets in this regard, that the casual help employed in connection with the experiment would pick out the two series without hesitation by this character alone. In respect to feeding and the disposition to exercise, no great difference could be made out.

There were idiosyncrasies as to minor matters in both sets, but the general behavior of the two was strikingly alike. The corn-fed pigs having had a number of minor changes of diet—cooked meal to raw, and cooked meal to cooked shelled corn — always lost in appetite or consuming power with every change.

After the regular diet had been decided upon, no difference could be made out in the appetites or digestion of the pigs of the two sets. As above intimated, the shorts-bran lot evidently drank the most water, as was plainly shown by the almost constant flow from the gutters of the pens occupied by these pigs.

POST-MORTEM STUDIES.

All of the pigs were slaughtered November 26th, after a fast of sixteen (16) or more hours, and at once a thorough examination of all the parts of each animal was made. The slaughtering was carefully done by bleeding, and the difference between the weights of the pigs before and after slaughtering is given as the weight of the blood.

After slaughtering and dressing, the thoracic and abdominal viscera were carefully cleaned and the principal parts weighed, together with the fat adherent to the intestines. The result of these weighings is shown in full in tabular form further on. After having been hung up in a cold place until the following day, the carcasses were taken down and cross-sections of each made at the middle loin, and between the sixth and seventh ribs. These sections were at once photographed, and reproductions of these are given hereafter. Each plate exhibits two like sections of two pigs. These pigs were, in the case of each plate, selected because of their resemblances in weight, ripeness and general make-up. The aim was to place side by side pictures of the flesh of those pigs which were nearest alike.

CHARACTER OF THE MEAT.

There were several notable differences in the character of the flesh of the two sets. The corn-meal-fed pork was pure white, and firm to the touch, while that from the shorts-bran-fed pigs was in color a dirty yellow, and in texture soft and flabby. In this respect, at least, the result of the experiment under consideration corresponds very closely with that of one year ago. The lean meat of the shorts-bran series was darker than that obtained by the corn-potatoes diet, and of every two animals compared, the proportion of lean meat to fat was clearly greater in the case of those pigs fed shorts-bran. The amount of this increased proportion was usually not large, but in every instance the distinction of the two sets in this respect could be clearly made out. But not only was the *proportion* of lean to fat greatest in the shorts-bran series, but the *actual amount* of lean meat was greater, as was the actual amount of fat in the corn-potatoes series, so far as could be judged by the eye, in every comparison made. Whether this difference is due to the large amount of nitrogen compounds contained by the shorts-bran, according to Professors Sanborn and Henry, or to the increased consumption of food, as would likely be claimed by Mr. Joseph Harris, I am unable to decide. The fact remains, however, that our young pigs gave in this and other important respects very different results from those obtained a year ago with mature hogs. It is to be observed, however, that then the consumption of corn meal was considerably greater than shorts-bran (6243:5597), while in the present instance the amount of shorts-bran used was to the corn-meal-potatoes feed as 3402: 2990½.

TABLE NO. 4.

		Live weight, lbs.	Dressed weight, lbs.	Per cent. of shrinkage.	Blood, lbs.	Tongue, oz.	Heart, oz.	Lungs, oz.	Liver, oz.	Kidneys, oz.	Spleen, oz.	Stomach, oz.	Uterus, oz.	Tenderloin, oz.	Intestinal fat, oz.	Leaf lard, oz.
SERIES I.	No. 1...	215	171	20	5	8	10	14½	74	12	3	28	18	18	50	116
	No. 2...	202	153	24	5	10	9	14	57	10½	2	25	14	25	24	90
	No. 3...	207	160	22	5	8½	9	13½	80	12½	4	28	18	20	56	99
Feed: Shorts-bran.	No. 4...	187	136	27	4	7	8	14	66½	11	3	23	......	17	67	89
	No. 5...	242	189	21	6½	10	12	15½	84	14	4½	29	21	25	88	133
Averages.....................		210.6	161.8	23	5.1	8.7	9.6	14.3	72.3	11.8	3.3	26.6	17.7	21.0	57	105.4
Average per cwt. dressed pig....		......	......	......	3.15	5.37	5.93	8.83	44.68	7.41	2.04	16.44	10.55	12.97	35.2	65.14
SERIES II.	No. 6...	201	164	18	3	8½	9	17	51	9	3	25	12½	13½	58	127
	No. 7...	163	125	23	4	7	9	14	54	7½	2½	19	13½	17	50	83
	No. 8...	138	107	22	3	6	6½	13	45	6	2½	17	2½	11	50	72
Feed: Corn meal and potatoes.	No. 9...	164	127	23	3	6	7	12	48	9	2½	18½	......	13	66	114
	No. 10..	251	206	17	4	10½	10	15½	48½	11	4½	24½	12	19	98	153
Averages.....................		183.4	145.8	20.6	3.4	7.6	7.9	14.3	49.3	8.5	3	20.8	10.1	14.7	64.4	109.8
Average per cwt. dressed pig....		......	......	......	2.33	5.21	5.41	9.8	33.81	5.83	2.05	14.26	6.72	10.08	44.17	75.3

In table No. IV is exhibited the weights of the principal organs concerned in the functions of nutrition, together with certain special parts, and the live and dressed weights and shrinkage of each pig from the condition of live weight to that salable carcass. The average shrinkage—not given in the table — in the shorts-bran lot was twenty-four (24) and in the lot fed corn-potatoes twenty (20) per cent. Manifestly the differences in weight of the pigs of the same or different series precludes a comparison of individuals. The true statement, therefore, of the development of the organs and parts named in the table, must be sought in the figures following "Average per cwt of dressed pig." We here see that the differences are generally in favor of the pigs fed shorts-bran, the exceptions to the rule being the lungs, the spleen, and the intestinal and "leaf" lard. In the weight of the blood, the liver, the kidneys, the uterus, the stomach, and the tenderloin, the balance in favor of the shorts-bran lot was considerable. The differences in the two lots in the particulars named may possibly be explained by the difference in the character of the food of the two sets, although to my mind other considerations have influenced this result. Thus the great comsumption of water by the first series may be a sufficient explanation of the excess of blood in that class; while the comparatively large amount of food, particularly in *bulk,* used by this set, must have called for increased activity and size in organs like stomach, liver, and kidneys, which are particularly concerned in utilizing it. Whether these suggestions of an explanation are true or not, matters but little; the practical fact remains that the corn-fed series were, to all appearances, in vigor, activity and strength, the equals of their companions of the shorts-bran diet.

THE DRY SUBSTANCE OF BOTH COMPARED.

To further test the difference of the meat of the two sets, samples of both were subjected to prolonged drying, with the object of showing the character of the meat from which moisture had been completely removed. Half-pound samples of the lean and fat of each were taken from different parts of each animal. The lean was cut from the loin, the muscles of the back, and the ham; while the fat was obtained from the superficial layer of the back and flank. Each sample, after having been reduced to thin strips, was subjected to prolonged drying in an oven kept at a nearly uniform temperature of 110° Centigrade. This drying process was maintained until the repeated weighings, at considerable intervals of time, showed no diminution in weight, and consequently no loss of moisture in the samples. The drying process was maintained with scarcely an interruption for 150 hours. The result of this drying is shown in the tabular statement on the following page.

TABLE NO. 5

SERIES I: SHORTS-BRAN-FED.	Per cent. of water in lean meat	Per cent. of water in fat meat	SERIES II: CORN-POTATOES-FED.	Per cent. of water in lean meat	Per cent. of water in fat meat
No. 1	73	9	No. 6	72	..
No. 2	75	12	No. 7	73	7
No. 3	73	10	No. 8	74	7
No. 4	74	11	No. 9	73	6
No. 5	73	9	No. 10	72	10
Average	73$\frac{3}{5}$	10$\frac{1}{5}$	Average	72$\frac{4}{5}$	7$\frac{1}{2}$

We here see that the difference in the character of the lean meat of the two sections was not great, so far as the water it contained is concerned, but the lesson of the table, in so far as it relates to the fat, clearly supports the direct evidence of the senses: it was greatly inferior in the shorts-bran-fed lot to that of the companion series.

STRENGTH OF THE BONES.

The left femur of each pig was removed and subjected to a careful test for strength by Prof. O. P. Hood, of the Department of Mechanics and Engineering. The report of these trials, made by one who I should say knew nothing of the antecedents of the pigs from which the bones had been taken, is given below:

PROF. E. M. SHELTON: I have the honor to submit the following report of a test of the strength of various bones submitted to me.

The bones were all the left femur, with all flesh removed by scraping. The bones were placed on supports four inches apart, and pressure sufficient to break was gradually applied to a point midway between supports. The accompanying table gives the breaking weights:

TABLE NO. 6.

SERIES NO. 1: SHORTS-BRAN-FED.	Weight of bone, ounces	Breaking weight, lbs.	Breaking weight per cwt. dressed pig, lbs.	SERIES NO. 2: CORN-POTATOES-FED.	Weight of bone, ounces	Breaking weight, lbs.	Breaking weight per cwt. dressed pig, lbs.
No. 1	5$\frac{1}{2}$	729	426	No. 6	5$\frac{1}{2}$	410	250
No. 2	4$\frac{1}{2}$	422	275	No. 7	5	572	458
No. 3	5$\frac{1}{2}$	495	309	No. 8	4	441	412
No. 4	5	595	437	No. 9	5	477	375
No. 5	6$\frac{1}{2}$	651	344	No. 10	7	525	254
Average	5$\frac{2}{5}$	578$\frac{2}{5}$	357	Average	5$\frac{3}{10}$	485	332

There were two characteristic fractures, but these were not so pronounced as in the set tested by me one year ago. The fractures of Nos. 1, 2 and 4 were nearly square across the bone, with broken surfaces nearly square across the structure of the bone. There were very few cracks in the fractured portions. Nos. 3 and 5 could be described in the same manner, except that the fracture was rougher and showed long cracks on the sides.

These all broke without any previous warning by cracking.

Nos. 6, 7, 8, 9, and 10, invariably cracked when under a strain of from 25 to 130 pounds less than the breaking weight.

No. 6, breaking at 410, showed long cracks on the under side at 280.

Nos. 7, 8, and 9, showed very irregular fractures, having sharp, flinty points, and breaking in a number of small pieces. Nos. 6 and 10 were very irregular, but less flint-like. Nos. 6, 7, 8, 9, 10, all show long cracks on the under side of the bone.

Respectfully submitted. O. P. HOOD, *Superintendent.*

The facts of this table, and Prof. Hood's report, certainly show no great difference in the character of the bones of the two sets. There is a difference plainly, and that difference, except in the weight of the bones, is in the case of every average made, in favor of the shorts-bran-fed series. It is noteworthy, however, as showing how impartially the excesses over averages are distributed between the two sets, that while the largest force in breaking was required in No. 1 of the shorts-bran lot, the heaviest bone (No. 10), and the bone requiring the largest stress per cwt. of pig (No. 7), were furnished by the second series.

THE COOKING TEST.

The meat of the two series received a thorough test by boiling and roasting, and in a less degree by frying. Of the four (4) double roasts tested, two were reported as showing no appreciable difference in texture or flavor; while in the case of two (2), the shorts-bran meat was pronounced distinctly dryer, harder, and more fibrous than that from the other series. The frying revealed in every case reported, a hard toughness in the meat of the shorts-bran lot not noticed in the flesh of the other series.

The peculiar greasiness of the fat of the shorts-bran lot has before been adverted upon. This character was, as might have been expected, brought out with emphasis in boiling. Four pounds of fat "side meat" were taken from each of two pigs (Nos. 5 and 10), typical specimens of the class to which each belonged; and these were subjected to thorough and equal cooking. The four pounds of meat obtained from pig No. 5 shrank to two pounds fifteen ounces, while that from No. 10 only wasted in the pot a half-pound in the course of the boiling. Clearly the meat from corn-potatoes feeding was a much better and more salable article than that yielded by the shorts-bran series.

These are essentially the facts of our experiment; and having faithfully given these, our chief duty is done. Opinions regarding the character and importance of the work, and the weight of evidence upon particular points, may safely be left with the reader.

PIGS FROM MATURE AND IMMATURE PARENTS.

A large proportion of Kansas swine-breeders breed sows when eight or nine months old. After weaning pigs, the sow is fattened and sold, and her immature offspring bred to furnish the supply of pigs required on the farm. A young boar is generally used, so that the whole herd is composed of immature animals, the offspring of immature parents. Many careful farmers object to this system of breeding, claiming that it is less profitable than that when mature hogs are coupled together, and, further, that when this system of breeding from immature animals is continued, the vitality of the stock is injured and greater loss sustained from disease.

The object of this experiment was to ascertain by actual trial what results could be obtained in breeding and feeding from mature and from immature animals. The plan adopted was to select two closely-related pure-bred Berkshire sows, one mature, the other young; the mature sow was to be bred to a mature boar, the young sow to an immature boar. Each litter of pigs was to be fed separately, from birth until ready for market, and an accurate record kept of feed consumed and gain made. A sow pig was to be taken from the immature sow's litter and bred while yet growing to an immature boar, and her pigs fed against a litter of pigs from mature parents. This method of selection and feeding was to be continued for a series of years.

The mature sow selected for the trial in 1888 was Perfection 12630, 3½ years old at the time of breeding. She was bred to Royal Peerless 17183, age 5½ years. Princess A. 2d 18493, age 7 months, a daughter of Perfection, was selected for the immature sow and bred to Hermit 18491, age 8 months. Perfection farrowed nine pigs April 19, 1888. Princess A. 2d farrowed eight pigs April 30,1888. Throughout the experiment the pigs of both litters were given all the feed they would eat, and the two litters were fed as nearly alike as could be done and keep them gaining satisfactorily. The subjoined tables give the feeding record of the two lots. The prices of feed used in calculating the cost of feed are, per 100 pounds: Bran, 50c.; corn meal, 50c.; shorts, 60c.; whole milk, 50c.; skim milk, 25c.; and wheat chops, 75c. Shelled corn is charged at 25c. per bushel.

MATURE SOW AND PIGS (PERFECTION).

WEEK ENDING —, 1888.	FEED, LBS.			PIGS.		SOW.		SOW AND PIGS.		Cost of feed	Remarks.
	Corn meal	Shorts	Milk	Weight, lbs.	Gain, lbs.	Weight, lbs.	Gain (+) or loss (—), lbs.	Weight, lbs.	Gain (+) or loss (—), lbs.		
April 19	......	......	......	25	......	422	......	447	......	......	April 19, weight of pigs at birth, $3\frac{1}{2}$, $3\frac{1}{4}$, 3, 3, $2\frac{3}{4}$, $2\frac{3}{4}$, $2\frac{1}{2}$, $2\frac{1}{4}$, and 2 lbs; av. wgt. per pig, 2.77 lbs.
" 23	......	30	......	38	13	402	—20	440	—7	$0 18	......
" 30	......	60	......	65	27	375	—27	440	0	36	......
May 7	$17\frac{1}{2}$	51	......	93	28	375	0	468	+28	39	......
" 14	7	80	......	120	27	355	—20	475	+7	52	......
" 21	3	81	Skim 21	152	32	368	+13	520	+45	55	......
" 28	......	81	Whole 177	185	33	417	+49	602	+82	1 37	......
June 4	......	100	160	235	50	380	—37	615	+13	1 40	June 8, boar pigs castrated.
" 11	......	100	163	282	47	378	—2	660	+45	1 42	June 11, pigs weaned.
Totals	$27\frac{1}{2}$	583	Skim 21 Whole 500	......	257	......	—44	......	+213	$6 19	

The total gain of pigs from birth to time of weaning was 257 pounds. The sow lost 44 pounds, leaving a total gain for the feed given of 213 pounds. The feed cost $6.19, making the average cost of gain 2.91 cents per pound.

IMMATURE SOW AND PIGS (PRINCESS A 2D), FIRST LITTER.

WEEK ENDING—	FEED, LBS.			PIGS.		SOW.		SOW AND PIGS.		Cost of feed	Remarks.
	Corn meal	Shorts	Milk	Weight, lbs.	Gain, lbs.	Weight, lbs.	Gain (+) or loss (—), lbs.	Weight, lbs.	Gain (+) or loss (—), lbs.		
1888. April 30	......	......	......	18	......	250	......	268	......	......	April 29, weight of pigs at birth, 3, 2½, 2½, 2¼, 2, 2, 2, and 2; average wgt. per pig, 2.28 lbs.
May 7	13	47	......	33	15	255	+5	288	+20	$0 35	May 4, one pig died.
" 14	16	60	Skim 34	55	22	245	—10	300	+12	52	....
" 21	......	50	17	70	15	245	0	315	+15	34	....
" 28	......	58	Whole 181	98	28	252	+7	350	+35	1 25	....
June 4	......	57	151	120	22	265	+13	385	+35	1 10	June 8, boars castrated.
" 11	......	75	112	163	43	250	—15	413	+28	1 01	June 11, pigs weaned.
Totals	29	347	Skim 51 Whole 444	......	145	......	0	......	+145	$4 57	

The total gain of pigs from birth to time of weaning, was 145 pounds. The sow neither gained nor lost weight. The total cost of feed was $4.57, making the average cost of gain 3.16 cents per pound, or ¼ cent per pound higher than for the pigs from mature sow.

The table on the following page shows the feeding record of the pigs after weaning and until sold for market.

PIGS FROM MATURE PARENTS (PERFECTION'S).

WEEK ENDING—	FEED, LBS. Corn meal	Bran	Shorts	Shelled corn	Whole milk	No. of pigs	Weight of pigs, lbs.	Gain, lbs.	Cost of feed
1888.									
June 18	......	......	24	......	198	9	319	37	$1 13
" 25	......	......	51	......	180	9	372	53	1 21
July 2	15	......	134	......	175	9	435	63	1 75
" 9	......	......	167	......	170	9	510	75	1 85
" 16	31	......	133	......	20	9	524	14	1 05
" 23	......	......	152	......	.....	9	569	45	91
" 30	......	25	162	......	.....	8	555	64	1 10
Aug. 6	......	45	145	......	.....	8	595	40	1 10
" 13	......	25	165	......	.....	8	660	65	1 11
" 20	......	25	175	......	.....	8	694	34	1 18
" 27	......	50	220	......	.....	8	803	109	1 57
Sept. 3	......	50	210	......	.....	8	856	53	1 51
" 10	50	50	174	......	22	9	1009	52	1 54
" 17	......	105	195	......	.....	9	1099	90	1 17
" 24	......	35	270	......	.....	9	1192	93	1 80
Oct. 1	......	35	301	......	.....	9	1270	78	1 98
" 8	......	85	274	......	.....	9	1312	42	2 07
" 15	268	128	......	......	.....	8	1269	86	1 98
" 22	241	110	......	......	.....	8	1355	172	1 75
" 29	268	134	......	......	.....	8	1444	89	2 01
Nov. 5	242	121	......	......	.....	8	1535	91	1 82
" 12	300	150	......	......	.....	8	1597	62	2 25
" 19	......	......	......	280	.....	5	1102	81	1 25
" 26	......	......	......	157	.....	4	961	60	70
Dec. 3	......	......	......	235	.....	4	1016	55	1 05
" 10	......	......	......	229	.....	4	1041	25	1 03
" 17	......	......	......	246	.....	4	1113	72	1 10
" 24	......	......	......	264	.....	4	1175	62	1 18
" 31	......	......	......	233	.....	4	1215	40	1 04
1889.									
Jan. 7	......	......	......	252	.....	4	1271	56	1 12
" 14	......	......	......	240	.....	4	1302	31	1 07
" 21	......	......	......	208	.....	4	1344	42	93
" 28	......	......	......	198	.....	4	1380	36	88
Feb. 4	......	......	......	205	.....	4	1430	50	91
" 11	......	......	......	225	.....	4	1463	33	1 00
" 18	......	......	......	167	.....	4	1463	0	74
" 25	......	......	......	198	.....	4	1478	15	88
Totals	1415	1173	2952	3337	765	...	......	2165	$48 72

PIGS FROM IMMATURE PARENTS (PRINCESS A. 2D'S).

WEEK ENDING—	FEED, LBS.					No. of pigs	Weight of pigs, lbs.	Gain, lbs.	Cost of feed
	Corn meal	Bran	Shorts	Shelled corn	Whole milk				
1888.									
June 18	......	......	23	......	140	7	190	30	$0 84
" 25	......	......	27	......	155	7	221	31	94
July 2	15	......	80	......	170	7	267	46	1 40
" 9	......	......	67	......	165	7	324	57	1 23
" 16	21	......	78	......	25	7	330	6	70
" 23	......	......	128	......	......	7	371	41	77
" 30	......	25	108	......	......	7	413	42	77
Aug. 6	......	25	111	......	......	7	444	31	79
" 13	......	25	130	......	......	7	495	51	91
" 20	......	25	155	......	......	7	538	43	1 05
" 27	......	50	160	......	......	7	610	72	1 21
Sept. 3	......	40	145	......	......	7	643	33	1 07
" 10	45	45	115	......	......	6	629	45	1 14
" 17	......	65	123	......	......	6	680	51	1 06
" 24	......	35	145	......	......	6	712	32	1 05
Oct. 1	......	35	187	......	......	6	750	38	1 12
" 8	......	60	174	......	......	6	812	62	1 34
" 15	115	47	50	......	......	6	833	21	1 11
" 22	163	89	......	......	......	6	868	35	1 26
" 29	162	81	......	......	......	5	808	49	1 21
Nov. 5	150	75	......	......	......	5	860	52	1 13
" 12	172	88	......	......	......	5	898	38	1 30
" 19	......	......	......	239	......	4	803	61	1 06
" 26	......	......	......	161	......	4	837	34	72
Dec. 3	......	......	......	212	......	4	877	40	95
" 10	......	......	......	250	......	4	905	28	1 12
" 17	......	......	......	203	......	4	954	49	91
" 24	......	......	......	254	......	4	997	43	1 13
" 31	......	......	......	196	......	4	1026	29	87
1889.									
Jan. 7	......	......	......	207	......	4	1072	46	92
" 14	......	......	......	210	......	4	1097	25	93
" 21	......	......	......	178	......	4	1128	31	79
" 28	......	......	......	170	......	4	1157	29	76
Feb. 4	......	......	......	160	......	4	1205	48	71
" 11	......	......	......	180	......	4	1229	24	80
" 18	......	......	......	143	......	4	1231	2	64
" 25	......	......	......	182	......	4	1247	16	81
Totals	843	810	2006	2945	655	...	......	1411	$36 52

Summing up the results as given in the table, the mature sow's pigs made a gain during this period of 2165 lbs. at a cost of $48.72, or 2.25c. per lb. The young sow's pigs made a gain during the same period of 1411 lbs. at a cost of $36.52, or 2.58c. per lb., 1/3c. more per lb. than for the mature sow's litter.

It would have been desirable to feed all the pigs belonging to each litter, and thus to ascertain the total amount of gain, with its cost, that could have been secured from each litter. Circumstances made this impracticable. Some of the pigs were lost by disease and others were taken out for breeding purposes. Whenever a pig was taken from a litter, its weight was deducted from the total weight of the litter and the gain thereafter calculated on the weight of the pigs remaining.

The following changes took place in Perfection's litter:

July 24.—Pig attacked by thumps; thrown out; weight 78 lbs.

Sept. 3.—This pig apparently well, and again fed with his mates; weight 101 lbs.

Oct. 8.—Pig again attacked by thumps, and thrown out; weight 129 lbs.

Nov. 12.—Three sows thrown out for breeding purposes; weight 576 lbs.

Nov. 19.—One sow thrown out for breeding; weight 201 lbs.

The changes in Princess's litter were as follows:

May 4.—One pig died.

Sept. 3.—Pig sick; thrown out; weight 59 lbs.

Oct. 22.—Pig sick; thrown out; weight 109 lbs.

Nov. 12.—One sow taken out to be bred for purpose of continuing experiment; weight 156 lbs.

The mature sow had 9 pigs; one pig was lost by disease, leaving 8 pigs that could have been fed for market. The young sow had 8 pigs; 3 were lost by disease, leaving only 5 that could have been fed. This difference in the number of pigs living to reach maturity from the two litters is considerably in favor of the mature sow.

It was noticed throughout the trial that the pigs from mature parents ate the most feed per head, eating with better appetites.

The results of the trial for this year (1888) are, that the pigs from mature parents weighed more at birth, ate more feed, and made a greater gain for feed consumed, and that a greater number lived to maturity.

TRIAL OF 1889.

The experiment was continued in 1889 with Princess A. 2d 18493 for the mature sow, and Princess B. 20190, a sow taken from the immature Sow's litter of 1888, to continue the line in breeding immature animals. Princess A. 2d was 20 months old when bred to Duke of Carlisle 20191, age 15 months. She farrowed 9 pigs May 19, 1889.

Princess B. was bred at the age of 8½ months to the 7½-months-old boar Novice 21365, and farrowed 7 pigs May 12, 1889.

The following tables give the feeding record of these litters:

Week ending—	Feed, lbs.						Pigs.		Sow.		Sow and pigs.		Cost of feed	Remarks.
	Bran	Shorts	Oats, ground	Wheat chop	Skimmed milk	Whole milk	Weight, lbs.	Gain, lbs.	Weight, lbs.	Gain, lbs.	Weight, lbs.	Gain, lbs.		
1889.														
May 20	.....	.....	.....	.....	.....	.....	29½	.....	390	.....	419½	.....	.....	May 20, weight of pigs at birth, 3.81, 3.56, 3.44, 3.50, 3.50, 3.25, 3.20, 2.70, and 2.62 lbs.; average, 3.29 lbs. per pig.
" 27	15	30	.....	.....	22	.....	57	27½	370	—20	427	7½	$0 21	
June 3	10	40	10	.....	57	.....	86	29	359	—11	445	18	51	
" 10	13	26	.....	.....	.....	40	116	30	345	—15	461	15	42	
" 17	17	34	.....	.....	.....	46	150	34	325	—20	475	14	52	
" 24	20	.....	.....	40	.....	76	178	28	319	—6	497	22	78	
July 1	.....	56	.....	.....	.....	79	210	32	276	—43	486	—11	73	
" 8	.....	73	.....	.....	.....	.....	252	42	266	—10	518	32	44	July 8, pigs weaned.
Totals,	75	259	10	40	79	241	.....	222½	.....	—125	.....	97½	$3 61	

NOTE.—The minus sign (—) in column headed "Gain, lbs." indicates loss.

IMMATURE SOW AND PIGS (PRINCESS B).

WEEK ENDING—	FEED, LBS.						PIGS.		SOW.		SOW AND PIGS.		Cost of feed.	REMARKS.
	Bran	Shorts	Oats, ground,	Wheat chop	Skimmed milk	Whole milk	Weight, lbs.	Gain, lbs.	Weight, lbs.	Gain, lbs.	Weight, lbs.	Gain, lbs.		
1889. May 13	....	.....	...	......	....	......	22	......	256	......	278	......	......	May 13, weight of pigs at birth, 3.94, 3.5, 3.06, 3, 3, 2.82, and 2.75 lbs.; average weight of pig, 2.76 lbs.; one pig born dead, not weighed; one pig killed, weight 2.82.
" 20	14	......	...	28	....	......	35	13	243	—13	278	0	$0 28	
" 27	20	16	...	26	98	......	56	21	242	—1	298	20	64	
June 3	10	50	7	53	....	......	75	19	234	—8	309	11	80	
" 10	15	36	...	......	....	50	95	20	231	—3	326	17	54	
" 17	18	36	...	......	....	53	115	20	230	—1	345	19	57	
" 24	20	......	...	40	....	76	136	21	220	—10	356	11	78	
July 1	....	76	...	......	....	79	165	29	212	—8	377	21	85	
" 8	....	78	...	147	....	......	182	17	210	—2	392	15	47	July 8, pigs weaned.
Totals	97	292	7	......	98	258	......	160	......	—46	......	114	$4 93	

NOTE.—The minus sign (—) in column headed "Gain, lbs." indicates loss.

The tables show that the 9 mature sow's pigs gained 222½ lbs. up to time of weaning, or an average of 24.7 lbs. per pig. The 6 pigs from the young sow gained in the same period 160 lbs., or 26.7 lbs. per head. The mature sow lost 125 lbs. during this time and the immature sow 46 lbs., leaving a total gain of 97½ lbs. for the feed given to the mature sow and pigs at a cost of 3.7c. per pound, and a total gain of 114 lbs. for feed given the immature sow and pigs at a cost of 4.3c. per pound—a difference of ⅗c. per pound in favor of cost of pork from pigs of mature parents.

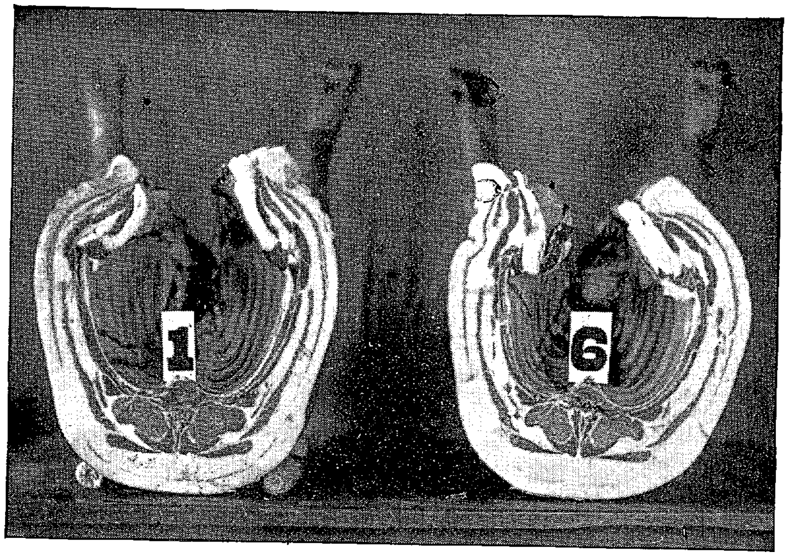
The following tables show feeding record after weaning:

PIGS FROM MATURE PARENTS (PRINCESS A. 2D).

WEEK ENDING—	FEED, LBS. Corn meal	Bran	Shorts	Shelled corn	Whole milk	No. of pigs	Weight of pigs, lbs.	Gain, lbs.	Cost of feed
1889.									
July 15	......	25	50	......	75	8	248	29	$0 80
" 22	......	......	64	......	90	7	250	35	83
" 29	......	......	84	......	90	7	280	30	93
Aug. 5	......	25	50	25	105	7	321	41	1 06
" 12	32	16	32	6	105	7	348	27	99
" 19	43	13	26	24	105	7	400	52	1 07
" 26	46	7	29	......	75	7	408	8	81
Sept. 2	40	20	40	......	......	7	430	22	54
" 9	43	43	43	......	......	7	451	21	69
" 16	38	38	38	20	......	7	486	35	70
" 23	......	35	70	50	......	7	512	26	82
" 30	......	63	63	30	......	7	552	40	83
Oct. 7	......	77	77	45	......	7	585	33	1 05
" 14	......	......	......	170	......	7	625	40	76
" 21	......	......	......	196	......	7	662	37	88
" 28	......	......	......	188	......	7	682	20	84
Nov. 4	......	......	......	222	......	7	725	43	99
" 11	......	......	......	262	......	7	785	60	1 17
" 18	......	......	......	196	......	7	820	35	88
" 25	......	......	......	183	......	7	850	30	82
Dec. 2	......	......	......	160	......	7	893	43	71
" 9	......	......	......	156	......	7	910	17	70
" 16	......	......	......	172	......	7	945	35	77
" 23	......	......	......	185	......	7	953	8	83
Totals	242	362	666	2290	645	...	......	767	$20 47

PIGS FROM IMMATURE PARENTS (PRINCESS B).

WEEK ENDING—	FEED, LBS.					No. of pigs	Weight of pigs, lbs.	Gain, lbs.	Cost of feed
	Corn meal	Bran	Shorts	Shelled corn	Whole milk				
1889.									
July 15	......	22	44	......	90	6	210	28	$0 86
" 22	......	......	64	......	90	6	232	22	83
" 29	......	......	68	......	90	6	252	20	86
Aug. 5	......	18	36	18	105	6	281	29	91
" 12	28	12	24	6	105	6	290	9	90
" 19	34	10	20	16	105	6	333	43	94
" 26	42	10	20	......	75	6	344	11	76
Sept. 2	38	10	40	......	......	6	366	22	48
" 9	39	39	39	......	......	6	380	14	62
" 16	38	38	38	20	......	6	413	33	70
" 23	......	30	60	50	......	6	445	32	73
" 30	......	60	60	30	......	6	482	37	79
Oct. 7	......	50	50	45	......	6	500	18	75
" 14	......	......	......	146	......	6	544	44	65
" 21	......	......	......	186	......	6	583	39	83
" 28	......	......	......	162	......	6	610	27	72
Nov. 4	......	......	......	198	......	6	629	19	88
" 11	......	......	......	201	......	6	678	49	90
" 18	......	......	......	192	......	6	717	39	86
" 25	......	......	......	182	......	6	733	16	81
Dec. 2	......	......	......	180	......	6	775	42	80
" 9	......	......	......	148	......	5	653	18	66
" 16	......	......	......	120	......	5	668	15	54
" 23	......	......	......	120	......	5	682	14	54
Totals	219	299	563	2020	660	....	......	640	$18 32



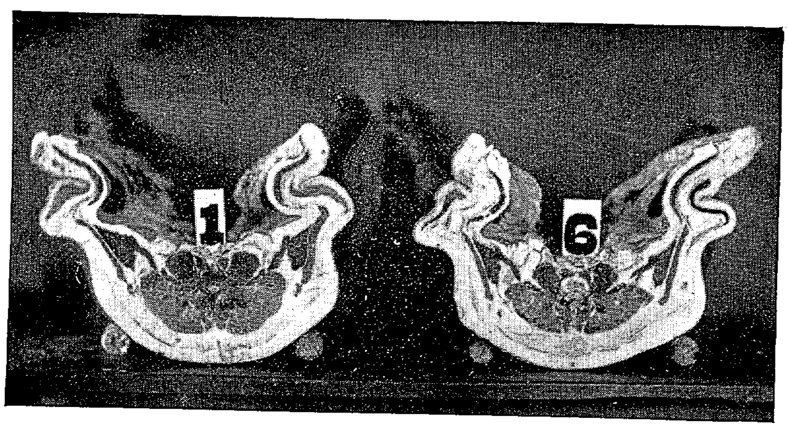
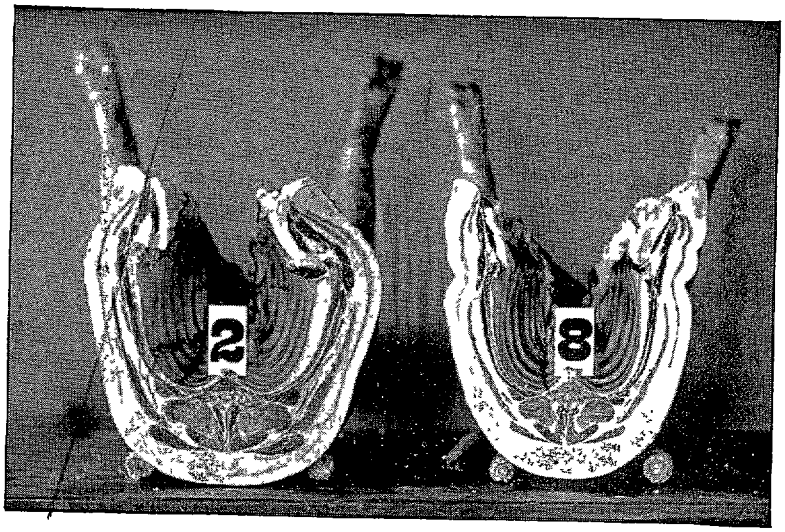


PLATE I.



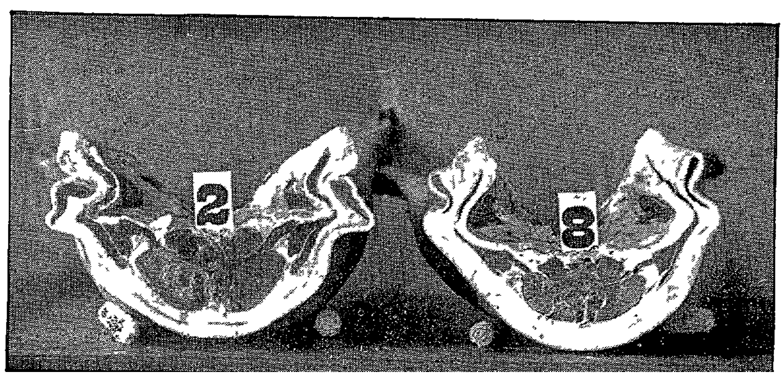
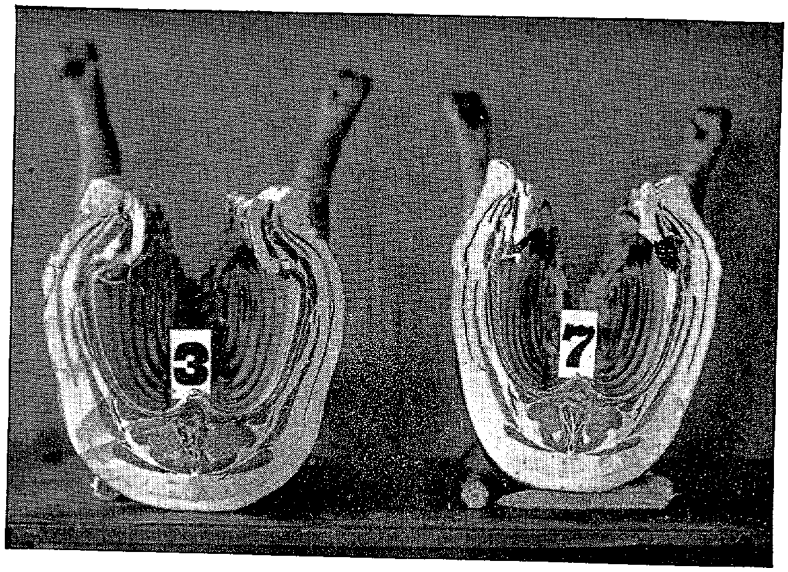


PLATE II.



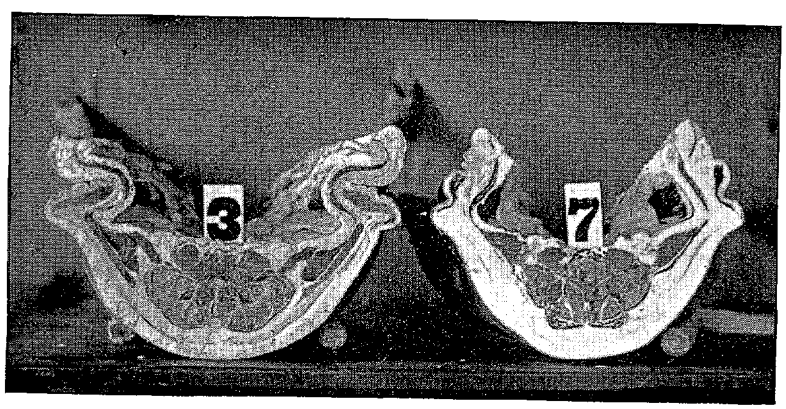
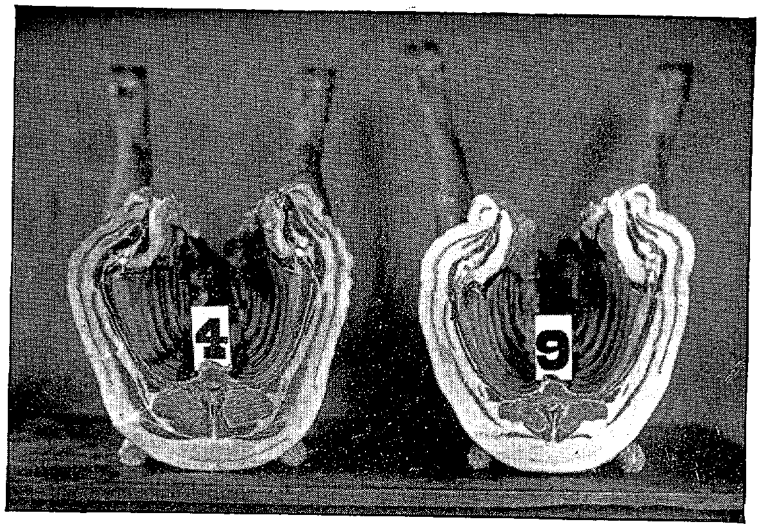


PLATE III.



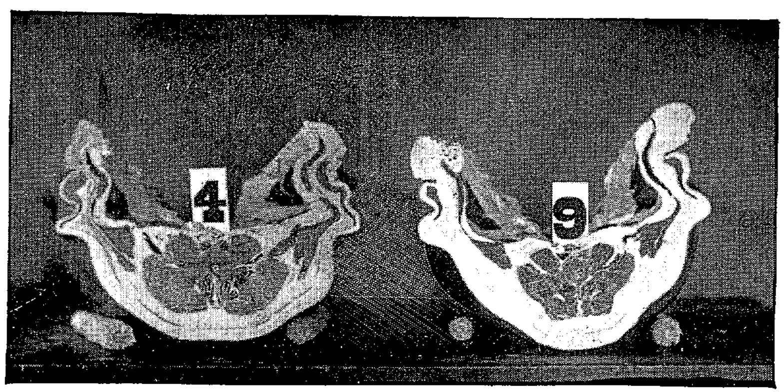
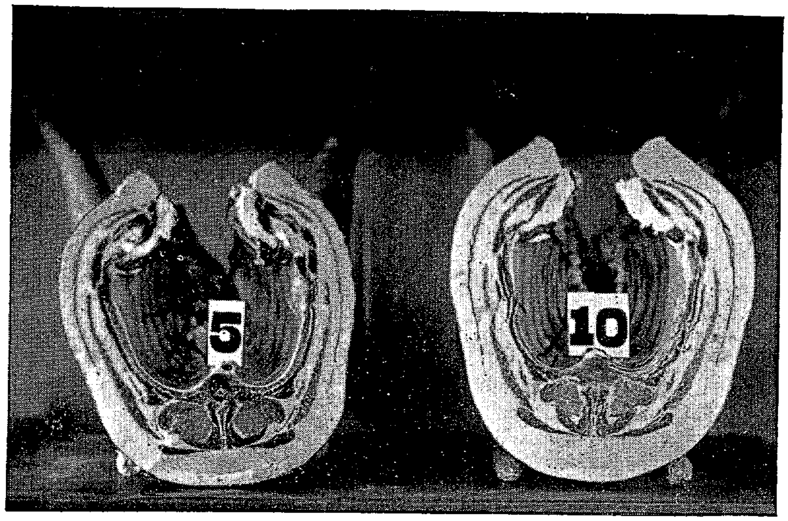


PLATE IV.



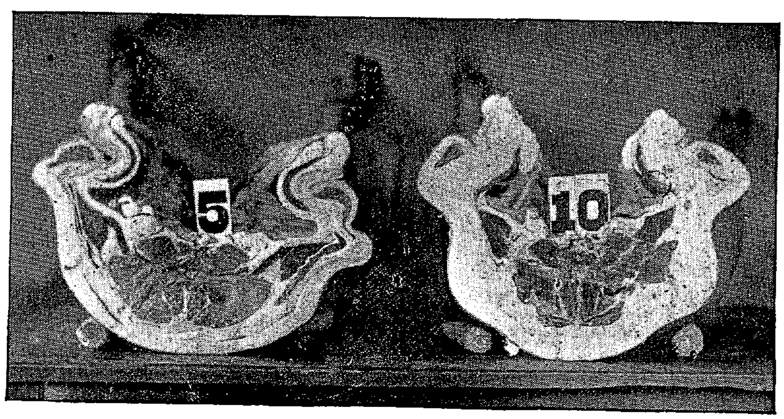
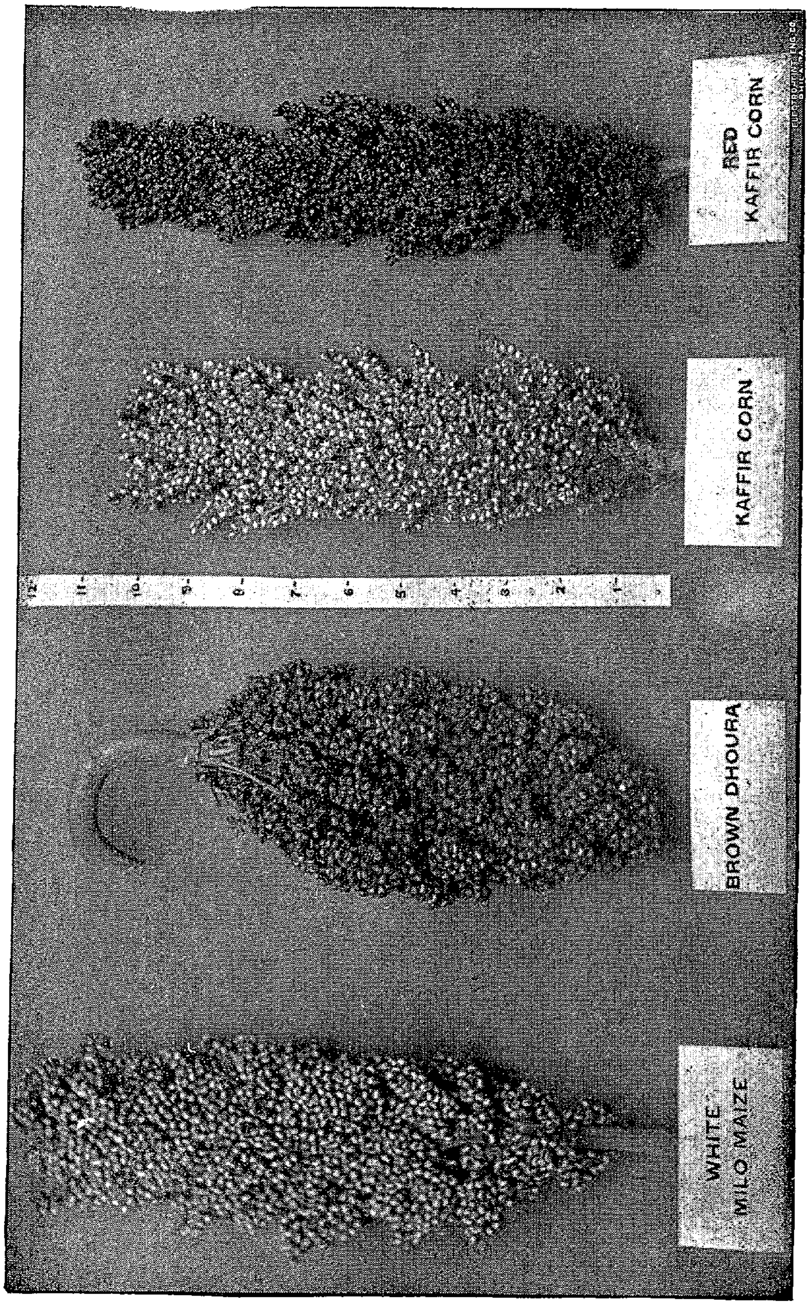


PLATE V.



FORAGE PLANTS.

These tables show that the mature sow's pigs made a gain of 767 lbs. at a cost of 2.8c. per lb., and the immature sow's pigs made a gain of 640 lbs. at a cost of 2.86c. per lb. The average weight of the pigs in each litter was 136 lbs. One pig of the immature sow's litter died May 13; all of the mature sow's pigs lived. The changes in the number of pigs fed, as shown in the record, were made when pigs were thrown out for breeding purposes. Neither litter fed satisfactorily at any time during the trial, but those in charge were unable to ascertain the cause.

Further trial seems necessary before any positive conclusion can be drawn from this experiment. In the trial of 1888 the pigs from mature parents were the most profitable; in the trial of 1889 there was little difference between the two litters.

REPORT OF CHEMICAL DEPARTMENT.

G. H. FAILYER, *Chemist.*
J. T. WILLARD, *Assistant Chemist.*

The subjects enumerated below have received attention the past year, and the results of the work so far as completed are given:

A comparison of one hundred and twenty-five varieties of sorghum.
Improvements of sorghum by seed selection.
Crossing of varieties of sorghum.
Time of planting sorghum.
A comparison of different-sized stalks of sorghum.
The composition of feeding-stuffs.
The composition of corn at different stages of growth.
Ammonia, nitric acid and nitrites in atmospheric water.

WORK UPON SORGHUM.

The work of the Department upon sorghum for the year has been far from satisfactory, and for reasons unexpected and beyond our control. The ground upon which it was planted was not finally placed at our disposal until very late—some days after the first of May. During the whole spring, which had been rather dry, a heavy growth of rye, sown for pasturage but not grazed off, covered the ground. This rye sucked up the moisture so that when the ground was plowed it broke up in the worst possible condition. Subsequent harrowing very imperfectly subdued it. But worse than all this, the rye nurtured a host of chinch-bugs, and they attacked the young sorghum plants, which a timely rain had brought up, as soon as they were out of the ground. Many of the varieties succumbed completely, and others gave a partial stand of debilitated plants, while a few plats furnished a fair stand of healthy plants. This field was planted on the 14th and 15th of May. Seeing the fate in store for this planting, we obtained, by the kindness of Prof. Popenoe, a few patches of soil remote from the infested field, and replanted such varieties as we could June 15th and 16th. Part of this soil was thin, however, and the sorghum made a growth hardly comparable with that grown on good ground; besides, it was planted a month later, and was thus placed at a disadvantage because of the lateness of its maturity. Especially is this destruction by the chinch-bugs regretted, as it caused the loss of a number of new varieties, the seed of which had been furnished by Dr. Collier. The whole of the seed of many of these varieties was planted in the first field, and a large portion of them destroyed to a plant. Further, we had planned to make a comparison of canes from seed of individual stalks of different qualities to test their power to transmit these. This was greatly interfered with by the uncertain character of the canes. Reference is made to this matter under its appropriate head.

COMPARISON OF VARIETIES.

The comparison of varieties of sorghum has been continued this year. All grown last year were replanted, and several other varieties were obtained from the Department of Agriculture. In addition to this, we are under great obligations to Dr. Collier, Director of the New York Agricultural Experiment Station, for small amounts of seed of 153 varieties; 59 of these had never been grown in this country, and most of the others had been grown but one year. Of these 153 varieties we obtained specimens of less than one-half, the others failing to germinate, or being destroyed by chinch-bugs.

In regard to the varieties grown last year but little need be said. The judgment pronounced then has been confirmed by this year's experience, and reference to the tables will show which are valuable. The sugar-content has in most cases been larger this season than last. Whether this is due to acclimation of the varieties, superiority of the season, the change in the soil, or to some other cause, we are unable to say.

In our report last year upon the keeping qualities of sorghum* we showed that after the cane became ripe its sugar-content remained sensibly constant until injured by severe frost. Owing to poor seed we had no Early Amber sorghum last year. This year Mr. J. C. Hart, of the Fort Scott sugar works, kindly sent us a supply of seed, and observation was made on the keeping ability of this variety. Analyses were made extending from September 14th to October 28th, and they showed that the juice remained nearly uniform during that period, although the leaves were wind-whipped and largely broken off, and the seed nearly all shattered out at the time the last analysis was made. The *amount* of juice diminished, however, as the season advanced. The results of these analyses are given on pages 93-101.

The *Early Tennessee* variety, which has been recommended for its earliness, seems unworthy of cultivation, unless our experience has been very exceptional. Two analyses were made—one of the first planting, the other of the second. Earliness in a variety is a very desirable habit, but unless it is accompanied by a fair sugar-content it can be of no practical use.

Folger's Early was much better than the Early Tennessee, but still an inferior cane.

The *Improved Orange,* from the Department of Agriculture, was inferior

*First Annual Report, p. 139.

to our town Kansas Orange this year. The result may be different another year.

Planters' Friend is a late variety, and as our first planting was almost entirely destroyed the only analysis made was of cane which had grown only 116 days, and was not ripe. If planted early enough to ripen, it may be a good variety.

The *Sorghum Saccharatum* of the table was obtained from the Department of Agriculture, and originally came from Cape Town, Africa.

Numbers 36 and 53 are other varieties from the Department of Agriculture. The latter contained three varieties; two of these may be the result of crossing the previous year.

The analyses given in Table II are of cane grown from seed furnished by Dr. Collier. A number of these varieties are practically worthless for sugar or syrup—the so–called non-saccharine varieties. They may be of value as fodder plants. Many are inferior, some are fair, and a few are good. Some of the seed germinated poorly, and the chinch-bugs killed some of the sorts. It is not thought that this season has given them a fair trial. They are new to the climate, and the second planting, from which many of these analyses were made, did not in all cases fully mature before frost. But analyses were made as the best that could be done under the circumstances. They will be given a new trial under more favorable conditions.

TABLE I OF ANALYSES OF SORGHUM.

VARIETIES.	DATE OF ANALYSIS.	No. stalks taken	Average height in feet	Average weight of dressed canes in grams	Average weight of dressed canes in pounds	Average weight of tops	Per cent. of juice extracted	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice
African	October 2	10	9.5	632	1.39	.30	46.39	1.068	9.07	5.51
African	October 9	42	......	......	......	......	......	1.066	7.58	5.21
Amber and Orange crossed	September 27	10	......	624	1.37	.34	45.83	1.070	13.04	1.41
Amber and Orange crossed	September 27	10	......	603	1.33	.32	46.84	1.078	14.83	1.54
Amber and Orange crossed	September 27	9	......	597	1.31	.38	46.79	1.066	12.02	1.84
Chinese	September 21	15	......	444	.98	......	48.09	1.050	7.28	2.74
Chinese	September 24	6	7	455	1.00	.44	44.76	1.060	10.53	1.82
Chinese	September 24	10	9	417	.92	.36	42.03	1.056	10.60	2.27
Chinese	October 12	....	8.8	......	......	......	45.36	1.070	10.07	......
Chinese, large var	October 21	10	12	707	1.56	.52	31.25	1.064	8.89	2.94
Dutcher's Hybrid	September 18	14	......	497	1.09	......	51.08	1.057	8.57	3.45
Dutcher's Hybrid	September 18	10	......	567	1.25	......	51.85	1.058	8.36	3.09
Early Amber	September 4	10	......	447	.98	......	47.00	1.077	15.06	.967
Early Amber	September 5	10	10.1	465	1.02	......	46.71	1.070	13.46	1.26
Early Amber	September 27	20	......	430	.95	......	42.35	1.074	13.95	1.76
Early Amber	October 10	14	......	......	......	.53	38.68	1.079	15.11	.97
Early Amber	October 28	20	......	385	.74	......	38.24	1.074	14.86	......

TABLE I—CONTINUED.

VARIETIES.	DATE OF ANALYSIS.	No. stalks taken....	Average height in feet........	Average weight of dressed canes in grams........	Average weight of dressed canes in pounds........	Average weight of tops........	Per cent. of juice extracted........	Specific gravity of juice........	Per cent. of cane sugar in juice......	Per cent. of reducing sugar in juice..
Early Tennessee........................	September 16..........	10	8.4	350	.77	.24	47.00	1.040	4.05	2 97
Early Tennessee........................	September 23.....	25	....	237	.54	.18	41.66	1.040	3.41	3.67
Enyama	October 7.............	10	10.2	972	2.14	......	50.20	1.062	10.34	2.16
Folger's Early.........................	September 18..........	10	10.3	563	1.24	......	44.69	1.062	10.74	2.14
Golden Rod	September 5..........	18	8.9	419	.92	......	49.20	1.042	5.67	......
Honduras	September 24..........	11	....	1061	2.33	.35	53.68	1.049	4.56	5.12
Honey Cane...........................	September 21..........	11	....	809	1.78	......	51.46	1.055	5.84	5.05
Honey Cane......................	October 12.............	....	12.0	......	....	......	47.18	1.060	6.56	......
Honey Dew	September 23..........	19	....	396	.87	......	35.90	1.071	13.63	1.03
Honey Drip.........	October 7.............	10	....	552	1.21	......	48.86	1.072	12.88	2.22
Honey Drip...........................	October 7...........	23	....	......	....	.37	....	1.068	11.73	2.31
Improved Orange.............	October 3.............	10	8.7	569	1.25	.45	41.30	1.070	11.22	4.31
Kansas Orange	September 21..........	15	....	578	1.27	......	48.92	1.072	12.33	2.89
Kansas Orange	September 25..........	10	....	721	1.59	.43	49.14	1.071	13.66	1.11
Kansas Orange	October 4.............	50	....	......	....	......	....	1.077	13.88	2.85
Kansas Orange	October 5...........	10	....	692	1.52	.40	48.12	1.070	13.07	1.15
Kansas Orange, large stalks	October 9.............	9	9.5	631	1.39	.37	47.50	1.071	11.40	3.59

Kansas Orange, medium stalks	October 9	12	9.8	488	1.07	.22	48.00	1.078	13.35	3.13
Kansas Orange, small stalks	October 9	15	9.3	285	.63	.13	41.40	1.081	14.85	2.65
Late Orange	October 3	10	8.0	625	1.37	.42	47.69	1.068	12.29	2.87
Late Orange	October 8							1.076	13.98	2.59
Liberian from Kansas	September 23	10		817	1.80	.36	45.41	1.051	6.71	3.26
Liberian from Kansas, var	September 26	6	9.3	566	1.24	.39	42.79	1.046	7.37	1.32
Little Sumach	September 30	9	7.3	657	1.44	.61	47.54	1.058	9.94	2.02
Link's Hybrid	September 24	13		722	1.59	.34	48.08	1.068	12.82	1.04
Link's Hybrid	October 8	40						1.081	15.32	1.01
Link's Hybrid	October 21	10		548	1.21	.19	45.12	1.073	13.43	1.03
Link's Hybrid	October 22	50						1.072	12.94	1.13
Medium Orange	September 17	10		605	1.33		49.30	1.054	9.96	1.29
Medium Orange	September 17	10		553	1.21		45.80	1.053	9.47	.97
Medium Orange	September 17	10						1.071	14.05	.51
New Orange	September 26	10		551	1.21	.40	48.09	1.061	9.26	4.31
New sugar cane from Central America	September 30	10	10.5	906	1.99	.38	46.96	1.066	11.48	2.18
Planter's Friend	October 9	15	8.7	339	.75	.23	42.57	1.055	7.61	3.42
Price's Early	September 16	10		591	1.30	.25	50.70	1.050	7.12	3.01
South Carolina Early Orange	October 7	9		760	1.67	.43	50.43	1.071	12.89	2.50
South Carolina Early Orange	October 8	15						1.063	10.57	2.77
Silver Top	October 1	10	11.5	893	1.97	.29	50.77	1.056	6.32	4.90
Sorghum saccharatum	September 30	9	10.5	801	1.76	.33	34.26	1.065	12.17	1.91

VARIETIES.	DATE OF ANALYSIS.	No. stalks taken	Average height in feet	Average weight of dressed canes in grams	Average weight of dressed canes in pounds	Average weight of tops	Per cent. of juice extracted	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice
Swain's Early Golden	September 27	25	......	275	.61	.10	38.60	1.071	13.51	2.15
Swain's Early Golden	October 5	10	10.0	419	.92	.11	43.43	1.068	12.59	1.68
Wabaunsee	September 20	10	......	634	1.39	.32	45.07	1.056	9.32	1.58
White African	September 26	8	......	627	1.38	.47	44.42	1.059	9.86	1.93
White African	October 3	22	......	......	......	......	......	1.075	12.72	1.98
White Amber	September 19	15	......	489	1.08	......	46.33	1.065	12.53	1.28
White Amber	September 19	15	......	472	1.04	......	44.57	1.065	12.42	1.55
White Mammoth	September 26	10	......	532	1.17	.37	46.05	1.070	12.61	2.25
Whiting's Early	September 30	3	7.7	567	1.24	.74	52.64	1.041	3.79	3.75
Variety with Early Amber	October 4	7	......	561	1.23	.13	46.11	1.072	13.77	1.53
Unnamed new variety	September 24	13	......	781	1.72	.29	48.41	1.054	7.65	3.03
No. 53, from South Africa	October 9	10	8.0	886	1.95	.66	53.32	1.045	4.03	4.58
No. 53, from South Africa, var	September 25	5	10.3	950	2.09	.62	55.22	1.057	8.68	3.04
No. 53, from South Africa, var	September 25	5	10.5	699	1.54	.85	38.42	1.042	5.99	1.37
No. 36, unnamed	September 25	10	9.3	428	.94	.37	28.27	1.051	6.27	1.81

TABLE II OF ANALYSES OF SORGHUM.

VARIETIES.	DATE OF ANALYSIS.	No. stalks taken	Average height in feet	Average weight of dressed canes in grams	Average weight of dressed canes in pounds	Average weight of tops in pounds	Per cent. of juice extracted	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice
Sorghum Vulgare; var. bicolor. Blk Sorghum, Calcutta	Sept. 30	2	8.5	636	1.40	.43	52.32	1.059	8.39	2.85
Sorghum Vulgare; var. bicolor. Blk Sorghum, Calcutta	Sept. 30	2	6.8	337	.74	.31	41.60	1.051	7.65	......
Sorghum No. 1, Foochau, China	Sept. 30	1	6.7	309	.68	.45	25.89	1.034	3.95	......
Sorghum No. 1, Foochau, China	Sept. 30	6	7.7	279	.61	.41	20.29	1.041	5.05	.57
Shanghai sorghum, China	Oct. 7	10	10.4	882	1.93	.33	46.56	1.068	11.68	2.53
Tsung Ming sorghum, China	Oct. 3	9	8.5	650	1.43	.35	44.44	1.062	10.78	2.35
Sorghum Saccharatum, Buitenzory, Java	Oct. 1	9	9.4	330	.72	.38	20.34	1.041	4.18	......
Sorghum Saccharatum, Buitenzory, Java	Oct. 1	4	10.5	513	1.13	.50	29.26	1.028	3.90	......
Sorghum Vulgare, Buitenzory, Java	Sept. 30	10	9.5	359	.79	.36	22.58	1.035	2.57	.71
Sorghum leneas pumam, Buitenzory, Java	Oct. 1	11	9.5	336	.74	.38	17.97	1.038	3.19	......
Sorghum Pontianark, Buitenzory, Java	Sept. 20	7	10.2	352	.77	.51	16.36	1.032	2.36	.69
Sorghum Glycyphyllum, Buitenzory, Java	Oct. 7	7	10.0	523	1.15	.35	39.61	1.042	4.92	......
Sorghum Elongatum, Buitenzory, Java	Oct. 1	12	10.2	341	.75	.37	20.41	1.036	3.03	......
Sorghum Nigrum, Buitenzory. Java	Sept. 23	14	10.4	333	.73	.34	21.04	1.038	3.69	.48
Chinese sugar-cane, Ning-Po, China	Oct. 3	10	10.0	652	1.43	.18	45.75	1.066	11.97	2.29
Sorghum bicolor (Saccharatum), red-seeded, India	Oct. 1	10	8.5	484	1.07	.40	46.14	1.057	8.89	2.56
Sorghum Saccharatum, black-seeded, India	Oct. 7	7	9.0	369	.81	.28	35.78	1.070	11.65	2.33

TABLE II—CONTINUED.

VARIETIES.	DATE OF ANALYSIS.	No. stalks taken	Average height in feet	Average weight of dressed canes in grams	Average weight of dressed canes in pounds	Average weight of tops in pounds	Per cent. of juice extracted	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice
Sorghum (bicolor) Saccharatum, black-seeded, India	Sept. 20	10	9.0	481	1.06	.38	41.81	1.047	6.71	1.95
Sorghum Caffraria, Calcutta, India	Oct. 19	4	10.4	373	.82	.29	23.82	1.056	8.89	1.03
Sorghum Saccharatum, Calcutta, India	Oct. 1	3	8.5	320	.70	.40	22.89	1.052	7.81	.88
White-seeded sorghum, Foochau, China	Sept. 25	5	8.5	287	.63	.40	11.14	1.037	3.60	.62
Red sorghum, No. 30, Cawnpoor, India	Oct. 1	2	7.3	401	.88	.32	40.57	1.049	7.87	1.04
Chinese sugar-cane, Shanghai, China	Oct. 1	6	9.5	725	1.59	.25	45.67	1.067	11.68	2.43
Sorghum Orange hatif, Algiers, Africa	Oct. 2	6	7.3	498	1.10	.46	43.98	1.070	11.57	3.40
Sorgho sucre de Changalard, Algiers, Africa	Oct. 2	11	......	569	1.25	.43	43.53	1.055	8.40	2.33
Sorghum from Caracas, Venezuela	Sept. 30	10	9.8	606	1.33	.34	41.02	1.062	11.03	2.00
Yellow-Cap glutinous millet, North China	Oct. 4	20	9.5	148	.32	.23	7.32	1.049	5.28	......
Yellow-Cap glutinous millet (c), North China	Sept. 28	10	......	265	.58	.26	17.10	1.056	7.55	......
Separated-Head red millet (Nesbit), North China	Sept. 20	8	7.9	237	.52	.41	19.41	1.038	3.37	.69
Separated-Head white millet, North China	Oct. 4	10	7.8	113	.25	.18	9.73	1.052	5.26	......
Second-Autumn red millet, North China	Sept. 28	10	......	373	.82	.17	48.47	1.063	11.22	1.96
Second-Autumn red millet, North China	Oct. 1	6	8.4	483	1.06	.30	43.86	1.065	10.84	2.80
Horse-Tail glutinous millet, North China	Oct. 1	6	7.5	146	.32	.28	9.14	1.043	4.45	......
Horse-Tail glutinous millet (Nesbit), North China	Oct. 3	1	8.0	287	.63	.54	22.64	1.046	5.45	......

Large Peoples Red Millet, North China	Oct.	8	25	9.3	106	.23	.11	58.27	1.072	9.68	......
Large Peoples Red Millet (b), North China	Oct.	8	9	9.0	106	.23	.09	10.00	1.069	9.37	......
Large Peoples Red Millet (g. n.), North China	Oct.	1	3	7.5	520	1.14	.34	44.23	1.058	9.64	2.33
Large Peoples Red Millet (Nesbit), North China	Sept.	30	2	9.5	285	.63	.38	13.18	1.080	7.07	......
Undendebule, Natal, Africa	Oct.	2	3	8.2	432	.95	.47	41.31	1.057	9.32	2.02
Ukubane (a), Natal, Africa	Oct.	5	10	10.5	492	1.08	.20	41.74	1.072	13.10	1.77
Ukubane (a), Natal, Africa	Oct.	2	4	9.7	500	1.10	.55	35.75	1.042	5.96	......
Ukubane (b), Natal, Africa	Oct.	30	15	6.9	229	.50	.26	40.84	1.039	4.63	1.14
Jyangentombi, Natal, Africa	Oct.	8	1	10.2	600	1.32	.26	39.16	1.073	12.83	2.13
Jyangentombi, Natal, Africa	Oct.	2	1	9.7	490	1.08	.66	31.63	1.039	3.50	......
Jyangentombi (b), Natal, Africa	Oct.	30	20	7.4	227	.50	.15	45.75	1.065	10.89	2.65
Jyangentombi (c), Natal, Africa	Oct.	19	8	......	819	1.80	.22	49.75	1.070	12.00	2.12
Ibohla, Natal, Africa	Oct.	2	8	8.0	702	1.54	.50	47.01	1.058	7.91	4.16
Dindemuka, Natal, Africa	Oct.	2	8	6.7	433	.95	.15	....	1.050	8.27	1.83
Dindemuka (Nesbit), Natal, Africa	Oct.	5	4	11.0	486	1.07	.21	42.10	1.065	11.92	1.66
Dindemuka, Natal, Africa	Oct.	5	10	9.8	494	1.09	.16	42.10	1.074	13.08	1.83
Dindemuka, Natal, Africa	Oct.	3	1	7.5	615	1.35	.33	43.90	1.057	8.81	......
Uboyana, Natal, Africa	Oct.	7	2	7.1	873	1.92	.78	51.86	1.047	4.87	......
Uboyana (b), Natal, Africa	Oct.	7	10	8.2	631	1.39	.55	45.24	1.051	7.83	1.90
Uboyana, Natal, Africa	Oct.	7	5	7.2	790	1.74	.76	51.01	1.043	5.58	2.46
Ufatane, Natal, Africa	Oct.	19	10	9.5	475	1.05	.28	46.00	1.057	9.78	1.75
Ufatane, Natal, Africa	Oct.	7	10	7.2	347	.76	.53	46.02	1.051	8.48	......

TABLE II—CONCLUDED.

VARIETIES.	DATE OF ANALYSIS.	No. stalks taken	Average height in feet	Average weight of dressed canes in grams	Average weight of dressed canes in pounds	Average weight of tops in pounds	Per cent. of juice extracted	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice
Ufatane (Nesbit), Natal, Africa	Oct. 19	1	9.5	780	1.72	.31	53.84	1.049	6.04	......
Unkunjana (N.) (b), Natal, Africa	Oct. 19	1	12.0	860	1.89	.31	44.76	1.067	11.69	1.73
White Imphee, Iowa	Oct. 2	1	9.4	615	1.35	.80	28.78	1.037	2.98	......
White Imphee, Iowa	Sept. 23	10	10.9	467	1.03	.20	46.25	1.052	7.83	2.07
White Imphee (b)	Sept. 23	10	10.5	470	1.03	.22	45.83	1.052	8.24	2.88
White Mammoth, Missouri	Oct. 19	10	11.2	743	1.63	.29	48.14	1.058	9.00	2.63
Early Amber	Sept. 23	25	9.3	345	.76	.12	47.16	1.055	9.75	2.02
Iowa Red-top, Illinois	Sept. 20	1	11.5	395	.87	.29	....	1.065	9.92	......
Iowa Red-top, Illinois	Sept. 20	12	10.2	364	.67	.13	42.66	1.060	9.98	2.41
Black Sorgho, Cawnpoor, India	Oct. 5	10	9.0	359	.79	.18	37.67	1.065	11.28	2.05
Black Sorgho (b), Cawnpoor, India	Sept. 23	5	9.0	716	1.58	.61	41.59	1.060	10.61	1.85
Black Sorgho (Nesbit), Cawnpoor, India	Sept. 20	6	9.4	519	1.14	.31	41.65	1.053	8.52	2.30
Red Sorgho (Nesbit), Cawnpoor, India	Oct. 5	3	9.9	267	.59	.31	21.25	1.070	10.26	......
Red Sorgho (Nesbit), Cawnpoor, India	Oct. 5	10	7.6	400	.88	.24	39.54	1.063	11.49	1.10
Standard, Tennessee	Oct. 5	2	10.2	395	.87	.42	27.21	1.051	6.30	.88
Neeazana	Oct. 3	10	7.8	507	1.11	.41	46.14	1.068	11.84	3.14
Gray-top, Tennessee	Oct. 2	3	....	527	1.16	.29	49.68	1.050	5.08	4.54

Gray-top, Tennessee	Oct. 4	10	9.2	489	1.07	.36	46.36	1.068	10.98	2.76
New variety, Hoswell, Iowa	Sept. 26	9	9.5	596	1.31	.47	46.32	1.063	10.91	2.55
New variety, Hoswell, Iowa	Sept. 26	2	9.0	583	1.28	.43	42.91	1.073	13.02	2.03
Chinese Imphee, California	Sept. 25	4	8.9	893	1.96	.63	52.60	1.062	11.37	.64
Chinese Imphee, California	Sept. 25	10	9.5	617	1.36	.41	43.64	1.059	10.90	.93
Chinese Imphee, California	Oct. 8	4	7.8	476	1.05	.42	46.71	1.061	5.51	4.95
New variety, Bradford, N. C.	Oct. 2	1	7.7	765	1.68	.29	45.75	1.057	6.70	3.44
H. P. W.'s seed, black seed	Oct. 3	3	8.3	668	1.47	.36	50.62	1.059	10.31	2.10
H. P. W.'s seed, gray heads	Oct. 3	3	10.0	740	1.63	.23	45.49	1.070	12.21	3.09

TABLE GIVING COMPARATIVE COMPOSITION OF DIFFERENT-SIZED STALKS.

KANSAS ORANGE CANE.	Number canes	Weight in grams of clean canes	Weight in pounds of clean canes	Per cent. of seed on clean cane	Per cent. of juice	Specific gravity of juice	Percentages calculated on the juice.			Percentages calculated on the clean cane.		
							Cane sugar	Reducing sugar	Total sugar	Cane sugar	Reducing sugar	Total sugar
Largest canes	9	631	1.39	19.5	47.5	1.0710	11.40	3.59	14.99	5.42	1.70	7.12
Medium canes	12	488	1.07	20.6	48.0	1.0775	13.35	3.13	16.48	6.41	1.50	7.91
Smallest canes	15	285	.63	20.0	41.4	1.0810	14 85	2.65	17.50	6.15	1.10	7.25

A COMPARISON OF DIFFERENT-SIZED STALKS.

An analysis was made to determine what difference, if' any, exists in the value of large canes as compared with small ones. All of the canes for a certain distance in a row of Kansas Orange sorghum were taken and divided into three parts, containing respectively the largest, the smallest, and the medium-sized canes. These divisions were analyzed separately; the details of the results are given in the table. Talking the percentages as calculated on the juice, it would seem that the value of the cane increases as the size diminishes, there being an increase in cane sugar and total sugars, and a decrease in reducing sugar, But as the smallest canes yielded a smaller percentage of juice, the calculation has also been made showing the per cent. of sugars extracted in the juice, but calculated on the weight of the dressed cane. From this it will be seen that the medium-sized stalks yield in grinding the largest per cent. of total sugars, but the proportion of reducing sugar is greater than in the smallest canes. For sugar-making there is probably little difference between the smallest and the medium canes, while the largest are inferior to these. (See table on preceding page.)

ATTEMPTS TO IMPROVE SORGHUM BY SEED SELECTION.

During the season of 1888 we made numerous analyses of individual stalks of sorghum, in the hope that by planting the seed of the best stalks of the several varieties we might establish a strain which would have an increased sugar-content. With a view to deciding sooner to what extent sugar-content is hereditary in sorghum, we saved seed not only from the best stalks but also from the poorest. We thought that by planting both, if we found that there was no essential difference in the product, we might regard it as very doubtful if sorghum can be improved by seed selection; while, if the product of the "best" seed was much superior to that of the "poorest," we could conclude that the sugar-content can be increased by this means. In addition to plats planted with the "best" and the "poorest" seed, we planted a corresponding one with average seed. The destruction of a large portion of the plats by chinch-bugs, and the injury of others, has rendered nearly, if not quite abortive, all our efforts in this direction this year. Those varieties upon which results were obtained in two or more of the three comparison-plats are given in the accompanying table. It should be stated that all of the "poorest" seed was planted upon one edge of the field, and was injured comparatively little by chinch-bugs. The "best" seed was planted further in, as a precaution against crossing with the "poorest." An inspection of the table will show that all three of the plats were available in only two varieties, and that they apparently supported the supposition that sugar-content is hereditary. With the other varieties, however, the evidence is in the contrary direction. The best that we can say is, that so far as our experiments go the question is still undecided.

TABLE COMPARING SORGHUM GROWN FROM DIFFERENT KINDS OF SEED.

VARIETIES.	DATE OF ANALYSIS.	No. of stalks	Kind of seed, 1888	Average weight of dressed canes in grams	Average weight of dressed canes in pounds	Average weight of tops	Per cent. of juice extracted	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice
Amber and Orange crossed	September 27	10	Best	603	1.33	.32	46.84	1.078	14.83	1.54
Amber and Orange crossed	September 27	10	Average	624	1.37	.34	45.83	1.070	13.04	1.41
Amber and Orange crossed	September 27	9	Poorest	597	1.31	.38	46.79	1.066	12.02	1.84
Dutcher's Hybrid	September 18	10	Best	567	1.25	......	51.85	1.058	8.36	3.09
Dutcher's Hybrid	September 18	14	Average	497	1.09	......	51.08	1.057	8.37	3.45
Honey Drip	October 7	23	Best	......	......	.37	......	1.068	11.73	2.31
Honey Drip	October 7	10	Poorest	552	1.21	......	48.86	1.072	12.88	2.22
Medium Orange	September 17	10	Best	......	......	......	......	1.071	14.05	.51
Medium Orange	September 17	10	Average	605	1.33	......	49.30	1.054	9.96	1.29
Medium Orange	September 17	10	Poorest	553	1.21	......	45.80	1.053	9.47	.97
South Carolina Early Orange	October 8	15	Best	......	......	......	......	1.063	10.57	2.77
South Carolina Early Orange	October 7	9	Average	760	1.69	.43	50.43	1.071	12.89	2.50
White Amber	September 19	15	Best	472	1.04	......	44.57	1.065	12.42	1.55
White Amber	September 19	15	Poorest	489	1.08	......	46.33	1.065	12.53	1.28

We have continued the selection of superior individuals from a large number of canes, and hope to do more another season in deciding this important question in regard to sorghum improvement. The mode of operation the past season has been somewhat different from that of the previous one. A much larger number of stalks has been taken of each variety, and this has been possible only by curtailing the observations upon each stalk to a determination of the specific gravity of the juice. If this was found to be high, it was set aside, attention being paid to the amount of the juice as a rough indication of the size of the stalk. Towards the close of the day, from the better ones thus preserved, the best, all things considered, were selected and analyzed. Sometimes more than one was taken, and with two varieties the poorest was also taken. As we show in another article, the size of the stalk seems to have an important influence on the strength of the juice, and as variations in size within a given variety are, in general, accidents due to the thickness of planting, it seems that seed should not be saved from a small stalk which excels only a few thousandths in specific gravity of juice. The concurrence of large size and juice of great density was the property we sought in our "best" stalks. In selecting a companion "poorest" stalk, we have taken one which was nearly the same size as the "best," and yielded juice of low density. Nearly seven hundred individual stalks from fourteen varieties have been examined in the manner indicated; the results are summarized in a table. As will be seen, the highest per cent. of cane sugar observed was 16.94, in a stalk of Link's Hybrid. Stalks of Kansas Orange and Late Orange, however, showed a higher per cent. of total sugars, the highest being 18.9, in Kansas Orange.

TABLE GIVING ANALYSES OF SINGLE STALKS.

VARIETIES.	DATE OF ANALYSIS.	KIND OF SEED, 1888.	No. stalks from which selections were made.	Specific gravity of juice.	Per cent. of cane sugar in juice.	Per cent. of reducing sugar in juice.
African	Oct. 8	Best	7	1.071	11.18	3.59
African *	Oct. 9	Best	46	1.062	7.25	5.29
African	Oct. 9	Best	46	1.071	9.63	4.38
Amber and Orange crossed	Sept. 27	Best	61	1.090	17.47	1.33
Amber and Orange crossed	Sept. 27	Best	61	1.079	15.38	1.23
Dutcher's Hybrid	Sept. 18	Best	68	1.066	10.80	3.03
Early Amber	Sept. 21	Average	60	1.081	15.56	.68
Honey Drip	Oct. 7	Best	24	1.080	15.21	1.14

* Poorest.

TABLE GIVING ANALYSES OF SINGLE STALKS—CONCLUDED.

VARIETIES.	DATE OF ANALYSIS.	KIND OF SEED, 1888.	No. stalks from which selections were made.	Specific gravity of juice..........	Per cent. of cane sugar in juice..........	Per cent. of reducing sugar in juice..........
Kansas Orange	Oct. 4	Best	95	1.080	15.28	2.43
Kansas Orange	Oct. 4	Best	95	1.084	14.46	2.83
Kansas Orange	Oct. 4	Best	95	1.089	16.79	2.11
Kansas Orange	Oct. 4	Best	95	1.088	15.73	.....
Kansas Orange	Sept. 28	Average..	80	1.090	16.56	1.02
Kansas Orange	Sept. 28	Average..	80	1.084	16.08	.81
Late Orange..................	Oct. 8	Best	52	1.087	16.48	2.05
Link's Hybrid *................	Oct. 8	Average..	40	1.071	12.63	1.88
Link's Hybrid	Oct. 8	Average..	40	1.089	16.94	.53
Medium Orange	Sept. 17	Best	34	1.084	16.16	.73
S. Carolina Early Orange	Oct. 8	Best	21	1.077	14.19	2.27
Swain's Early Golden	Oct. 5	Best	22	1.081	15.32	2.03
White African	Oct. 3	Best	24	1.087	15.50	.....
White African	Oct. 3	Best	24	1.078	13.77	1.72
White Amber	Sept. 19	Best	20	1.080	15.56	1.18
Variety with Late Orange	Oct. 7	One head,	28	1.081	15.61	.84

* Poorest.

CROSSING VARIETIES OF SORGHUM.

The question, "Do varieties of sorghum cross?" has been a mooted one for a good many years, some maintaining that they do, others as stoutly denying it. Dr. Peter Collier, whose great services in bringing sorghum into prominence are well known, has given the subject considerable attention, and in his work "Sorghum; its Culture and Manufacture," he expresses the belief that varieties have little or no tendency to cross. This book was written in 1884. Whether its author still holds to this opinion or not we do not know. Probably few of our readers have not heard it said by farmers that broom-corn and sorghum will "mix." It may be remembered that in our last Report we especially avoided an expression of opinion on this point. We are ready now, however, to offer demonstrative evidence that varieties do cross, and in some cases with great ease apparently.

During the season of 1888 some forty varieties of sorghum were grown in rows side by side. From these, selections of seed were made, and the product in the crop of 1889 has furnished the proof mentioned. For example, a panicle of White African, which belonged to the best stalk of that variety analyzed, was carefully preserved without separating the seed until the day it was planted. The separation of the seed was so conducted as to render admixture of other seed impossible. The seed from this panicle produced two perfectly distinct kinds of cane. We do not feel justified in asserting that either of these was pure White African. The variety which most resembled that of 1888 had larger panicles, and the glumes were somewhat browner. The other variety had large, handsome panicles, seed of a light-brown color, glumes darker, and of quite a different appearance from the White African of 1888. The cross seems to be a really valuable one for feed, in that the cane while still containing about 12 per cent. of total sugars, gives a large yield of palatable seed, which does not seem to be especially attractive to sparrows as the White African is. This same cross was observed in all our plats of this variety this year. It made up nearly if not quite one-third of the cane. An Orange cane seemed to have furnished the pollen which produced this cross.

Crosses were observed in several other varieties where the cane had grown from seed of a single panicle. In a plat of African (Imphee, Liberian), containing 406 stalks, fifteen crosses were noticed. Other varieties showed a less number. A plat of Link's Hybrid, containing about 400 stalks, had at least thirty-five crosses. This was from mixed seed of several panicles, none of which showed the slightest indication of crossing. These crosses with Link's Hybrid were apparently referable to three varieties —Amber, Orange, and Enyama, or varieties closely resembling these.

Not a single cross was observed in any of the plats of the various so-called varieties of the Orange, while the appearance of many of the crosses in other varieties indicated that fertilization had been effected by an Orange cane.

But few complete analyses were made of crosses, as the specific gravity of the juice showed their inferior character. The crosses were almost always below the average of the variety in which they occurred. Only one was found which seems to be of special promise—that is apparently a cross with Enyama, which was found with Link's Hybrid. Its juice contained 15.77 per cent. of cane sugar and .8 per cent. of reducing sugar.

The accompanying table gives the results of all our analyses of crosses in which the work was carried farther than to obtain the specific gravity of the juice.

TABLE GIVING ANALYSES OF CROSSES.

VARIETIES WITH WHICH THE CROSS WAS OBSERVED.	DATE OF ANALYSIS.	No. of stalks taken	Average height in feet	Average weight of dressed cane in grams	Average weight of dressed cane in pounds	Average weight of tops in pounds	Per cent. of juice extracted	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice
African	October 2	2	11.0	843	1.85	.48	52.81	1.063	8.57	4.85
African	October 2	1	11.3	835	1.83	.45	45.50	1.055	8.20	3.22
Chinese No. 1	September 21	1	......	610	1.34	.....	....	1.055	7.93	.....
Chinese No. 2	September 21	1	......	.....	......	.....	....	1.060	9.34	.....
Early Amber	October 4	3	9.8	968	2.13	.49	49.05	1.062	9.98	3.04
Enyama	October 3	2	11.3	912	2.01	.40	45.40	1.066	12.31	1.30
Enyama	October 3	1	11.5	127	.28	.42	44.49	1.057	....	.....
Link's Hybrid	October 10	1	......	.....	......	.....	....	1.082	15.77	.80
Link's Hybrid	October 10	1	......	.....	......	.....	....	1.076	13.99	.....
Link's Hybrid	October 10	1	......	.....	......	.....	....	1.072	11.31	.....
White African	September 26	9	......	695	1.52	.57	46.81	1.058	9.52	2.48
White African	September 26	8	......	424	.93	.47	44.72	1.059	9.86	1.93

TIME OF PLANTING SORGHUM.

The time of planting sorghum is a matter of considerable practical importance. When young the plants are delicate, and grow quite slowly. This is a critical time for the plants, being able to offer but little resistance to enemies, whether in the form of insects or unfavorable weather. A field of corn and one of sorghum on the same ground as our sorghum were equally subject to the attacks of the chinch-bugs. The corn maintained its own, while the field of sorghum was destroyed, and was plowed up.

In another field, in good condition and free from chinch-bugs, we planted four varieties — Chinese, Early Amber, Kansas Orange, and Link's Hybrid — at four different dates. The first planting was on April 16th, and subsequent plantings were at intervals of eight days. The same seed was used throughout. The earlier plantings germinated less satisfactorily, and made a slow growth. They matured somewhat earlier than the later plantings, but there was no perceptible difference in the first two plantings, and scarcely any between these and the third. The character of the season, however, had much to do with the slow growth of the early plants; it was a cold and backward spring until about the first of May. The lesson, however, is obvious: it is a loss and not a gain to plant before the soil is warm. But the ground should be ready to take advantage of the first warm, growing weather. The plant must be fully mature to get the best results, and the season will be lengthened by planting to utilize this earliest warm weather.

ANALYSES OF FEEDING-STUFFS.

Before giving the results of our analyses of several feeding-stuffs, it seems desirable to make them more intelligible to the farmers of the State by prefacing them with a brief statement of the meaning of the terms used, together with some account of the function of the various food-ingredients in nutrition.

Analyses of feeds usually include *water, ash, crude protein, crude fat, crude fiber,* and *nitrogen-free extract.*

Water is present in all feed, however dry it may appear to be. This water, as such, has no more value than water taken as drink. Its amount varies in common stock-foods, from about 10 per cent. in corn, bran, shorts, etc., to 80 or 90 per cent., or even more, in green fodders and roots. Since water is present in such variable amount, we can compare feeds absolutely only by estimating the water and then calculating the other results to a water-free basis.

The *ash* is the incombustible portion of the substance. It furnishes the necessary mineral elements to the animal, but a large amount is superfluous, and diminishes the value of the feed to the same extent as the introduction of the same amount of earth would.

Crude protein includes all the nitrogenous constituents, the principal ones belonging to the group of bodies called *albuminoids*. They are so called because of their resemblance to albumen, which is well known in the white of eggs. These substances are also called *proteids*. Common examples are: The gluten of wheat, fiber of muscle, casein or curd of milk, and white of eggs. The albuminoids are the most important constituents of a fodder. They are no more essential than some others, but they are less abundant, and consequently more costly. The albuminoids of plants closely resemble those of animal tissues, and, are necessary in a food to replace the waste of the various organs in performing their functions. They also perform other offices in nutrition, in some of which they can be replaced by the non-albuminoid constituents of crude protein, by carbo-hydrates, or fat.

The crude protein of root-crops, young plants, and germinated seeds, contains a class of compounds which have no common names nor representatives among well-known substances. They are often referred to in analyses as *amido-compounds.* The nitrogen which they contain is called amide nitrogen, while that of the albuminoids is called albuminoid nitrogen. These amide-compounds are crystallizable salts. Their food value has not been satisfactorily determined as yet, and, in this country especially, but little attention has been paid to them either in experiments or in analyses. When their proportion rises to two-thirds or three-fourths of the total crude protein, as it does in some of our analyses of roots, the question of their food value becomes of great importance. Asparagine is the most common of these substances; it occurs abundantly in asparagus, and is formed in germinating seeds by the partial breaking-up of albuminoids. A number of experiments seem to show that asparagine, can replace the albuminoids to a certain extent in a ration. For example, it has been found that with cows the albuminoids of the feed may be replaced up to a certain limit by beets or malt-sprouts (substances containing much amide nitrogen) without detriment to the milk, either in quality or quantity. In respect to the food value of amide-compounds occurring in plants, other than asparagine, but little seems to be known. Such experiments as have been tried have not given entirely concordant results. Whether the amide-compounds themselves can be converted by the organism into the casein of milk or muscular fiber, or whether they can take the place of albuminoids only in the performance of functions which would otherwise require the destruction of albuminoids, is a question not yet positively settled. It is generally held, however, that animal have not the power of elaborating the animal proteids from other food constituents than vegetable albuminoids or the proteids of other animals. Sometimes, as with beets, the crude protein includes a considerable per cent. of nitrates. The *crode fat is* the mixture of substances extracted from the dry fodder by pure ether. In addition to fats proper it may contain various other substances, such as waxes, resins, etherial oils, and chlorophyll, which is the green coloring-matter of plants. The extract from grains is a comparatively pure fat, while that from green fodders is much more impure. If ordinary ether is used the extract becomes still more impure, and may even contain crystallizable salts. The chlorophyl and wax-like substances are almost entirely indigestible, while the true fats are highly digestible. A much larger per cent. of the crude fat from grains is digested, therefore, than of that from green fodders. Young and tender plants yield a more digestible ether-extract than older ones do.

The fats are important elements of a feed, in that they supply heat and muscular force and aid in fattening. They occur in such relatively small amount, however, in plants that they are of less importance to herbivorous than to carnivorous animals. Owing to the higher percentage of carbon which they contain, fats are nearly two and one-half times as valuable for food as starch or sugar, and this factor is used in reducing one to an equivalent of the other.

Crude fiber is that part of the plant which is insoluble in dilute acid, dilute alkali, alcohol, or ether. It consists chiefly of cellulose and woody fiber. The fiber of cotton is almost pure cellulose. Cellulose occurs throughout a plant. As the tissues advance in age the cellulose becomes incrusted and penetrated by lignin, which contains a higher per cent. of carbon. It is then called woody fiber, and is much less digestible than before. The lignin does not seem to be at all digestible. Cellulose is digested to a considerable extent, especially by ruminants. It is most digestible in the young and tender plant, and can be utilized by hogs at no other time. From 30 to 75 per cent. of the crude fiber of common feeds is digestible.

The sum of the previously-described constituents, subtracted from the whole, gives what is called the *nitrogen-free extract.* It consists largely of starch, sugars, gums, pectous compounds, and other less-studied substances. Many of these are included in the group of substances called the carbo-hydrates. The carbo-hydrates of food supply heat, muscular force, and fat. They constitute the larger amount of the most common feeding materials.

Animals are complex machines, whose various parts differ as widely in composition as they do in function. Flesh, fat, and bone, each requires its proper provision for maintenance or growth. It would be expected that a fattening animal would require a different ration from that of one at work, and that a young and growing individual would not be nourished by the food which would sustain an adult one.

The organic digestible constituents of food may be classed as nitrogenous and non-nitrogenous. In considering rations, the ratio existing between the two classes is of importance. In calculating this ratio the amount of fat is multiplied by two and one-half, since the energy evolved by the complete combustion of fat has been assumed to be nearly two and one-half times as great as that obtained from an equal weight of starch. The ratio of the nitrogenous constituents to the sum of two and one-half times the fat, and the other non-nitrogenous constituents, is called the *nutritive ratio*. In calculating the nutritive ratio, only the *digestible* portion of the several constituents is to be considered. *Example:* If a sample of corn meal contains in the dry substance the following per cents of digestible principles, viz.: crude protein, 8; carbo-hydrates, 67; and fat 2, the nutritive ratio is as 8 is to 67+(2X2½)=8 to 72, or 1:9. When there is a large difference between the amount of the nitrogenous and non-nitrogenous constituents, the nutritive ratio is said to be *wide;* when there is comparatively little difference, it is *narrow*.

The nutritive ratio best suited to the purposes of maintenance, growth, labor, fattening or milk-production in the several classes of domestic animals, has been the subject of elaborate study by German investigators. Although these results have been questioned by some American workers, it will require much careful work to demonstrate that they cannot be used as a basis for feeding in this country.

The nutritive ratio is not the only factor to be considered in deciding upon a ration. The total amount of digestible substance given is important. It has been found, too, that a diet consisting of a mixture of the various alimentary principles produces better results than a feed containing a limited number. The digestibility of each constituent does not seem to be an entirely fixed factor, but is influenced by the amount and character of the accompanying constituents.

The food consumed by an animal may be conveniently considered in two parts: first, that expended in maintaining the present condition; and second, that which is required for growth or fattening, or the performance of labor.

The various organs of the body are suffering a continual waste, due to the exercise of their functions. The tissues themselves are disintegrated, and the products of decomposition eliminated. This waste must be made up, or the animal will loose in weight. Feed given in such quantity and of such quality as to exactly compensate for this waste is called a *maintenance ration*. For maintenance, animals require a ration with a wider nutritive ratio, that is, a less proportion of albuminoids, than they do when at work, or growing either in flesh or fat. The nutritive ratio for maintenance of oxen is 1: 12; for sheep, 1:8 with fine breeds, and 1:9 with coarse.

When animals are kept at labor they require not only a larger amount of food than when at rest, but it should be richer in albuminoids. It was formerly believed that albuminoids were the sole source of muscular force, on the supposition that the muscles themselves were wasted by their exertion. It has, however, been shown that the chief source of muscular force lies in the oxidation, the internal combustion, of the carbonaceous elements of the juices which permeate the muscular tissue, and not from destruction of the tissue itself. Using a well-worn but good illustration, we may say that just as very little steel and brass, but much carbon in the form of coal, is required for the development of great power from a steam engine, so the animal machine is itself comparatively little wasted, while the carbon required in the food is directly proportional to the work done. The craving for fat bacon which is noticed in laborers is justified by their needs, and " hog and hominy " is by no means a poor diet for the production of muscular energy. There is, however, during hard labor, an increased destruction of all the bodily tissues, owing to the greater amount of work demanded in the vital processes of digestion, assimilation, and excretion. This increase must be met by a corresponding increase of the albuminoids.

In feeding growing animals a narrower nutritive ratio is necessary than with full-grown ones. The tissues and organs of the body are being increased in size, and as they consist largely of proteids these substances must be present in large proportion in the feed. Calves and young pigs require the most highly nitrogenous food of any animals on the farm. The best nutritive ratio for pigs of about 50 pounds weight is 1:4, which is gradually widened, until at one year of age it reaches 1:6.5. The nutritive ratio with calves of 175 pounds weight should be about 1:4.7, the non-nitrogenous substances being increased with age until at two years the ratio becomes 1:8. Growing sheep require food of about the same composition as young cattle, except that with lambs it should not be quite as highly nitrogenous.

For fattening, a ration rich in albuminoids has been found to give the best results, although carbohydrates are undoubtedly converted into fat. With hogs the nutritive ratio at the beginning may be 1:5.5, which is constantly widened, and at the end of the process may be 1:8, or even 1:10 if the food is palatable. In fattening cattle which are in a good thrifty condition to begin with, a nutritive ratio of about 1 :6.5 is best until the animals have accumulated an appreciable amount of fat. The ratio is then narrowed to 1:5.5, which is continued for the greater part of the feeding period. Towards the end of the feeding a widening of the nutritive ratio to 1 : 6 seems to produce meat which is better flavored and more tender and juicy. If the cattle are not thrifty to begin with, a few weeks of preliminary feeding with food rich in albuminoids (nutritive ratio 1 : 5.5) is advisable.

In the above imperfect presentation of the variation of feed desirable, depending on the purpose for which the animal is kept, we have given the nutritive ratios recommended by E. Wolff.* It is not expected that farmers will be able to calculate exactly what feeds to use, neither is the fact that our Western farmers are limited somewhat in the choice of feed, forgotten. That mixture of feeds which will produce the greatest increase may not yield its increase the cheapest. On the other hand, it is frequently the case that the admixture of a certain amount of a more expensive feed will cause the cheaper portion to be so much better utilized that the joint effect is cheaper production. We have given the nutritive ratios that read-

*"Rationelle Fiiterung der Landwirthschaftlichen Nutztiere." Fünfte Auflage, 1888.

ers may compare by that means the kinds of feed best suited to the several needs of animals, so that their feeding may be *relatively* correct, if not absolutely. The average nutritive ratio of several feeding materials is as follows: Grass, just before blooming, 1:7; red clover, in full bloom, 1:5.7; green corn, 1:13;, sorghum, 1:7.4; meadow hay, of medium quality, 1:8; very good, 1:6; red clover hay, medium, 1:6; very good, 1:5; corn (grain), about 1:9; oats, 1:6.8; wheat bran, 1:4.8; linseed meal, 1:1.4; winter wheat straw, 1:46; oat straw, 1:30; cornstalks, 1:35. By consideration of the nutritive ratio of the feeds available to a man he can easily decide what one or ones of those at his command will best meet the conditions most suitable for successful feeding in his case.

In the table below, which is compiled from Wolff's, the nutritive ratios best suited for the various kinds and conditions of animals are summarized for convenience of comparison. It is not expected that these can be adopted literally. Thought and discrimination are necessary in applying the principles of feeding.

TABLE OF NUTRITIVE RATIOS FOR NORMAL FEEDING OF DOMESTIC ANIMALS

	Maintenance	LABOR.		GROWTH.					FATTENING GROWN ANIMALS.		
		Moderate	Hard	1st period	2d period	3d period	4th period	5th period	1st period	2d period	3d period
Oxen	1:12	1:7.5	1:6	....	....	....	....	....	1:6.5	1:5.5	1:6
Hogs	....	....	....	....	....	....	....	....	1:5.5	1:6	1:6.5
Sheep, coarse breeds	1:9	....	....	....	....	....	....	....	1:5.5	1:4.5	....
Sheep, fine breeds	1:8	....	....	....	....	....	....	....	....	....	....
Milk cows	1:5.4	....	....	....	....	....	....	....	....	....	....
Horses	....	1:7	1:6	....	....	....	....	....	....	....	....
Growing cattle, 2 to 24 months	....	....	....	1:4.7	1:5	1:6	1:7	1:8	....	....	....
Growing sheep, 5 to 20 months	....	....	....	1:5.5	1:5.5	1:6	1:7	1:8	....	....	....
Fat-growing swine, 2 to 12 months	....	....	....	1:4	1:5	1:5.5	1:6	1:6.5	....	....	....

During the past season the farm department grew two varieties of kohl rabi. (see page 47.) Only a few analyses of this plant are on record, and none appear to have been made in this country. The result of our analysis of the two varieties is given in the table. The most interesting feature presented is the large proportion of nitrogen which is present in other forms than that of the albuminoids. In the case of the purple-topped variety, only one-fourth of the total nitrogen is albuminoid. With the green-topped variety the albuminoid nitrogen is slightly greater, but the total per cent. of nitrogen is considerably less.

Having discovered this interesting and important fact in regard to the nitrogenous constituents of kohl-rabi, we thought it desirable to make analyses of other root crops to see to what extent the same were true of them.* Analyses of turnips, rutabagas, and beets were made, therefore, and showed that, of the total nitrogen of beets, less than 24 per cent. was in albuminoids; of rutabagas, less than 44 per cent., and of turnips less than 35 per cent. The beets contained a large percentage of nitrates. We are indebted to the Horticultural Department for the samples of beets, turnips and rutabagas. The beets had been dug some time, but the others were harvested on the day the analysis was begun.

Considering these roots together, and comparing them with other feeding-stuffs, it will be seen that while ordinary dry feeding-stuffs contain about 10 per cent. of *water*, these roots in the fresh state contain less than 10 per cent, of *dry matter*. To make any useful comparison, therefore, we must consider the percentages, as calculated on the dry substance. If this be done, taking corn as an example, it will be seen that the roots have a larger proportion of ash, fiber, and crude protein, while corn has the larger amount of fat and nitrogen–free extract. The nutritive ratio of the roots, if they were wholly digestible, would be about 1:2, as ordinarily calculated; while that of corn would be about 1:7. This would indicate that these roots are of high value as nitrogenous feed, but the fact above noticed, that only from 24 to 44 per cent. of the nitrogen is present in abuminoids, makes such a calculation of the nutritive ratio of very little value. Considering only the pure albuminoids, fat, and nitrogen–free extract, the average nutritive ratio of the roots mentioned is about 1:7. Or, if the non-albuminoid nitrogenous constituents be classed with the carbhydrates, the nutritive ratio becomes 1:9.6. Until more is known of the nutritive value of the amido-acids and acid-amides, it will be impossible to give an accurate opinion upon the value of roots containing so large an amount of these compounds. One of the most pressing needs in feeding experiments, is a careful, exhaustive research upon this subject, of the function of amido compounds in nutrition.

The extent to which sorghum is being grown in this State for feed as well as for syrup and sugar, warrants a study of the food value of its different parts. As a contribution toward this end, we have made three analyses of sorghum seed, and one of the blades. The seed analyzed was white in each case. Analyses of colored seeds have not been made as yet. Two of the varieties, viz., Kaffir corn and Milo maize, were of the so-called non-sac-

* We have been able to find but one other analysis of kohl-rabi recorded, in which mention is made of the large proportion of non-albuminoids in the crude protein. J. Böhmer found only 44.18 per cent. of the nitrogen to be in the form of albuminoids. *(König, Nahrungs and Gunussmittel, Dritte Auflage, page 710.)*

charine sorts; the other was from Honey Dew sorghum, which is a good variety for syrup. An examination of the results will show that the three varieties have substantially the same composition and that this is very nearly the same as that of corn. Whether sorghum seed is of equal value with corn or not, depends not only upon its chemical composition, but upon its physical condition. The small size and greater hardness of the sorghum grain may lead to a less perfect digestion of it on account of defective mastication. Grinding the seed, unless it be made very fine, would not wholly remedy the evil.

The accumulation of large quantities of sorghum leaves at sugar factories, and the desirability of using them for fodder, give a special interest to their composition. The analysis shows them to have an unusual amount of ash, but otherwise they compare favorably with hay.

Analyses of other feeding materials are given in the table. They were made for special purposes, and are placed on record and may be used as standards for comparison of the feeds more especially mentioned in the text.

TABLE SHOWING PERCENTAGE COMPOSITION OF CERTAIN FEEDING-STUFFS.

FEEDING-STUFFS.	IN THE ORIGINAL SUBSTANCE.											IN THE DRY SUBSTANCE.								
	Water	Dry matter	Crude ash	Ether extract, crude fat	Crude protein	Crude fiber	Nitrogen-free extract	Total nitrogen	Albuminoid nitrogen	Nitrogen not in albuminoids	Albuminoids	Crude ash	Ether extract, crude fat	Crude protein	Crude fiber	Nitrogen-free extract	Total nitrogen	Albuminoid nitrogen	Nitrogen not in albuminoids	Albuminoids
Kaffir corn, seed	8.58	91.42	1.63	2.69	11.29	1.54	74.27	1.81	1.72	.09	10.75	1.78	2.95	12.35	1 68	81.24	1.98	1.88	.10	11.75
Sorghum, seed	11.61	88.39	1.49	2.59	10.63	1.25	72.43	1.70	1.62	08	10 12	1.68	2.93	12.02	1.41	81.96	1.92	1.83	.09	11.46
Milo maize, seed	10.05	89.95	1.29	2.90	12.11	1.49	72.16	1.94	1.93	.01	12 06	1.44	3.22	13.46	1.66	80.22	2.15	2.14	.01	13.38
Corn-chop	10 82	89.18	1.69	2 32	10.86	2.10	72.21	1.74	1.65	.09	10.31	1.90	2.60	12.18	2.35	80.97	1.95	1.85	.10	11.56
Bran	9.27	90.73	5.18	3.31	17.24	7.87	57.13	2.75	2.22	.53	13.88	5.71	3.65	19.00	8.67	62.97	3.04	2.45	.59	15.31
Bran	10.84	89.16	4.77	3.22	16.17	7.21	57.79	2 59	....	....	....	5.35	3.61	18.13	8.09	64 82	2.90	....	....	....
Bran	9.19	90.81	6.72	3.66	14.38	10.39	55.66	2.30	1.84	.46	11.50	7.39	4.03	15.88	11.44	61.31	2.53	2.03	.50	12.69
Shorts	10.35	89.65	2.76	2.33	16.39	3.68	64 49	2.62	1.87	.75	11 69	3.08	2.59	18.28	4.11	71.94	2.92	2.09	.83	13.03
Shorts	9.78	90.22	2.80	2.42	16 31	3.74	64.95	2.61	2.10	.51	13.12	3.10	2.69	18.08	4.15	71.98	2.89	2.33	.56	14 56
Shipstuff	8.72	91.28	4.03	3.94	17.78	5.91	59 61	2.84	2.36	.48	14.75	4.41	4.31	19.48	6.48	65.32	3.12	2.59	.53	16.19
Sorghum leaves	9.10	90.90	14.80	3.82	9.31	18.63	44.34	1.49	1.23	.26	7.69	16.28	4.20	10.26	20.50	48.76	1.64	1.35	.29	8.44
Hay	10.27	89.73	6.96	2.39	11.28	25.33	47.77	1.80	1.52	.28	9.50	7.76	2.66	12.57	28.23	48.78	2.01	1.70	.31	10.63
Cottonseed-meal	7.10	92.90	7.27	10.01	49.23	3.13	23.26	7.88	7.45	.43	46.56	7.82	10.78	52.99	3.37	25.04	8.48	8.02	.46	50.13
Turnips	92.71	7.29	.90	.06	2.04	.82	3.47	.33	.12	.21	.72	12.35	.86	28.02	11.29	47.48	4.43	1.45	3.03	9.05
Rutabagas	89.99	10.01	.69	.10	2.03	1.09	6.10	.33	.14	.18	.89	6.92	1.01	20.31	10.91	60.85	3.25	1.42	1.83	8.88
Beets	92.89	7.11	1.14	.04	1.95	.71	3.27	.31	.07	.24	.46	16.08	.62	27.41	9.96	45.93	4.39	1.03	4.36	6.43
Kohl-rabi, purple	90.91	9.09	1.25	.09	2.31	1.11	4.33	.37	.09	.28	.56	13.79	1.01	25.39	12.24	47.57	4.06	1.02	3.04	6.38
Kohl-rabi, green	91.25	8.75	1.29	.08	1.71	1.43	4.24	.27	.07	.20	.44	14.75	.96	19.50	16.34	48.45	3.12	.85	2.27	5.31

METHODS OF ANALYSIS.

The methods of analysis employed were, in general, those adopted by the Association of Official Agricultural Chemists. As we have in the details made some departures from the published directions, and have employed a number of useful expedients, more or less new, a somewhat detailed description of methods will be given. Unless otherwise stated, the official directions have been followed.

Crude Ash. — This is determined by charring the substance in a good-sized platinum dish, at a heat below redness, and without allowing the escaping gases to ignite. If the gases take fire the substance is set to burning with a flame, and portions of the ash are almost certain to fuse and inclose carbon. The thoroughly-charred substance is exhausted with boiling water, the insoluble residue ignited, the water extract returned to the dish and evaporated to dryness, the whole heated gently, cooled, and weighed. Proceeding in this way we have almost invariably obtained white, or light-gray ashes.

Water. — This has always been determined by heating the substance in a current of dry hydrogen, at the temperature of the water–oven. It has seemed to us more suitable to determine the moisture expelled at the boiling point of water than at 100° C., or any other constant temperature. The tendency of water to escape from the substance may be fairly assumed to vary with the variations in the atmospheric pressure. If boiling water be the source of heat, its temperature will vary at the same time, and to the same extent, while if the bath be kept constantly at 100° the moisture expelled will vary with every oscillation of the barometric column. When we consider, further, the constant difference, due to differences of altitude, it would seem apparent that, to obtain comparable results, chemists must adhere to boiling water as the standard of temperature.

We have found that the interior of the common water-oven may be kept at the full temperature of boiling water by fitting a board into the open side, inside the door, thus providing a non-conducting wall. The temperature of our oven is usually 98° to 99.5° C.

To facilitate the desiccation in hydrogen, we have had a copper box made, to contain the weighing–bottles. The box is 6x3x2½ inches, and holds eight weighing–bottles. The top is provided with two openings, large enough to admit the bottles conveniently, which are closed air-tight by wide corks. The hydrogen is admitted by another opening at the lower side, near one end of the box, and escapes through a glass tube drawn to a small opening, and placed in the cork at the other end of the top. This arrangement has been in use in our work for nearly a year, and has given good satisfaction. Another device which has proved of considerable service in the desiccation of substances may be described here, although we have not used it in the estimation of water in fodders. It consists of a T-tube of glass, with two of the openings sealed, and having two to six short, upright branches. Drying-tubes are connected with these branches by means of perforated corks. The drying-tubes are like short, wide test-tubes, but are open at the bottom, and have a short piece of tubing fused on. This tubing is of the same size as that used for the upright branches of the connecting tube. When any branch is not in use, it is closed by substituting a sealed piece of tubing for the drying–tube. When a current of hydrogen is being passed into the apparatus, each drying–tube is nearly closed by a cork bearing a bit of glass tubing, drawn to a small opening. This may be omitted when the drying is effected in a current of air. We have used this arrangement in the analysis of milk by Babcock's method, and in the analysis of butter. The weighed butter is melted down into asbestos, and the further treatment is the same as with milk.

In the estimation of water in fodders, four to five grams are weighed out in a weighing-bottle, about one and one-fourth inches in diameter, and dried to a constant weight in a current of pure dry hydrogen. Twenty to thirty hours are usually required. As this experience seems to be contrary to that published by some others, we submit the following results, upon a sample of corn-meal, pulverized to pass through a sieve containing 4800 meshes to the square inch (60x80). It was placed in one of the weighing-bottles mentioned, and connected directly with the source of hydrogen, not placed in the above-described box. There could be no doubt that a steady current of pure dry hydrogen flowed through the bottle. The dryness of the hydrogen was assured by passing it through an additional weighed calcium chloride tube during the whole experiment. 4.8807 grams of the substance were taken. Weighings were made at intervals, with the following results: After 2 hours, 4.4670; 4 hrs., 4.3762; 6 hrs., 4.3458; 8 hrs., 4.3285, 10 hrs., 4.3187; 12 hrs., 4.3114; 14 hrs., 4.3090; 16 hrs., 4.3088; 21 hrs., 4.3058; 26 hrs., 4.3020; 34 hrs., 4.2969. After this the weight was not materially altered. The substance had lost 10.34 per cent. after four hours' heating, 11.66 per cent. after 12 hours, and 11.96 per cent. after 34 hours. It will be seen that heating for less than twelve or fourteen hours would have involved a considerable error, while the loss by longer heating was not of as great significance.

Ether Extract. — Crude Fat. — In most of the work published at this time, the ether extract has been determined in the residue after determination of moisture. The substance is exhausted by absolute ether, in a Soxhlet extraction apparatus, about 2 grams being weighed off for each estimation. The substance is inclosed in a small fat-free filter-paper, which is folded into a sack–like form. This is held together by a ring of platinum wire, and the whole covered by a small cone of filter-paper with the apex cut off. The latter is to prevent the dropping ether from beating out the substance. The extract is dried in hydrogen, and weighed.

In a few of the later analyses the air-dried substance was weighed into the filter-paper sack and dried in hydrogen for four hours, in the second form of desiccating apparatus described above.

Crude Fiber.— The substance used in the determination of the ether extract is readily detached from the filter-paper and transferred to an Erlenmeyer flask. Two hundred c. c. of boiling 1.25 per cent. sulphuric acid is added from a wash-bottle, brought to boiling again as quickly as possible and kept boiling for thirty minutes. During the boiling the flask is connected with an inverted condenser which keeps the acid of constant strength. The flask is also connected with an air-blast. The blast enters through a glass tube drawn out to a small opening and reaching a few centimeters into the flask. The jet of air thus directed upon the surface of the boiling liquid completely controls the foaming, which usually gives so much trouble in fiber determinations, and allows the liquid to be kept in perfect and constant ebullition. In heating without this blast of air it is usually impossible to keep the liquid boiling at all constantly, and there is great danger of loss from foaming over. The inequalities of treatment thus induced may account for much of the disagreement of results obtained by different chemists in fiber determinations. The blast may be obtained from any source of compressed air, or it may be *drawn* in by connecting the upper end of the condenser with a pump. This use of the blast, so far as we know, originated in this laboratory.* It has been incorporated in the official method. It enables the analyst to start the substance to boiling and leave it with scarcely any further attention, if care has been taken to wash adhering substances down from the side of the flask with the last portion of the acid. After boiling thirty minutes the residue is filtered off. In most cases in the past the fine linen filter has been used, but recently the new method of filtration upon an asbestos welt has been used with satisfaction. The residue is washed back into the Erlenmeyer flask with 200 c. c. of a boiling 1.25 per cent. solution of sodium hydroxide, and boiled for thirty minutes, the flask being connected with the blast and inverted condenser as before. The residue is collected in a Gooch crucible and estimated as usual. In drying the fiber we use the Victor Meyer drying apparatus, with toluene as the boiling liquid.

The use of the inverted condenser to maintain the acid or alkali at its original strength, has long been known, but seems to have been employed but little. The importance of this will be seen by consideration of the fact that with ordinary gentle boiling, a 1.25 per cent. solution of sodium hydroxide or sulphuric acid, in thirty minutes will become a 2.00 per cent. solution, and even with a very low flame it will reach 1.65 per cent. At the same time the boiling point is raised appreciably. By proceeding as we have indicated in the description above, we have almost uniformly obtained highly concordant results in parallel determinations of fiber.

Nitrogen, Albuminoids, Crude Protein.— The nitrogen is determined by Kjeldahl's method as detailed in the official directions, except that the ar-

*Since this was in the hands of the printer we have learned from Prof. Caldwell that this device was independently and successfully used by Mr. Withers in the laboratory of Cornell University.

rangement described by Armsby and Short* is used to prevent the passage of fixed alkali into the distillate, and a current of steam is passed through the liquid during distillation. The current of steam prevents bumping and hastens the distillation. The tube delivering the steam is put in the place occupied by the funnel-tube in the apparatus of Armsby and Short. In the presence of nitrates Scovell's modification of the Kjeldahl method is used.

The crude protein is calculated by multiplying the total per cent. of nitrogen by 6.25. In the presence of any considerable amount of amide or nitric nitrogen, the "protein" obtained by this calculation is very "crude." This inaccuracy does not consist wholly in the fact that "crude protein" includes not only true albuminoids, but also other nitrogenous ingredients, but it involves the further error that it does not even represent the sum of the various nitrogenous elements of the substance. The calculation proceeds on the assumption that each of the nitrogenous constituents contains 16 per cent. of nitrogen. This assumption is approximately true of the albuminoids only. Of the others which may be present, asparagine contains 21.21 per cent.; glutamine, 19.18 per cent.; betaine, 10.37 per cent.; glutamic acid, 9.52 per cent.; ammonium salts, 21 to 35 per cent.; potassium nitrate, 13.86 per cent., etc. Unfortunately, in the present condition of chemical science, it is impossible to separate the various nitrogenous constituents of plants from each other, and perhaps the assumption that the total nitrogen is 16 per cent. of the total nitrogenous constituents, is as close an approximation as can be made.

Nitrogen-free extract is determined by difference All errors in the calculation of crude protein are therefore carried over to this. If the protein as calculated is too high, the figures for nitrogen-free extract will be too low to the same extent.

COMPOSITION OF CORN AT DIFFERENT STAGES OF GROWTH.

An examination was made into the chemical composition of the grain obtained in the experiment by the Farm Department detailed in the First Annual Report of the station, pages 48–52. A sample of the corn was placed in our hands after it was shelled, ground and mixed. The data regarding the corn previous to this time are taken from the report referred to.

The two varieties of corn — King Philip and a yellow dent — were cut at the dates and at the degree of ripeness indicated in the table. The analyses were made to study the changes in composition of the grain. The stalks were not available for the purpose of analysis. A study of their composition would give interesting facts in connection with those obtained by analyzing the grain. The fodder of the dent increased about one-sixth

*American Chemical Journal, 8, 323.

in weight, but the character of this increase was not determined. The fodder of the King Philip made but little increase in weight. Where the quantity varies so little it becomes more important to know the quality. Common experience, however, has shown the inferior quality of fodder cut when the corn is hard and the stalks drying up. The quality when the corn is in the milk and dough stages is not so well known. Various cutting of whole plants have been made the present year to study the comparative development, but the analyses are not completed, and the results are necessarily reserved for a future publication. The results of the analyses of the corn of 1888 are published now in connection with other analyses of feeding materials completed within the year.

TABLE GIVING THE COMPOSITION OF CORN (GRAIN ONLY) AT DIFFERENT STAGES OF RIPENESS.

DATE OF CUTTING.	CONDITION OF GRAIN.	IN THE ORIGINAL SUBSTANCE.											IN THE DRY SUBSTANCE.								
		Water	Dry matter	Crude ash	Ether extract, crude fat	Crude protein	Crude fiber	Nitrogen-free extract	Total nitrogen	Albuminoid nitrogen	Nitrogen not in albuminoids	Albuminoids	Crude ash	Ether extract, crude fat	Crude protein	Crude fiber	Nitrogen-free extract	Total nitrogen	Albuminoid nitrogen	Nitrogen not in albuminoids	Albuminoids
KING PHILIP.																					
August 8	In milk	10.40	89.60	1.63	2.02	10.19	1.60	74.16	1 63	1 56	.07	9.75	1.82	2.28	11.38	1.78	82.74	1.82	1.74	08	10.88
August 15	In dough	10.31	89.69	1.54	3.04	9.81	1.51	73.79	1.57	1.49	.08	9.31	1.72	3.37	10.98	1.68	82.25	1.75	1.67	.08	10.44
August 20	Hard dough	10.40	89.60	1.55	2.71	9.63	1.55	74.16	1.54	1.46	.08	9.13	1.73	3.02	10.74	1.74	82.77	1.72	1.63	.09	10.19
August 24	Ripe	10.74	89.26	1.37	2.93	9.62	1.38	73.96	1.54	1.48	.06	9.25	1.54	3.29	10.75	1.55	82.87	1.72	1.66	.06	10.38
September 4	Ripe*	10.22	89.78	1.40	2.53	9.58	1.49	74.78	1.53	1.49	.04	9.31	1.56	2.82	10.67	1.66	83.29	1.71	1.66	.05	10.38
YELLOW DENT.																					
August 8	In milk	10.29	89.71	1.78	1.80	11.21	1.74	73.18	1.79	1.72	.07	10.75	1.98	2.01	12.50	1.94	81.57	2.00	1.92	.08	12.00
August 15	In dough	10.06	89.94	2.16	1.45	11.88	2.24	72.21	1.90	1.84	.06	11.50	2.40	1.62	13.19	2.49	80.30	2.11	2.05	.06	12.81
August 20	Hard dough	10.84	89.16	1.55	2.12	10.38	1.58	73.53	1.66	1.64	.02	10.25	1.74	2.38	11.66	1.77	82.45	1.86	1.84	.02	11.50
September 4	Ripe*	10.88	89.12	1.42	2.08	10.69	1.47	73.46	1.71	1.66	.05	10.38	1.60	2.33	12.00	1.65	82.42	1.92	1.86	.06	11.63

*Stalks drying up.

The water and dry matter are in the air-dry meal. It will be seen that there is scarcely any difference in the power of retaining water. In the dent the retentive power seems to increase with ripeness, while the King Philip varies irregularly. As no special effort was made to have the samples in the same condition, all these differences may be purely accidental. This would seem to be hinted at by the erratic variations. The comparison should therefore be made upon the dry substance.

The second cutting of dent is anomalous, judged from the other results. It is excepted in what follows. An inspection of the table will show that the so-called carbonaceous materials —fat and nitrogen-free extract — increase proportionately as the grain develops. The fiber, ash, and nitrogenous materials decrease. This means, of course, that the corn plant, in maturing, deposits fatty and starchy substances in the seed in greater proportion than it does the other proximate constituents. There is one notable exception to an orderly increase or decrease of components — the second cutting of the dent. No explanation of this exception is apparent. But the changes in composition are so inconsiderable as to make the grain practically equal, pound for pound, at all these dates of cutting. Not so the actual quantity of grain, however. Observant farmers well understand the light and chaffy corn that results from very dry weather before the corn hardens, and the shortening of the crop by drought, at any time before the corn is fully ripe. The yield of corn at the several cuttings is strikingly shown in the experiment mentioned. In the case of yellow dent, a yield of fifteen bushels of corn in the dough increased to thirty-nine bushels by the time it was ripe, and the quality was sensibly the same. King Philip increased from thirty bushels to sixty-one of equal quality.

AMMONIA AND NITRIC ACID IN ATMOSPHERIC WATERS.

The necessity of compounds of nitrogen to plants, their scarcity in, and liability to be exhausted from, the soil, and their consequent importance as artificial fertilizers, is well known. Indeed, nitrogen holds the first place among manures. Important as are super-phosphates and potash salts, and as others in special cases may be found to be, nitrates and ammonia salts, in the great majority of cases, are most effective in increasing the yield of crops and in developing those that are of most value. While the sources of most of the other elements of plant-food have been fairly well settled, there has continued to be much uncertainty regarding the element nitrogen. Assuming that ammonia salts and nitrates are the direct sources of nitrogen to plants, whence these? It has been known that both exist in the atmosphere, and that they are washed from the latter by the rains and snows. This source of nitrogen compounds to the soil has received attention in Europe, and various attempts have been made to determine the amount thus added. The results have been far from uniform. Some investigators report much more than others. To what extent these differences have been strictly local, that is, the amount increased by local emanations; to what extent to the territory traversed by the wind-currents previously to reaching the station; and to what extent to errors in the determinations themselves, it is impossible to form an opinion. But it is quite certain that the analytical methods employed in much of this work were not susceptible of great accuracy when employed upon such dilute solutions as rain-water. Moreover, these observations were not made in this country. As similar work was being conducted in England, and on the continent at a few localities, the investigators availing themselves of recent methods, it seemed desirable that like work should be undertaken in this country. Accordingly, in the winter of 1886, arrangements were made for collecting and analyzing rain-water that falls on our College grounds. As the work has been carried on for four years, it is deemed proper to publish the results. We had constructed a rain-gauge of tin-lead-lined copper. The area of the gauge is one-fivethousandth ($^{1}/_{5000}$) of an acre. It is nearly square in form, and is placed with its upper rim about eighteen inches above the surface of the ground. A pit is boarded up under the gauge, so that the water can be drawn from the gauge through a cock. The volume of water is taken in litres, and thus we have the means of calculating the depth of the rainfall as well as the volume per acre. A sample of each rain* was preserved, separately, in glass-stoppered bottles for analysis. But in addition to this, full notes have been taken of incidental facts, such as time of beginning and ending of rain, direction of wind during the fall, whether there was lightning, and some estimate of its extent. It was thought that if any connection exists between these phenomena and the quantity of either nitric acid or ammonia, it would be rendered apparent. The first year, extending from March 1st, 1886, to March 1st, 1887, the total nitrogen existing as ammonia and as nitrates was determined without distinguishing between these two. Since March 1st, 1887, such distinction has been made. The method of analysis will be detailed later. Until September 1st, 1889, each rain was analyzed separately. Since that time, a sample representing the rain of the month has been analyzed. The amount of the work where each rain is analyzed by itself is so great that the monthly analysis has been adopted. Having been continued for three and a half years, the first course has furnished data that should answer such questions as it is especially suited to solve. Thus, the varying relation between the ammonia and the rain-water would seem to be given with sufficient fullness and repetition, by the two hundred and forty-two rains of the three and a half years.

* The water was collected when the rain seemed to be over. In some cases the precipitation extended over several days. In other cases, after clearing up, another shower would occur on the same day.

During the year, March 1st, 1886, to March 1st, 1887, as has been said, the ammonia and the nitric acid were determined together, as ammonia. After some study and investigation, the following treatment was adopted: A quantity of the rain-water was placed in a wide-mouthed bottle for reduction of the nitrates and nitrites to ammonia, by the copper-zinc couple. The couple was prepared after Williams; that is, clean strips of zinc, after being rinsed in distilled water, are immersed in a three-per-cent. solution of copper sulphate. A deposit of spongy copper takes place over the surface of the zinc. If the action goes on too long, the copper deposit becomes heavy and less adherent, so that in the subsequent washing in distilled water it is likely to be loosened, and the efficiency of the couple greatly reduced. We bend the zinc strips so as to form a hook at one end. A copper wire, bent at right angles, serves to lift these about in the preparation of the couple. The reduction bottle, containing the water and the couple just described, was set aside and had the common temperature of the laboratory. In four or more days a measured portion of the water was made alkaline by ignited sodium carbonate, distilled, and the ammonia determined in the distillate by Nesslerization. Tests showed that complete reduction had taken place in this time. The method by Nesslerization has proved quite accurate, considering the nature of the liquid to be analyzed. A standard ammonia solution containing .00001 gram of ammonia per cubic centimeter was used. We have been able to get the most satisfactory results when about three cubic centimeters of the ammonia solution were required in the comparison tube. Much more than this quantity gives a color so deep that slight differences are not apparent. And as the quantity becomes much less, the error becomes proportionately greater for a fixed difference as a tenth or a half-tenth of a cubic centimeter of the standard solution. This desired depth of color for Nesslerization was approximated, either by taking more or less of the water for distillation, or by diluting the distillate with ammonia-free water. By the method given above, and which was employed the first year, the equivalent in ammonia of the nitrogen existing in the three states of combination, nitrates, nitrites, and ammonia salts, was found. From the strictly agricultural standpoint it may make little difference whether the nitrogen is in all of these forms, or but one. But other questions seemed to justify, if not demand, a separation of these classes of compounds. Accordingly, with and after March, 1887, the ammonia existing as such in the fresh rain-water, *i.e.*, as ammonia salts, was first determined, and then the ammonia obtained by the reduction of the oxidized nitrogen, (nitrates and nitrites.) The method before used was modified in such way as to give the additional data desired. A preliminary trial of the water shows the experienced Nesslerizer about what quantity of water to take to bring the depth of color within the desired range. This amount may be 100 c.c., 50 c.c., 25 c.c., or, in some cases, as low as 10 c.c. For ammonia 50 c.c. are more frequently taken than any other quantity;

for nitric acid 200 c.c. are generally used, but a less quantity if the ammonia is unusually strong. As before, dilution after distillation is sometimes resorted to. The amount required is taken out in a volume pipette, made slightly alkaline, distilled until two-thirds or more have come over, and the distillate Nesslerized. To the residual liquid in the distilling-flask usually a 250 c.c. flask, another portion of the rain-water is added, and the whole boiled with the flask disconnected from the condenser. When the water has mostly boiled away, the boiling is stopped, the residue made slightly acid with hydrochloric acid, a little ignited sodium chloride added, the copper-zinc couple, previously described, placed in, the flask corked and set aside to give the nitrates time to be reduced. The liquid is finally made alkaline and distilled from this flask, the distillate being Nesslerized as before. From the ammonia obtained, the weight of the nitric acid can be calculated. These details are given at length, that chemists may be able to judge of the value of the methods employed.

In the four years from March 1st, 1886, to March 1st, 1890,* there have been two hundred and sixty six rains when enough water was collected for analysis. In a very few instances there was too little to distinguish between ammoniacal and nitric nitrogen. It has not seemed profitable to publish at this time the results for the whole four years by rains. A careful study of these rains and the attendant phenomena might lead to important conclusions as to circumstances that influence the composition of these waters. But this work is one that is beset with many difficulties. The factors involved are so numerous and complicated as to make it next to impossible to determine how much of any particular result is due to one, and how much to another of these factors. If the effect of all other conditions could be eliminated, or, what amounts to the same thing, if cases when they are uniform could be taken, it would be easy to tell the effect of any one factor. But this is where the difficulty lies. As an illustration, it seems from a study of our figures that the quantity of nitric acid is greater in proportion to the ammonia in rains accompanied by much lightning, than in those of little lightning. But this cannot be certainly known by any superficial study; and it is still less easily determined whether the total nitrogen is increased, thus indicating the oxidation of nitrogen gas; or, on the other hand, whether the acid comes from the oxidation of ammonia. We have thought the latter probable. But is it really true that the figures show an increased amount of nitric acid with increase of visible electrical disturbance? Other factors that act conjointly with this are: the direction of the wind; amount of rain; length of time since rain; duration of rain; season of the year; kind of weather preceding rain; silent and invisible electrical disturbances; errors in estimating the quantity of visible electrical action. The electrical discharges, though vivid, may be so distant that the atmosphere through which they pass is not that washed by the water collected in

*We take advantage of the slight delay in publication to bring the data up to March, 1890.

the gauge. Allowance must be made for each of these in estimating the influence of any one. Further study will be given this matter, but no attempt is now made to generalize.

In the table on page 128, the analytical results for the year, extending from March 1st, 1888, to March 1st, 1889, are given. This is the last full year that the separate rains have been analyzed. In the table are included the number of rains, the depth, the parts of nitrogen in ammonia and in nitric acid per million of water, the grams of each per acre, and the total nitrogen per acre.

TABLE GIVING THE NITROGEN IN AMMONIA AND IN NITRIC ACID IN EACH RAIN FOR AN ENIRE YEAR.

DATE, 1888-89.	Rainfall in inches	NITROGEN IN AMMONIA.		NITROGEN IN NITRIC ACID.		Total nitrogen, grams per acre......
		Parts per million.	Grams per acre.	Parts per million.	Grams per acre.	
March 3	.423	.807	35.190	.099	4.310	39.500
March 4	.165	.412	7.018	.146	2.491	9.510
March 5	*.001	5.468	.685	....	....	.685
March 10	.044	1.235	5.635	.480	2.189	7.824
March 19	.378	1.071	41.723	.231	8.986	50.709
March 19	.105	.222	2.396	.056	.599	2.995
March 25	.916	.408	38.564	.119	11.274	49.838
April 3	.038	5.024	19.641	.627	2.453	22.094
April 9	.329	.856	29.043	.238	8.827	37.869
April 17	.148	1.001	15.311	.499	7.626	22.936
April 25	.017	10.376	18.204	1.851	3.247	21.452
April 26	.187	1.005	19.313	.229	4.401	23.714
April 27	.119	.819	9.992	.096	1.180	11.171
April 28	.010	2.429	2.557	.449	.473	3.030
April 28	.475	.376	18.400	.107	5.246	23.645
May 3	.222	.777	18.237	.391	9.176	27.413
May 7	.252	.576	15.026	.375	9.767	24.792
May 11	.565	.436	25.400	.167	9.705	35.105
May 15	.041	1.109	4.725	.576	2.453	7.178
May 17	.080	1.103	9.127	.476	3.939	13.066
May 22	.029	.955	2.849	.579	1.725	4.574
May 23	.080	1.911	1.580	.194	.160	1.740
May 26	1.186	†........	....	.084	10.316	10.316
May 26	.301	.242	7.519	.101	3.141	10.660
May 28	.261	.219	5.928	.036	.978	6.906
June 1	.083	.807	6.877	.329	2.807	9.684
June 8	.722	.167	12.423	.060	4.444	16.867
June 12	.039	.774	3.104	.198	.793	3.897
June 14	.274	.362	10.244	.113	3.201	13.445
June 18	.016	2.511	4.092	.539	.878	4.970
June 19	.082	.280	2.358	.142	1.196	3.554
June 20	1.094	.033	3.715	.142	16.022	19.737
June 22	.097	.329	3.302	.321	3.220	6.522
June 24	2.007	.156	32.353	.084	17.453	49.806
June 25	1.347	.198	27.478	.194	27.053	54.525
June 26	.025	1.235	3.220	.719	1.873	5.093
June 26	.107	3.656	4.051	.189	2.098	6.149
July 8	.122	.560	7.060	.211	2.658	9.717
July 9	.543	.371	20.736	.102	5.714	26.450
July 14	.086	.725	6.393	.514	4.533	10.927
July 16	3 039	.054	16.761	.070	21.718	38.678
July 17	.008	2.009	1.612	.703	.564	2.175
July 23	.203	1.111	23.238	.412	8.607	31.845
July 25	.009	2.347	2.176	.878	.815	2.991
August 3	.500	.519	26.734	.243	12.518	39.253
August 5	1.082	.161	17.910	.202	22.503	40.413
August 5	.464	.136	6.504	.140	6.702	13.206
August 7	.179	.235	4.545	.210	3.863	8.408
August 14	.139	.486	6.941	.601	8.588	15.529
August 25	.200	.340	6.990	.243	4.993	11.983
August 26	.134	.301	4.143	.105	1.447	5.591
August 27	1.906	.206	40.412	.062	12.124	52.536
September 12	2.284	.259	61.244	.280	66.105	127.349
September 14	.125	.519	6.684	.301	3.872	10.556
September 21	.431	.519	23.067	.291	12.998	36.066
October 5	.095	3.582	35.015	.739	7.171	42.187
October 10	1.265	.383	49.907	.120	15.660	65.567
October 12	.038	2.168	8.578	.538	2.132	10.711
October 15	1.029	.317	33.613	.082	8.731	42.343
October 22	.312	.519	16.462	Lost.	....	16.462
November 7	.034	7.494	26.295	.568	1.994	28.289
November 9	.440	.478	21.668	.222	10.087	31.754
December 15	.078	7.494	59.915	.601	4.806	64.721
December 25	.502	.774	39.998	.202	10.425	50.423
December 30	.400	.313	12.897	.041	1.697	14.594
January 15	.606	.568	35.461	.029	1.799	37.260
January 19	.121	.404	5.026	.107	1.334	6.360
February 18	.168	2.182	37.740	.590	10.197	47.937
February 25	022	2.023	4.700	.684	1.576	6.276
February 28	.116	1.087	13.023	.226	2.979	16.002

* The amount of water was so small that the total nitrogen was determine without distinguishing between ammoniacal and nitric nitrogen

† No ammonia was found in this water. Heavy hail with considerable lightning.

It will be seen that the parts per million of nitrogen in ammonia vary from 0 to 10.38, and in nitric acid from .036 to 1.85. The average for the year from ammonia is .387 parts per million; from nitric acid .160 parts. The ammonia washed down to the soil is 3.072 pounds per acre; the nitric acid (NO_3, is 4.645 pounds. The whole amount of nitrogen by which the soil was enriched by the rains, was 1,627 grams, equal to 3.579 pounds per acre.

The next table presents the monthly summaries for four years. It requires no explanation, excepting to say that the means of "parts per million" are not obtained by averaging the figures for the separate months, but from the total weight of water, and of ammoniacal, or nitric nitrogen, as the case may be.

TABLE GIVING THE RESULTS FOR FOUR YEARS, BY MONTHS.

MONTHS.	RAINFALL. 1886-7.		1887-8.		1888-9.		1889-90.		TOTAL NITROGEN GRAMS PER ACRE.				NITROGEN IN AMMONIA. Parts per million.			Grams per acre.			NITROGEN IN NITRIC ACID. Parts per million.			Grams per acre.		
	No.	Inches.	No.	Inches.	No.	Inches.	No.	Inches.	1886-7.	1887-8.	1888-9.	1889-90.	1887-8.	1888-9.	1889-90.	1887-8.	1888-9.	1889-90.	1887-8.	1888-9.	1889-90.	1887-8.	1888-9.	1889-90.
March	7	1.99	3	.39	7	2.03	3	1.73	121.4	71.7	160.4	205 3	1.487	.625	.812	59.0	130.5	144.7	.322	.143	.340	12.8	29.8	60.6
April	8	3.94	6	2.23	8	1.33	6	1.84	106.1	156.4	165.9	193.2	.578	.974	.659	132.6	132.5	125.0	.104	.246	.360	23.8	33.5	68.2
May	7	4.52	5	2.65	10	2.95	10	6.41	217.9	154.7	141 8	221.8	.380	.298	.220	103.6	90.4	144.6	.187	.169	.117	51.0	51.4	77.2
June	6	4.87	13	4.94	12	5.90	6	3.27	100.2	187.4	194.3	129.1	.227	.187	.211	115.3	113.2	73.4	.142	.134	.166	72.1	81.0	55.7
July	3	2.41	6	.35	7	4.01	10	7.42	187.4	37.8	122.8	336.4	.582	.189	.272	20.9	78.0	207.5	.475	.109	.169	17.0	44.8	128.9
August	11	1.88	10	6.03	8	4.61	7	2.60	115.4	287.7	186.9	141.2	.305	.241	.381	189.2	114.2	98.8	.159	.154	.164	98.5	72.7	42.4
September	6	1.04	8	6.37	3	2.85	5	1.91	46.3	249.2	174.0	141.3	.279	.311	.644	183.1	91.0	127.2	.101	.283	.072	66.1	83.0	14.1
October	3	2.17	2	2.13	5	2.73	3	1.42	84.2	52.2	177.3	140.2	.169	.511	.914	36.8	143.6	133.3	.071	.120	.047	15.4	33.7	6.9
November	1	1.07	2	.43	2	.48	4	2.22	65.5	113.5	60.0	118.4	2.195	.984	.416	96.7	48.0	95.1	.381	.248	.080	16.8	12.1	18.4
December	4	1.43	5	.80	3	.98	2	.015	50.8	71.0	129.7	29.9	.768	1.121	16.47	62.2	112.8	25.9	.107	.168	2.52	8.7	16.9	4.0
January	2	.18	3	.44	2	.73	5	2.30	20.1	33.4	43.6	120.5	.634	.542	.305	28.6	40.5	72.1	.108	.042	.204	4.9	3.1	48.4
February	3	.88	6	2.66	3	.31	5	.23	107.4	119.5	70.2	93.5	.336	1.761	2.84	91.8	55.5	69.0	.101	.468	1.01	27.7	14.8	24.5
Means													.370	.387	.408				.137	.160	.170			
Totals	61	26.9	69	29.4	70	28.9	66	31.4	1223.	1535.	1627.	1866.				1120.	1150.	1317.				415.	477.	549.
Totals in pounds									2.690	3.376	3.579	4.105				2.464	2.530	2.897				.913	1.049	1.208

The following table presents in concise form the averages deduced from the table giving the results by months:

SUMMARY OF RESULTS OF ANALYSES OF RAIN-WATER.

	Total nitrogen—means for four years.	Nitrogen. in ammonia—means for three years.	Nitrogen in nitric acid—means for three years.
Parts per million of water.	.522	.388	.156
Grams per acre.	1563.	1196.	480.
Pounds per acre	3.44	2.63	1.06

Mean rainfall for four years, 29.14 inches.

Some results of other investigators may properly be given for comparison with the above. At Strasburg an average of .5 parts of ammoniacal nitrogen were found in one million of rain-water; at Leipzig, 1.2 parts; in Silesia, 2.5 parts; at Rothamsted, 1.1 parts. Of nitric nitrogen, .12 part per million were found at Rothamsted; .18 part at Kuschen; .65 part at Regenwalde, Prussia.

But the quantities per acre are more important since the proportion would vary with the quantity of rain-water. At Rothamsted nearly 7 pounds of nitrogen as ammonia and .8 pound as nitric acid were brought down to the acre; in Silesia, 10 pounds from ammonia and 1 from nitric acid; in North Prussia, 5 pounds from ammonia and .9 from nitric acid. These determinations were made some years ago.

R. Warington has published* the results obtained at Rothamsted in recent years by essentially the same process as that which we have been using, and which has been described above. He found 2.8 pounds of nitrogen as ammonia and .9 pound as nitrates and nitrites, per acre, in the water collected from May, 1888, to April, 1889, inclusive. The total amount was 3.74 pounds. At Tokio, Japan, Kellner finds a total of 2.8 pounds. At Caracas, Venezuela, latitude 10° N., Muntz and Marcano find in two years' rainfall an average of 2.23 parts of nitric nitrogen per million. This is estimated to amount to 5.16 pounds per acre of nitric nitrogen alone. At St. Denis, latitude 20° S., the proportion is still greater, being 2.67 parts per million, equivalent to 6.19 pounds per acre of nitric nitrogen.

But what significance have these figures to the farmer? The nitrogen brought to the soil by rains is worth the same as a fertilizer as that quantity of nitrogen in Chili saltpeter or commercial ammonia salts. An ordinary dressing of Chili saltpeter may be taken as 200 pounds per acre. How does the nitrogen of rain-water compare with this amount? If the nitrogen be multiplied by six it will give approximately its equivalent in Chili saltpeter,

*Jour. Chem. Society, Aug. 1889, p. 537.

sodium nitrate. The nitrogen of the rain-waters at Rothamsted is equivalent to 22.5 pounds of sodium nitrate per acre; at Tokio, to about 16.8 pounds; within the tropics, about 34 pounds as nitrates alone. At our Station the nitrogen collected is equivalent to 20.9 pounds of Chili saltpeter. Although this amount is not large it is of some consequence, being about one-ninth of a dressing of nitrates.

Credit should be given Mr. C. M. Breese for much of the work upon these rain-waters, he having had immediate charge of it for more than two years. It may be added that he also gave valuable assistance in the work upon sorghum.

NITRITES IN THE RAIN-WATER.

From May, 1887, to September, 1889, inclusive, the rain-water was tested for the presence of nitrites. The very delicate naphthylamine and sulphanilic acid test, first proposed by Griess, as modified by Warington,* was employed. The test can hardly be used quantitatively, but a rough comparison can be made by noting the depth of color produced by the reagent. In some rains the color was the faintest pink, in some a deep rose-red, in others there was no evidence of nitrites. In the time mentioned, one hundred and seventy-one rains were tested. Of these, one hundred and twenty-eight gave the reaction for nitrites in the water without concentration; twenty-nine gave no reaction, and fourteen were doubtful. There were one hundred and thirty-two rains in the six months from April to September, inclusive. Nitrites were present in 86 per cent. of these, and absent or doubtful in 14 per cent. There were thirty-nine rains in the remaining six months, October to March, inclusive. In 36 per cent. of these, nitrites were present, and in 64 per cent, absent or doubtful. This points to a less favorable condition for the production or conservation of nitrites in winter than in summer. This is more strikingly shown if we compare the four months, December, January, February and March, with June, July, August and September; 28 per cent. of the rains of the former, and 89 per cent. of those of the latter, contained nitrites.

Nitrites may be regarded as intermediate between nitrates and ammonia salts; the former produced by complete oxidation, the latter by reduction. In fact, both nitrites and ammonia may be produced by reduction of nitrates, and these in turn by the oxidation of nitrites and ammonia. Whether the deficiency of nitrites in winter results from excessive oxidation, nitrates being produced, from a minimum reduction of nitrates, or from a minimum oxidation of nitrogen and ammonia, is an interesting and probably complex problem. The solution is hinted at in the fact, that the relation of nitric acid to ammonia is greater in summer than in winter. It would seem, then, that nitrates as well as nitrites are deficient in winter.

*Jour. Loud. Chem. Soc., May, 1881.

Report of the Department of Horticulture and Entomology.

E. A. Popenoe, A. M., *Professor of Horticulture* and *Entomology.*
S. C. Mason, *Foreman Horticultural* Department.
F. A. Marlatt, B.Sc., *Assistant in Entomology.*

The present report covers the work of this department during the past year in the following lines:

Comparative trial of garden beans.
Further trial of peas, tomatoes, and potatoes.
Notes on bean insects.

Experimental work in progress in forest-tree planting, in propagation of woody plants by cuttings, in vineyard and small fruits, in trials of lawn plants, and in other lines of work in horticulture, with other studies of injurious insects, is not here included, being reserved for more complete report in future publications.

GARDEN TESTS OF VEGETABLES.

A COMPARATIVE TRIAL OF GARDEN BEANS.

The beans of the following list were planted May 4th, in good bottom loam, old ground, in fine condition, and were given clean culture throughout the season, without the use of fertilizers of any kind. To each sort was allotted thirty feet of row, varieties of similar habit being placed near together for comparison, so far as their habit was known before planting. Pole beans were supported in growth by osage orange stakes, five or six feet in height.

The season was quite favorable, the only drawback experienced being the prevalence, during a part of the midsummer, of a "bean rust" that interfered with complete results in the case of some varieties of bush beans.

The product was gathered as fast as the beans ripened, and the figures in the tenth column of the table give in ounces the total product of the several pickings, for each variety. For the purpose of comparing the amount of product of the different sorts, the last column shows in ounces the proportional product of each sort per 100 vines.

Following the tables will be found a descriptive list of the sorts that made growth sufficient to allow for such observation. In this list the varieties are arranged with slight modification, after a scheme of classification proposed by Mr. H. H. Wing, in the report of the New York Station for 1883. This arrangement is based upon the variations in the shape of the ripe seeds, the ultimate division being dependent upon their color and markings. While this arrangement sometimes violates the more natural relationships shown in the habit and aspect of the plant, it seems the most satisfactory yet proposed, and we have accordingly adopted it for the present.

BUSH BEANS.

No.	Source.	VARIETIES.	First appearance.	First bloom.	First edible string.	First edible shelled.	First ripe.	Number vines.	Total weight dry beans.	Weight per 100 vines.
			*Days.**	*Days.**	*Days.**	*Days.**	*Days.**		*Ounces.*	*Ounces.*
1	Cleveland	Best of All	7	42	53	62	75	78	21.5	27.6
2	Buist	Bismarck	6	40	51	58	71	82	19.0	23.2
3	Cleveland	Broad Windsor	....	37	58	69	86	51	10.5	20.6
4	Cleveland	Canadian Wonder	7	42	51	62	83	57	30.0	52.6
5	Cleveland	China Red Eye	6	39	49	58	69	81	22.5	27.8
6	Cleveland	Cleveland's Improved Valentine	6	40	49	58	76	111	33.0	29.7
7	M. L. S. S. Co.†	Crystal White Wax	6	42	54	62	75	109	16.0	14.7
8	Henderson	Crystal White Wax	7	49	58	68	79	90	21.0	23.2
9	Henderson	Cylinder Black Wax	6	42	51	60	76	97	21.0	21.6
10	Henderson	Date Wax	7	40	49	58	71	97	14.5	14.9
11	Bouk	Dolly Varden	6	39	49	58	71	114	15.0	13.1
12	Thorburn	Dun-Colored Bush	6	37	49	58	77	65	50.5	77.7
13	Cleveland	Dwarf Black Wax	7	42	51	62	76	81	18.5	22.8
14	Thorburn	Dwarf Mexican Tree	6	62	75	83	....	94	63.5	67.6
15	Cleveland	Dwarf Mont D'Or	7	39	49	58	75	106	14.0	13.2
16	Vaughan	Emperor William	7	37	48	56	69	93	19.0	20.3
17	Wilson	Flageolet	7	42	52	60	77	60	8.5	14.2

* Days from planting. † Michigan Lake Shore Seed Co., Chicago.

BUSH BEANS—CONTINUED.

No.	Source.	VARIETIES.	First appearance.	First bloom.	First edible string.	First edible shelled.	First ripe.	Number vines.	Total weight dry beans.	Weight per 100 vines.
			*Days.**	*Days.**	*Days.**	*Days.**	*Days.**		*Ounces.*	*Ounces.*
18	Cleveland	Flageolet, Improved Green †	......	......	......	......	......	......	......	......
19	Thorburn	Flageolet, Improved Green	6	40	52	67	81	94	8.0	8.5
20	Wilson	French Asparagus	6	......	69	75	79	......	68.0	......
21	Thorburn	Fulmer's Early Dwarf	9	42	52	60	77	42	4.5	10.7
22	Cleveland	Golden Wax	7	39	49	58	72	96	14.0	14.6
23	M. L. S. S. Co.	Golden Wax	7	39	49	58	72	83	14.5	17.5
24	Henderson	Henderson's Earliest Red Valentine	7	40	49	58	75	100	24.5	24.5
25	Henderson	Henderson's Black-Eyed Wax	7	39	49	60	69	......	10.0	......
26	Farquhar	Improved Yellow Eye	7	44	56	67	77	100	26.5	26.5
27	Henderson	Ivory Pod Wax	7	41	52	62	75	105	15.0	14.3
28	Thorburn	King of the Greens	6	40	52	67	76	119	14.0	11.8
29	Landreth	Landreth's First in the Market	7	39	49	58	69	75	14.0	18.7
30	Landreth	Landreth's Scarlet	7	39	49	58	76	98	12.0	12.2
31	Landreth	Landreth's Violet	7	44	54	62	76	105	22.0	20.9
32	Cleveland	Large Yellow Six Weeks	7	39	49	58	69	91	19.5	21.3
33	Henderson	Low's Champion	7	42	49	58	73	91	18.0	19.7
34	Farquhar	Marblehead	7	39	49	58	69	59	23.0	39.0
35	Cleveland	Mohawk	7	37	49	58	73	102	32.0	31.4
36	Thorburn	Ne Plus Ultra	6	39	49	58	69	110	27.0	24.5

37	Vick	New Prolific German Wax	7	39	51	60	76	95	22.0	23.2
38	Vaughan	Perfection Wax	7	40	51	60	76	68	11.5	18.3
39	Landreth	Pink Eye Wax Golden Pod	7	40	49	58	75	79	12.0	15.2
40	Thorburn	Pride of Newton	7	40	52	60	73	80	21.5	26.9
41	Cleveland	Red Kidney	6	42	51	60	76	47	23.5	50.0
42	Cleveland	Red Round Pod Valentine	6	40	54	60	75	108	31.5	29.1
43	Cleveland	Refugee, or Thousand to One	7	51	62	69	89	100	5.0	5.0
44	Henderson	Rhode Island Dwarf Case Knife	7	37	51	60	75	101	14.5	14.3
45	Gregory	Snowflake	6	40	52	62	71	105	33.5	31.2
46	Thorburn	Volger's Kidney	7	40	51	60	77	35	5.5	15.7
47	Henderson	Wardwell's Kidney Wax	7	39	51	60	73	82	28.5	34.7
48	Farquhar	White's Extra Early	9	39	52	62	76	36	18.0	50.0
49	Thorburn	White Flageolet	7	40	52	62	76	50	10.0	20.0
50	Cleveland	White Kidney	7	42	52	62	79	69	22.5	32.6
51	Cleveland	White Marrowfat	7	46	56	62	79	85	42.5	50.0
52	Cleveland	White Navy	7	44	52	68	73	93	35.0	37.6
53	Farquhar	White Pea	6	46	73	79	91	....	59.5	....
54	Cleveland	White Valentine	7	40	53	62	76	84	21.0	25.0
55	Cleveland	White Wax	7	44	53	62	73	79	13.5	17.1
56	Everitt	White Wonder Field	6	46	54	62	73	94	36.0	38.3
57	Wilson	Wilson's Best of All Dwarf	7	60	....	....	....	....	....	....

[a] Days from planting. † No seed germinated.

BUSH BEANS—CONCLUDED.

No.	Source.	VARIETIES.	First appearance.	First bloom.	First edible string.	First edible shelled.	First ripe.	Number vines.	Total weight dry beans.	Weight per 100 vines.
			*Days.**	*Days.**	*Days.**	*Days.**	*Days.**		*Ounces.*	*Ounces.*
58	Farquhar	Wonder of France	6	40	52	62	75	93	4.0	4.3
59	Henderson	Yosemite Mammoth Wax	10	41	60	62	....	....	....	....

POLE BEANS.

No.	Source.	VARIETIES.	First appearance.	First bloom.	First edible string.	First edible shelled.	First ripe.	Number vines.	Total weight dry beans.	Weight per 100 vines.
60	Thorburn	Algerian Wax	7	42	55	62	79	....	53.5	....
61	Farquhar	Arlington Cranberry	9	40	53	62	79	78	19.5	25.0
62	Farquhar	Cream Pole	9	48	58	68	93	66	45.0	68.2
63	Landreth	Cream-Seeded Cut Short Cornfield	9	60	....	....	....	48	71.0	147.9
64	Vaughan	Crease-back	7	48	58	69	76	60	47.5	79.1
65	Farquhar	Crosby Horticultural	7	42	60	68	83	72	89.5	124.3
66	Cleveland	Crystal Wax	7	48	58	69	79	53	25.5	48.1
67	Cleveland	Dutch Case Knife	7	42	56	62	79	69	107.5	155.7
68	Henderson	Early Golden Cluster Wax	9	56	69	77	....	55	57.0	103.6
69	Cleveland	German Black Wax	10	56	62	75	....	38	.25	.66
70	Cleveland	Horticultural Cranberry	9	49	69	77	86	....	21.5	....
71	Gregory	Hungarian Butter	6	44	55	62	79	82	30.5	37.2
72	Cleveland	Ivory Pod Wax	7	42	55	62	75	31	42.0	135.5
73	Vaughan	Lazy Wife	9	72	....	....	....	....	16.0	....
74	Everitt	New Golden Andalusian	9	58	....	....	....	34	9.5	27.9

75	Cleveland.....	Red Cranberry	10	40	56	62	79	47	10.0	21.3
76	Cleveland.....	Red Giant Wax......................	9	56	60	69	....	70	58.0	82.9
77	Thorburn.....	Ruby of Erfurt......................	6	46	55	62	76	83	12.0	14.5
78	Cleveland.....	Southern Prolific	7	58	67	75	86	55	142.5	259.1
79	Thorburn.....	Transylvania Butter	7	48	56	65	79	81	4.0	4.9
80	Wilson	Wilson's Best of All Pole............ ..	7	93	....	....	....	63	93.0	147.6
81	Wilson	Wilson's Golden Podded Lazy Wife	10	....	....	....	....	32	0.0	0.0
		LIMA BEANS.								
82	Cleveland.....	Dreer's Improved Lima	7	58	....	....	... .	42	38.0	90.5
83	Landreth	Dwarf Carolina......................	10	55	... .	75	88	....	40.0	....
84	Cleveland....	Extra Early Lima	10	62	....	94	....	....	32.5	....
85	Henderson....	Henderson's New Bush Lima	9	49	....	72	86	74	32.0	43.2
86	Henderson....	Jersey Extra Early Lima Pole.........	·9	51	....	94	....	31	56.5	182.2
87	Thorburn.....	Kumerle's Dwarf Lima................	10	60	....	91	....	17	....	....
88	Cleveland.....	Large White Lima...........	10	55	....	....	....	51	40.0	78.4
89	Cleveland.....	New Challenger Lima........	7	60	....	....	....	30	41.0	136.7
90	N. B. & G. Co.‡	New Dwarf Lima†	6	40	52	56	69	65	42.5	63.8
91	Cleveland.....	Small Lima	7	51	58	76	88	54	175.5	325.0

*Days from planting. †Not a Lima; see description. ‡Northrup, Braslan & Goodwin Co., Minneapolis.

BEANS,—DESCRIPTIVE LIST.

PHASEOLUS VULGARIS, L. The Kidney-bean.

I. Seeds oblong, not more than twice as long as broad, flattened sidewise.

(a) Very strongly flattened, usually strongly kidney shape.

*Seeds of uniform color.

†Seeds white, edible pods green.

Dutch Case Knife, Cleveland, (No. 67.)

A very rank grower; leaflets large, as broad as long, rough; flowers white; pods abundant, six to eight inches long by three-fourths to seven-eighths of an inch wide, thin, flat, light green, curved; beans five to eight, large, kidney-shaped, flattened, greenish. Ripe beans white, slightly polished, indistinctly veined and often wrinkled.

Emperor William, Vaughan, (No. 16.)

Vines ten to twelve inches high, stout, erect; leaflets of medium size, rough, wrinkled, and rolled at the edges; flowers cream and white; pods four to five inches long by three-fourths of an inch broad, flat, thick, light green; beans four to six, white, broad, flat; when ripe, polished, veined, smooth and plump.

Landreth's First in the Market, Landreth, (No. 29.)

Vines eight to twelve inches high, erect, rather coarse; leaflets small, rough; flowers white; pods five to six inches long by five-eighths of an inch broad, flat, light green; beans four to six, white, flat, kidney-shaped. Ripe beans impure white, polished, indistinctly veined, uneven, shriveled.

Rhode Island Dwarf Case Knife, Henderson, (No. 44.)

Vines twelve to sixteen inches high, slender and inclined to short runners; leaflets small, rather rough; flowers cream and white; pods abundant, four to six inches long by three-fourths of an inch wide; beans four to six, oval or oblong, white; when ripe, white, plump, smooth, shining, often distinctly veined.

†† Seeds white; edible pods yellow.

Early Golden Cluster Wax, Henderson, (No. 68.)

A medium to tall climber; leaflets large; flowers white; pods four to ten inches long by one inch broad, deeply lobed by beans, golden yellow; beans three to eight or ten, large, white, oval, plump and of fine appearance; when ripe, shining and veined; quite prolific during the latter part of the season.

††† Seeds of uniform color (not white), edible pods green.

New Dwarf Lima, Northrup, Braslan & Goodwin Co., (No. 90.)

A pole bean of medium strength and height, not a lima in leaf, bloom or pod; has more the habit of some of the cranberry beans; leaflets medium sized, broad, rough, dark green; flowers white; pods abundant, five to seven inches long, nearly straight, flat, five-eighths to three-fourths of an inch wide, green; beans four to six, white when young, ripening to taffy yellow, oval, flat, plump; polished, indistinctly veined. An early and productive bean, and a valuable sort this season, worthy to be sold on its own merits and not as a lima.

**Seeds variegated.

Cream Seeded Cut Short Corn Field, Landreth, (No. 63.)

A rank climber; leaflets very large, coarse, wrinkled; flowers white; pods four to eight inches long, irregularly curved laterally, greenish, with pale-reddish splashes as in the Horticultural Cranberry; beans four to eight, broadly reniform, ground color white, curiously splashed with pale brown and lilac; when ripe, drab, varying to yellowish or light lilac, splashed with yellowish brown; eye broadly ringed with yellow.

(b) Seeds strongly flattened, not kidney-shaped.

Red Giant Wax, Cleveland, (No. 76.)

A rank growing runner, with large, rough leaflets; flowers white; pods four to six inches long by three-fourths inch wide, few, irregular, thick, coarse, light green; beans six to eight, large, roundish and flattened, greenish white, reddening from the eye outward as they ripen; when ripe, smooth, polished, dull crimson to brownish red; above the hilum a black tubercle.

Transylvania Butter, Thorburn, (No. 79.)

A very low growing pole bean with purple stems, few slender runners; very small leaflets, strongly veined and recurved; flowers deep violet; only a medium number of pods, four to five inches long by three-fourths inch wide, some a little splashed with red; beans four to five, of the cranberry type, large, greenish white while young; ripe beans clay-yellow, varying darker.

II. Seeds oblong, at least twice as long as broad.

(a) Perceptibly flattened sidewise, often truncate at the ends.

*Seeds of uniform color.

†Edible pods green.

White Flageolet, Thorburn, (No. 49.)

Vines eight to twelve inches high, erect; leaflets medium sized, rough; flowers white; pods not plenty, three to four inches long by one-half inch wide, flat; beans four or five, white, oval; ripe beans ivory white, veined, plump, moderately shining.

Green Flageolet.

Syn. Improved Green Flageolet, Thorburn, (No. 19); Flageolet, Wilson, (No. 17); Wonder of France, Farquhar, (No. 58); King of the Greens, Thorburn, (No. 28).

Stalks eight to fourteen inches high, slender, erect, much branched; leaflets small to medium, dark green, rough, strongly veined; flowers cream or white; pods four to five inches long, one-half inch wide, slender, curved, flat, color of leaf; beans four to six, small, flat, kidney-shaped, light green to greenish white, moderately polished, obscurely veined.

Red Kidney, Cleveland, (No. 41.)

Vines sixteen to twenty inches high, stout; leaflets medium size to large, thin, rough; flowers pale violet; pods four to five inches long by one-half-inch wide, a little curved, thick, color of leaf; beans four to five, long, kidney-shaped, pale rose, deeper around the eye; when ripe, dull crimson, varying to brownish red, plump, polished, shining; somewhat injured by rust.

Canadian Wonder, Cleveland, (No. 4.)

Stalks eighteen inches high; leaflets broad, rather coarse, of medium green color; flowers pale pink; pods four to five and one-half inches long by one-half an inch broad, curved, rather flat, light green, thick and a trifle rough; beans two to six; when ripe, smooth polished, light to dark crimson, in old beans nearly black.

†† Edible pods yellow.

Perfection Wax, Vaughan, (No. 38.)

Vines twelve to sixteen inches high, erect; leaflets medium sized, light green; flowers violet; pods four to six inches long by five-eighths inch broad, flattened, thick, rich yellow; beans four to five, long kidney-shaped, rich purple, mottled; when ripe, dull to dark purple or almost black; smooth and shining. This and the following are scarcely distinct.

Landreth's Scarlet, Landreth, (No. 30.)

Vines twelve to fourteen inches high, stout, erect; leaflets medium sized, light green; flowers pale violet; pods five to six inches long by nine-sixteenths inch broad, curved and rather flat, thick, light yellow; beans four to six, large, kidney-shaped, flattened, light or dark purple, smooth, shining.

Bismarck, Buist, (No. 2.)

Stalks one foot high, slender, erect; leaflets small, light green; flowers pink; pods pale yellow, four to five and one-half inches long, a little curved; beans three to five, dark-bluish purple; when full ripe, plump, shining, dark-bluish purple to bluish black, in lighter specimens a brown ring around the eye. Of second quality as a string bean.

Hungarian Butter, Gregory, (No. 71.)

A weak, slender climber; leaflets small to medium, broad and obtuse; pods abundant, five to eight inches long by one-half inch broad, nearly cylindrical, irregularly curved or abruptly angular; beans four to eight, long kidney-shaped, greenish white with a black ring around eye; when ripe, brownish dun, shining, veined, a dark ring around the eye. A good string or shell bean.

** Seeds variegated.

Best of All, Cleveland, (No. 1.)

Stalks one foot high, stout, spreading; leaves large; leaflets three to six inches long, rather rough, medium green in color; flowers white; pods abundant, four to five inches long by one-half to five-eighths of an inch broad, slightly curved, light green, rather thick; beans four to seven; when ripe, plump, smooth, light clay - drab, splashed or almost solidly covered by purple, a distinct yellow ring around the eye.

(b) Seeds cylindrical or nearly so.

*Seeds white, (or in one case marked around the eye.)

White Kidney, Cleveland, (No. 50.)

Vines sixteen to twenty inches high, erect; leaflets large, coarse, dark green; flowers white; pods four to five inches long by one-half inch broad, thick, of leaf-green color; beans four to six, flat, irregular, kidney-shaped, pale green; when ripe, ivory white, little shining, veined, smooth and plump.

White Valentine, Cleveland, (No. 54.)

Vines twelve to fourteen inches high, erect; leaflets medium size, light green; flowers cream and white; pods numerous, four to five inches long, cylindrical or broader laterally, light green; beans four to five, sub-cylindrical, white; when ripe, dull white, little shining, veined, plump, skin often wrinkled.

Creaseback Pole, Vaughan, (No. 64.)

A medium runner; leaflets of medium size, coarse; flowers white; pods numerous, four to five inches long by one-half inch in diameter, nearly cylindrical, thick, puffy, light green; beans four to six, kidney-shaped, white; when ripe, white, little shining, indistinctly veined, sometimes wrinkled.

Wilson's Best of All Pole, Wilson, (No. 80.)

A medium-sized climber; leaflets small to medium, obtuse, strongly veined and rough; bearing profusely during the last three or four weeks of the season; pods six to seven inches long by one-half inch broad, rounded and creased in the back, ripening to golden; snap well when young; beans four to eight, oval or oblong, white, of excellent quality; ripe beans plump, smooth, white, veined.

**Seeds of uniform color (not white).

† Edible pods green.

Large Yellow Six Weeks, Cleveland, (No. 32.) Date Wax, Henderson, (No. 10.) Pride of Newton, Thorburn, (No. 40.)

Vines ten to twelve inches high, erect, of medium strength; leaflets small, light green; flowers pale violet; pods four to five inches long by one-half inch wide, straight or a little curved, color of leaf, ripening to yellow; beans four to six, long, kidney-shaped, pale dun with violet eye.

Ne Plus Ultra, Thorburn, (No. 36.)

Vines eight to ten inches high, erect; leaflets medium sized, light green; flowers pale violet; pods four to five inches long by seven-sixteenths inch wide, thin, curved, color similar to leaf, ripening to yellow; beans four to six, long, kidney-shaped, occasionally truncate, pale dun with violet eye; ripe beans smooth, somewhat shining, of a characteristic dark tawny yellow with darker eye. Similar to the preceding, but much smaller.

Dun-Colored Bush, Thorburn, (No: 12.)

Stalks sixteen to twenty inches high, stout, rank; leaflets three to six, long, rather dark colored; flowers white; pods not abundant, four to five inches long by one-half inch wide, a little curved, not well filled; beans three to five, dark purplish dun, long kidney-shaped, often truncate, a pale purple mark around the eye; pods green, tough.

***Seeds variegated.

Henderson's Earliest Red Valentine, Henderson, (No. 29.) Cleveland's Improved Valentine, Cleveland, (No. 6.) Red Round Pod Valentine, Cleveland, (No. 42.)

Vines ten to sixteen inches high; leaflets medium or small, light green, rather rough, thin, acute, flowers cream or white; pods numerous, three to five inches long, cylindrical, thick, curved, of leaf-green color; beans three to five, long, nearly cylindrical, greenish white with splashings of pale pink around the eye; when ripe, often truncate, plump, little shining, color dark-brownish red, mottled and splashed with light tan.

Fulmer's Early Dwarf, Thorburn, (No. 21.)

Vines twelve to eighteen inches high, stout, erect; leaflets large, round, coarsely wrinkled, dark green; flowers pale violet; pods three to four and one-half inches long by one-half inch broad, thick, straight, color of leaf; badly attacked by rust; beans four to five; when ripe, large, plump, shining, of the color and markings of the Red Valentine, but a half larger.

Wardwell's Kidney Wax, Henderson, (No. 47.)

Vines twelve to sixteen inches high, erect; leaflets medium to large, light green, rough; flowers cream and white; pods abundant, four to five inches long by five-eighths inch broad, thick, bright golden; beans four to six, large, long, plump, kidney-shaped, smooth and shining, white with deep dull-violet splashes around the eye. Quite productive.

Henderson's Black-Eyed Wax, Henderson, (No. 25.)
Vines eight to ten inches high; leaflets medium or small, acute, rather rough, dark green; flowers cream and white; pods four to five inches long, one-half inch wide, a little curved, flat or roundish, light yellow; beans four to five, long oval, plump, not shining, white with irregular black splash around eye.

Refugee, or Thousand-to-one, Cleveland, (No. 43.)
Vines sixteen to eighteen inches high, slender, much branched and spreading; leaflets small, numerous, bright green; flowers violet; pods abundant, three to four and one-half inches long by seven-sixteenths to one-half inch wide, a little curved, rather flat, light green like under side of leaf becoming slightly splashed with purple as they mature; beans three to five, when ripe, plump, smooth, dark purple and light brown variously splashed and intermingled.

III. Seeds oblong, never more than twice as long as broad, often nearly spherical.

(a) Seeds distinctly oblong, usually with rounded ends.
*Edible pods green.
† Seeds of uniform color.

White Navy, Cleveland, (No. 52), White Wonder Field, Everitt, (No. 56.)
Vines twelve to eighteen inches high, slender, branching, with a few short runners; leaflets small, thin, light green; flowers cream and white; pods numerous, sometimes three on a stem, three to four inches long, by three-eighths inch broad, nearly straight, light green; beans four to six, small, opaque, white, plump.

Snowflake, Gregory, (No. 45.)
Vines fourteen to eighteen inches high, slender and much branched, a few short runners; leaflets very small, one to two and one-half inches long, thin, light green; flowers white; pods numerous, three to three and one-half inches long by three-eighths inch wide, green, ripening to yellow; beans four to six, small, plump, opaque, white.

White Pea, Farquhar, (No. 53.)
Vines sixteen to twenty inches high, much branched and slender, with numerous short runners; leaflets small, dark green, rough; flowers white; pods few, straight, slender, three to four inches long by three-eighths of an inch wide, light green; beans four to six, plump, opaque, white, often distinctly veined.

Dwarf Mexican Tree, Thorburn, (No. 19.)
Stalks twelve to eighteen inches high, slender and much branched, spread-

ing, with a tendency to runners; leaflets small; flowers late, white, abundant; pods few, three to three and one-half inches long by three-eighths of an inch wide, nearly straight, flat, of leaf-green color; beans six to eight. Apparently identical with No. 53, but a few days later.

White Marrowfat, Cleveland, (No. 51.)
Vines sixteen inches high, branching, slender, with many short runners; leaflets small to medium, dark green; flowers white; pods numerous, four to five inches long by five-eighths inch broad, nearly straight, flat; beans four to five, roundish oval, white, somewhat shining, often wrinkled, eye plane.

Southern Prolific, Cleveland, (No. 78.)
A rank-growing climber, with medium sized, rough, dark-green leaflets; flowers white; pods numerous, six to eight inches long by one-half inch wide, nearly straight, flattened, green; beans six to eight, long kidney-shaped, grayish brown in color; continues to bloom and set freely till frost. Stands heat and drouth well. The most productive of all beans except the lima.

†† Seeds variegated.

China Red Eye, Cleveland, (No. 5.)
Stalks twelve to fourteen inches high, rather slender; leaflets medium-sized, light green; flowers cream and white; pods abundant, four to five inches long, one-half inch wide, nearly straight; beans four to six, plump, smooth, white, splashed and speckled with red around the eye.

Improved Yellow Eye, Farquhar, (No. 26.)
Stalks eighteen to twenty inches high, branching and spreading, with short runners; leaflets small, deeply veined and rough; flowers white; pods three to four inches long by nine-sixteenths of an inch wide, straight, thick, flat, color of the leaf; beans four to five, oval, greenish white; when ripe, plump, smooth, white with yellowish-brown blotch, the eye ringed with darker.

** Edible pods yellow or yellowish white.

White Wax, Cleveland, (No. 55), Crystal White Wax, M. L. S. S. Co., (No. 7.)
Vines ten to fourteen inches high, erect; leaflets small, light green; flowers white; pods abundant, three to four inches long by nine-sixteenths inch wide, flat, nearly straight, light yellow; beans four to six, roundish oval, shriveled, dull white.

Ivory Pod Wax, Henderson, (No. 27.)
Vines ten to twelve inches high, slender, branching, with short runners; leaflets small, thin; flowers white; pods three to three and one-half inches long by seven-sixteenths of an inch wide, much twisted and curved, light

ivory yellow; excellent as snap beans; ripe beans four to six, small, white, often slightly shrunken.

Ivory Pod Wax, Cleveland, (No. 72.)

A low, slender runner; leaflets small, light green; flowers white; pods abundant, three to four and one-half inches long by one-half inch broad, curved, ivory white; beans four to six, oval, often truncate, white; when ripe, polished, veined, often shrunken irregularly.

Crystal White Wax, Henderson, (No. 8.)

Stalks eight to twelve inches high, slender, branching and spreading; leaflets rather small, three inches long; flowers cream and white; pods numerous, three to four inches long, clear greenish white while young, ripening to purplish and becoming loose and puffy; ripe beans small, plump, smooth, ivory white.

Crystal Wax, Cleveland, (No. 66.)

A very low runner, much branched and spreading, with but few tendrils; leaflets small to medium, light green flowers white; pods numerous, three to four inches long by one-half inch in diameter, curved, puffy, creamy white, purplish as they ripen; beans four to six, small, oval, plump, smooth, ivory white. Distinct from the Crystal White Wax of Henderson only in a taller habit.

Algerian Wax, Thorburn, (-No. 60.)

Vine of medium strength; leaflets small to medium, broad, rough, thick; flowers white; pods abundant, four to five inches long by one-half inch wide, with position of beans clearly marked, thick, green, ripening to yellow; beans three to five, medium in size, oval, smooth, shining, white.

Dwarf Black Wax, Cleveland, (No. 13.) Cylinder Black Wax, Henderson, (No. 9.) New Prolific German Wax, Vick, (No. 37.)

Stalks eight to twelve inches high, of medium strength; leaflets small; flowers violet; pods three to four inches long, narrow, curved, yellow; beans three to five; when ripe, smooth, plump, polished, shining purple black. Of fair quality as a snap bean.

Dwarf Mont D' Or, Cleveland, (No. 15.)

Stalks eight to ten inches high; leaflets small; flowers violet; pods three to four inches long, curved, yellow, rather thick; beans four to six, plump, broad, oval, shining, deep purple, ripening to black. A fine string bean, but soon struck by rust.

Low's Champion, Henderson, (No. 33.)

Vines eight to ten inches high, stout, erect, dark green; leaflets small to medium, broad, rather thick and rough; flowers pale violet; pods four to five inches long by three-fourths of an inch broad and quite thick, white, shaded with pale pink; ripe beans of medium size, broad, oval, plump, shining dark red. Slightly injured by rust.

Landreth's Violet, Landreth, (No. 31.)

Vines ten to fourteen inches high, erect; leaflets rather large, light green; pods abundant, four to five inches long by one-half inch thick, a little curved, cylindrical, light yellow; beans four to seven, of medium size and fine appearance, pale violet; when ripe, short, oval, truncate, polished, dark purple to blue black. Badly injured by rust.

Golden Wax, Cleveland, (No. 22.) M. L. S. S. Co., (No. 23.)

Vines eight to ten inches high, not strong; leaflets small, rather rough; flowers cream or white; pods plenty, three to four inches long by one-half inch wide, *a* little curved; beans, broad, oval, rounded, white tinged with rose or speckled on eye side; when ripe, plump, shining, some wrinkled; the half the bean about the eye, or often a broader space, covered with purple and light brown in splashes, the remaining surface shining and white.

Dolly Varden, Bouk, (No. 11.)

Seems to be a selected strain of Golden Wax, the beans more uniformly half white.

Pink-Eye Wax, Golden Pod, Landreth, (No. 39.)

We cannot separate this from the Golden Wax, the most obvious difference being the restricted area of the spotted portion.

(b) Seeds spherical or nearly so.
*Seeds of uniform color.

Volger's Kidney, Thorburn, (No. 46.)

Vines eight to ten inches high; leaflets medium sized, dark green, thick, rough; flowers cream and white; pods three to four inches long by seven-sixteenths inch wide, a little curved, light green, thick; beans four to six, roundish, flattened, white. With us not worth planting.

Lazy Wife, Vaughan, (No. 73.)

A rank-growing runner; leaflets large and coarse; flowers white; pods three to four inches long, five-eighths of an inch broad, curved, compact, ripening to yellow; beans four to seven, roundish, very slightly flattened, white, distinctly veined, smooth.

New Golden Andalusian, Everitt, (No. 79.)

A medium-sized climber with medium light-green leaves; flowers white; pods four to six inches long by three-fourths inch broad, somewhat curved, rather compact, golden yellow when ripening; snap short and tender; beans four to eight, plump, roundish, white, smooth, shining. Excellent.

Cream *Pole,* Farquhar, (No. 62.)

A medium runner; leaflets medium to large, rather thick and coarse; flowers violet; pods numerous, four inches long by five-eighths inch broad nearly straight, flattened, light green, whitening as they ripen; beans three to five, very large, roundish oval, flattened, greenish white, ripening to a smooth dun color, the eye ringed with dark brown.

Red Cranberry, Cleveland, (No. 75.)
A low, slender runner with small leaflets; flowers violet; a fair setting of pods three to four inches long by three-fourths inch wide, somewhat curved and flattened but showing the place of each bean strongly marked, light green, thick; beans four or five, large, oval, plump, greenish white, coloring to shining dark purple as they ripen.

Arlington Cranberry, Farquhar, (No. 61.)
A medium or small runner; leaflets small to medium; flowers violet; pods numerous, three and one-half to four and one-half inches long by five-eighths inch broad, a little curved, thick, the color of underside of leaf; beans three to five, roundish oval, white shaded with violet from eye outward; ripe beans somewhat shriveled, brownish red, shining.

German Black Wax, Cleveland, (No. 69.)
A small to medium runner; leaflets of medium size, light green; flowers violet; pods few, four to five inches long by three-eighths inch wide, a little curved, thick, yellow; beans four to six, blue black, smooth, shining; a good sort for string beans.

**Seeds variegated.

Horticultural Cranberry, Cleveland, (No. 70.) Crosby's Horticultural Pole, Farquhar, (No. 65.)
A rank climber, with medium to large leaves; flowers pale violet; pods not numerous, three to four inches long by five-eighths inch wide, rather flat, curved, thick, green; beans four to six, roundish oval, greenish white; when ripe, plump, smooth, moderately shining, light brown, splashed with brownish red.

Marblehead, Farquhar, (No. 34.)
Vines ten to eighteen inches high, rather thin and straggling, some with short runners; leaflets small, rather acute; flowers violet with darker wings; pods three and one-half to five inches long by one-half inch wide, rather thick, green when young, soon splashed with purple, ripening to yellow and purple; beans four or five, roundish oblong, a little angular and flattened, white, ripening to light brown, splashed all over with purplish red.

IIII. Seeds of peculiar shape, shouldered.

Ruby of Erfurt, Thorburn, (No. 77.)
A low slender runner with purplish and small dark-green leaflets, deeply wrinkled; flowers pale pink, deeper outside; pods abundant, deep red while young, fading to nearly white as they ripen, six to eight inches long by three-fourths inch broad, usually unevenly curved; beans four to six,

greenish white, much larger at end from stem, ripening to a light greenish brown or brownish pink, the eye ringed with dark brown.

PHASEOLUS LUNATUS, L. Lima Beans.

A. Leaflets long, ovate-lanceolate, light green. Pods very broad, flat, and often curved laterally.

a: Beans large, flat, thin, white or greenish white.

Large White Lima, Cleveland, (No. 88.) Plate I.

Leaflets large, light green, mottled. A bean of medium productiveness late in the season. Flowers white.

Extra Early Lima, Cleveland, (No. 84.)

A tall growing vine; flowers white; but few pods set, apparently mixed.

Jersey Extra Early Lima, Henderson, (No. 86.)

A slender vigorous climber; leaflets of medium size, rather acute; fairly productive late in the season.

aa: Beans medium, thick, short, fleshy, white or greenish white.

b: tall-growing pole beans.

Dreer's Improved Lima, Cleveland, (No. 82.) Plate II.

A tall-growing bean; leaflets light green, long, lanceolate; flowers white; pods three to four inches long by one inch broad, thick, blunt, wide, a heavy ridge on back; beans three to six, short, thick, fleshy, tender; of excellent quality.

New Challenger Lima, Cleveland, (No. 89.)

Vines rank; leaflets large, light green, rather narrow. Gave a good yield late in the season.

bb: low-growing, prostrate runner.

Kumerle's Dwarf Lima, Thorburn, (No. 87.) Plate III.

Ten to fourteen inches high, but rather spreading and some stems prostrate; leaflets three to six inches long, tapering, lanceolate, light green; pods two to three inches long by one inch broad, flat, curved laterally; beans two or three, thick, short, fleshy, of excellent quality. Yield very small and late.

B. Leaflets broad, triangular, ovate, dark green, shining. Pods symmetrical, firm, not laterally curved, tipped with an acute point.

c: Beans small, white, flat.

Small Lima, Cleveland, (No. 91.) Plate IV.

A very rank, vigorous-growing lima; leaflets much shorter and more nearly heart-shaped than in other limas, and dark green, glabrous; flowers white; pods three to three and one-half inches long by three-fourths *to* seven-eighths of an inch broad, flat, a little curved; beans two to four, small, flat, broadly oval. The most productive bean of any class grown.

New Bush Lima, Henderson, (No. 85.) Plate V.
A bush bean, ten to fourteen inches high, not so rank and leaflets not so large as in No. 83; pods average shorter, two or sometimes three beans to the pod. In abundant bloom and vines full of young pods when killed by October frosts.

cc: Beans medium, flat, variegated.

Dwarf Carolina, Landreth, (No. 83.) Plate VI.
A bush bean, twelve to sixteen inches high; has a leaf similar to the tall Carolina, but darker green and more glabrous; flowers white; pods similar, rather more curved, setting abundantly; beans much like those of Small Lima till they begin to ripen, when they become splashed and colored with brick-red and purple of various shades.

A COMPARATIVE TRIAL OF PEAS.

The peas on trial in our gardens during the season of 1889 numbered 137 lots. The number of distinct varieties is somewhat less than this, however, as the variety was sometimes in duplicate, the seed from different sources, or, again, appeared under different names, as will be shown in the descriptive list below.

Each lot occupied thirty feet of row in well-prepared bottom land, the seed being drilled in and covered to the depth of about three inches, clean cultivation following throughout the season. Of many of the sorts two plantings were made: the first on April 16th, the second on May 4th. The data given show for each planting, where two were made, the number of days from the planting to the first bloom, to the first gathering of edible peas, and to the date when half the apparent product of each sort was ready for use.

The absence of data upon the ripening and product is due to an attack of mildew, which with the advance of hot weather made its appearance at the south end of the plat, in lower ground, and extending northward did such general damage to the growing vines — cutting off the bloom, and destroying the fruit in all stages, or ripening it prematurely—that the further comparison of sorts was useless.

In the descriptive list following the table will be found observations upon the characteristics of the different varieties, which are arranged according to a provisional classification having for its leading characters the surface and color of the seed, and the time of ripening of the product.

COMPARATIVE TRIAL OF PEAS.

No.	Source.	VARIETIES.	FIRST BLOOM. First planting....	FIRST BLOOM. Second planting..	FIRST EDIBLE. First planting....	FIRST EDIBLE. Second planting..	HALF EDIBLE. First planting....	HALF EDIBLE. Second planting..
			Days	*Days*	*Days*	*Days*	*Days*	*Dys*
1	Hort. Dept....	Abundance, Bliss................	51	42	65	58	73	62
2	Vaughan......	Alaska	30	30	48	44	53	46
3	Cleveland.....	Alaska, Cleveland's.............	30	30	48	44	53	46
4	Hort. Dept....	Alaska, Cleveland's.............	30	30	48	44	53	46
5	Hort. Dept....	Alpha, Extra Early.............	44	35	49	51	58	54
6	Cleveland.....	American Wonder...............	34	32	51	46	57	54
7	Landreth	Beck's Gem.....................	34	32	50	46	55	51
8	Gregory	Bergen Fleet Wing.............	32	30	48	44	53	49
9	Henderson....	Blue Beauty	34	35	51	51	57	54
10	Hort. Dept....	Blue Peter, Early...............	36	35	53	51	60	54
11	Hort. Dept....	Buist's Premier, Extra Early.....	30	30	50	45	53	51
12	Cleveland.....	Caractacus......................	34	32	49	49	53	51
13	Cleveland.....	Carter's First Crop.............	30	32	48	45	53	51
14	Farquhar.....	Clipper.........................	30	32	48	44	53	49
15	Hort. Dept....	Daniel O'Rourke................	34	32	48	45	53	51
16	Cleveland.....	Daniel O'Rourke................	30	32	48	45	53	51
17	Hort. Dept....	D. M. Ferry & Co.'s Extra Early..	32	32	51	44	58	51
18	Ferry	Earliest of All..................	30	32	48	44	53	46
19	Buist.........	Early Morning Star, Buist's......	32	30	48	44	53	46
20	Henderson....	Epicure	36	35	53	49	60	54
21	Everitt.......	Everitt's Extra Early Alliance....	30	32	50	44	53	46
22	M. L. S. S. Co..	Extra Early.....................	30	....	50	....	60	...
23	Hort. Dept....	Ferry's First and Best...........	30	....	48	....	53	...
24	Cleveland.....	First and Best	30	32	48	44	53	51
25	Hort. Dept....	First and Best, Cleveland's.......	34	....	50	....	53	...
26	Gregory	Hancock	32	30	48	44	53	46
27	Henderson....	Henderson's First of All.........	30	32	48	44	53	46
28	Huntington...	Huntington's First of All........	30	32	48	44	53	46
29	I. Seed Co....	Iowa Challenge..................	30	30	48	44	53	46
30	Hort. Dept....	Kent Extra Early	34	....	51	....	62	...

NOTE — The seed credited to "Hort. Dept." was grown on the grounds of this station in 1888; that credited to "M. L. S. S. Co." was donated by the Michigan Lake Shore Seed Co., of Chicago; that credited to the "I. Seed Co." was purchased from the Iowa Seed Company, of Des Moines.

COMPARATIVE TRIAL OF PEAS — CONTINUED.

No.	Source.	VARIETIES.	FIRST BLOOM. First planting	FIRST BLOOM. Second planting	FIRST EDIBLE. First planting	FIRST EDIBLE. Second planting	HALF EDIBLE. First planting	HALF EDIBLE. Second planting
			Days	*Days*	*Days*	*Days*	*Days*	*Dys*
31	Cleveland	Kent Extra Early, Cleveland's	30	32	48	44	53	46
32	Cleveland	Kentish Invicta	30	32	48	46	62	54
33	Hort. Dept	Kentish Invicta, Cleveland's	30	32	50	44	53	46
34	M. L. S. S. Co.	Kentish Invicta	34	....	55	....	62	...
35	Landreth	Landreth's Extra Early	30	30	48	44	53	51
36	Cleveland	Laxton's Alpha	34	....	51	....	60	...
37	Hort. Dept	Lightning	34	....	48	....	53	...
38	Vaughan	Little Gem	34	35	53	49	58	54
39	Vaughan	Maud S.	34	32	48	44	55	46
40	Hort. Dept	Maud S. Extra Early	34	....	50	....	55	...
41	Hort. Dept	McBeth's Pride	34	....	48	....	53	...
42	Cleveland	McLean's Blue Peter	34	34	53	51	58	54
43	Cleveland	McLean's Little Gem	34	....	53	....	58	...
44	Hort. Dept	Morning Star, Early	34	....	51	....	58	...
45	Cleveland	Philadelphia, Extra Early	30	32	48	46	53	51
46	Hort. Dept	Premium Gem	36	35	53	51	58	54
47	Cleveland	Premium Gem	34	33	51	51	58	54
48	Hort. Dept	Premium Gem, Carter's	34	....	53	....	58	...
49	Cleveland	Rural New Yorker, Cleveland's	32	32	48	44	53	51
50	Landreth	Short Straw Marrow	53	44	64	58	73	...
51	Landreth	Sitka	32	30	50	44	53	51
52	Thorburn	Small French	30	30	49	46	53	51
53	N. B. & G. Co.	Summit, N. B. & G. Co.'s	30	30	48	45	53	51
54	Hort. Dept	Sunrise	39	35	50	51	73	60
55	Thorburn	Thorburn's Extra Early Market	30	30	50	44	53	46
56	Cleveland	Tom Thumb	34	...	51	....	58	...
57	Hort. Dept	Tom Thumb, Ferry's Extra Early	36	....	53	....	58	...
58	Landreth	Very Dwarf Early Frame	30	30	50	44	53	46
59	Vick	Vick's King of the Dwarfs	34	35	50	51	58	53
60	Hort. Dept	William I	30	....	53	....	64	...

COMPARATIVE TRIAL OF PEAS — CONTINUED.

No.	Source.	VARIETIES.	FIRST BLOOM.		FIRST EDIBLE.		HALF EDIBLE.	
			First planting....	Second planting..	First planting....	Second planting..	First planting....	Second planting..
			Days	Days	Days	Days	Days	Dys
61	Cleveland.....	Abundance	44	....	62	....	73	...
62	Cleveland.....	Bishop's Dwarf Long Pod........	39	....	62	....	74	...
63	Hort. Dept....	Bishop's Improved Long Pod	53	....	67	....	74	...
64	Gregory	Brown's New Dwf. Ear. Marrowfat.	44	39	67	53	74	...
65	Buist.........	Carter's Anticipation	50	44	67	62	74	...
66	Cleveland.....	Cleveland's Advancer............	39	....	62	....	72	...
67	Gregory	Delicious	48	44	69	60	78	...
68	Cleveland.....	Eugenie	39	35	60	53	73	62
69	Hort. Dept....	Fillbasket	55	46	69	52	78	...
70	Gregory	Hair's Dwarf Marrowfat	62	54	76	....	80	...
71	Thorburn.....	Horsford's Market Garden	48	42	64	56	73	62
72	Cleveland.....	McLean's Advancer	44	....	62	....	73	62
73	Cleveland.....	McLean's Wonderful	48	44	64	58	74	...
74	Hort. Dept....	Pride of the Market.............	57	....	67	....	76	...
75	Hort. Dept....	Pride of the Market, Carter's.....	57	....	69	....	76	...
76	Hort. Dept....	Quality	44	35	62	51	69	56
77	Hort. Dept....	Telephone	51	....	67	....	76	...
78	Henderson....	American Champion	51	42	69	56	76	...
79	Hort. Dept....	Black-Eyed Marrowfat...........	55	....	69	....	76	62
80	Cleveland.....	Black-Eyed Marrowfat...........	55	....	69	....	76	...
81	Cleveland.....	Blue Prussian....................	34	....	51	....	62	...
82	Hort. Dept....	Blue Prussian, Field.............	62	....	76	....	80	...
83	Cleveland.....	British Queen...................	62	54	76	....	....	...
84	Cleveland.....	Canada Field....................	57	....	74	....	78	...
85	Cleveland.....	Carter's Telephone	50	....	64	....	74	...
86	Cleveland.....	Champion of England...........	51	....	69	....	76	...
87	M. L. S. S. Co..	Champion of England...........	50	....	69	....	76	...
88	Hort. Dept....	Cleveland's L. I. Mammoth	50	42	64	60	74	62
89	Cleveland.....	Cleveland's L. I. Mammoth	44	....	62	....	72	...
90	Hort. Dept....	Common White Field............	58	....	73	....	80	...

COMPARATIVE TRIAL OF PEAS — CONTINUED.

No.	Source.	VARIETIES.	FIRST BLOOM. First planting....	FIRST BLOOM. Second planting..	FIRST EDIBLE. First planting....	FIRST EDIBLE. Second planting..	HALF EDIBLE. First planting....	HALF EDIBLE. Second planting..
			Days	*Days*	*Days*	*Days*	*Days*	*Dys*
91	Hort. Dept....	Common Blue Field	62	....	....	....	....	...
92	Henderson....	Culverwell's Telegraph.........	50	42	62	56	72	60
93	Henderson....	Dr. McLean.......	53	46	72	60	76	...
94	Cleveland.....	Dwarf Blue Imperial...........	50	....	67	....	76	...
95	Cleveland.....	Edinburg Beauty..............	44	42	62	54	69	60
96	Cleveland.....	Everbearing	53	....	67	....	74	...
97	Vaughan	Everbearing	51	....	69	....	74	..
98	M. L. S. S. Co..	Everbearing, Bliss's	53	....	69	....	74	...
99	Hort. Dept....	Evolution.....................	62	....	74	....	80	...
100	Cleveland.....	Forty-Fold	53	...	69	....	76	...
101	Landreth	French Canner...............	53	....	69	....	....	...
102	Henderson....	G. F. Wilson	48	44	74	60	....	...
103	Hort. Dept....	Golden Vine Field.............	48	....	67	....	....	...
104	Henderson....	Henderson's Midsummer.... ..	48	44	62	56	....	...
105	Hort. Dept....	Large Blue Imperial..........	50	....	69	....	....	...
106	Landreth	Large White Marrowfat........	58	....	67	....	....	...
107	Farquhar.....	Laxton's Long-Pod............	48	....	64	....	....	...
108	Cleveland.....	Ne Plus Ultra	57	51	74	....	....	...
109	Henderson....	Payne's Conqueror	57	54	73	....	....	...
110	Landreth	Peruvian, or Black-Eyed Marrowfat.....................	55	....	69	....	76	...
111	Cleveland.....	Pride of the Market...........	50	...	64	....	73	...
112	Hort. Dept....	Prince of Wales	50	....	67	....	76	...
113	Hort. Dept....	Quantity...	50	44	62	56	70	60
114	Hort. Dept....	Royal Dwarf Marrowfat........	53	....	69	....	78	...
115	Henderson....	Sander's Marrow	62	54	74	....	....	...
116	Cleveland.....	Stratagem	50	46	67	60	74	...
117	Hort. Dept....	Stratagem, Carter's............	57	...	72	....	78	...
118	Hort. Dept....	Superlative	48	44	66	58	74	...
119	Cleveland.....	Telegraph	48	....	62	....	69	...
120	Cleveland.....	Veitch's Perfection............	62	46	....	58	....	...

COMPARATIVE TRIAL OF PEAS — CONCLUDED.

No.	Source.	VARIETIES.	FIRST BLOOM. First planting....	FIRST BLOOM. Second planting..	FIRST EDIBLE. First planting....	FIRST EDIBLE. Second planting..	HALF EDIBLE. First planting....	HALF EDIBLE. Second planting..
			Days	*Days*	*Days*	*Days*	*Days*	*Dys*
121	M. L. S. S. Co. .	White Marrowfat..............	53	....	67	....	74	...
122	Cleveland.....	White Marrowfat, Royal Dwarf..	57	53	73	....	76	...
123	Cleveland.....	White Marrowfat, Tall..........	58	....	72	....	....	...
124	Henderson....	Yorkshire Gem................	53	46	69	58	74	62
125	Cleveland.....	Yorkshire Hero	51	....	67	....	73	...
126	Cleveland.....	Dwarf Gray Sugar.............	53	....	64	....	67	...
127	Hort. Dept....	Dwarf Sugar..................	44	....	60	....	67	...
128	Hort. Dept....	Dwarf Sugar, Edible Pod.......	53	....	64	....	67	...
129	Gregory	Extra Early Dwarf Edible Pod..	50	....	64	....	67	...
130	Landreth	Extra Early Dwarf Sugar.......	48	....	64	....	67	...
131	Thorburn.....	Melting Sugar	48	....	67	....	67	...
132	Hort. Dept....	Purple Blossom Sugar...... ...	53	....	67	....	67	...
133	Gregory	Tall Butter Sugar	53	....	67	....	67	...
134	Cleveland.....	Tall Gray Sugar..............	55	....	67	...	67	...
135	Hort. Dept....	Tall Sugar....................	55	....	70	....	74	...
136	Hort. Dept....	Tall Sugar, Edible Pod	55	....	70	....	74	...
137	Cleveland.....	Tall White Sugar..............	51	....	74	....	....	...

PEAS.—DESCRIPTIVE LIST.

A. Seed smooth.

B. SEED GREEN.

C. *Early varieties.*

Foliage, light green; leaflets two to four.

Alaska, Vaughan, (No. 2.) Cleveland's Alaska, Cleve., (Nos. 3 and 4.)
Vines slender, eighteen to twenty-four inches high, pale green; leaflets two to four, smooth, thin; pods two and one-half inches long, one-half inch in diameter, straight, cylindrical, compactly filled by five to seven peas of small size and fair quality.

Sitka, Landreth, (No. 51.)
Vines of medium strength, twenty to twenty-four inches high, often forked at the ground, color light green; leaflets two to four, entire or faintly

toothed, rather elongated; pods single, two to two and one-half inches long, slightly curved, well filled; peas four to six, of fair quality.

Kentish Invicta, Cleveland, (No. 32.) Cleveland's Kentish Invicta, Hort., (No. 33.) M. L. S. S. Co., (No. 34.)

Vines of medium strength, eighteen to twenty-four inches high, branching a little, color medium green; leaflets two to four, entire or obscurely toothed; pods, single, two to two and one-half inches long; peas six to eight, of good quality.

McBeth's Pride, Hort., (No. 41.)

Vines of medium strength, twelve to eighteen inches high, somewhat branched, color light green; leaflets two to four, entire or obscurely toothed; pods single, one and one-half to two and one-half inches long, straight, not evenly filled; peas three to six, of fair quality.

Earliest of All, Ferry, (No. 18.)

Vines slender, sometimes forked, two to two and one-half feet high; leaflets medium green, usually four, rather broad, and often obscurely toothed; pods one and one-half to two and one-fourth inches long, single, straight or slightly curved; peas four to six, small, of medium quality.

Foliage, bluish green; leaflets two to four.

McLean's Blue Peter, Cleveland, (No. 42.)

Vines stout, eight to twelve inches high, rarely branching; foliage, dark bluish green; leaflets two to four, entire or finely toothed; pods often paired, uneven in size, one and one-half to two and three-fourths inches long, not evenly filled; peas three to six, of fair quality.

Blue Beauty, Henderson, (No. 9.)

Vines small, of medium strength, twelve to eighteen inches high, little branched; leaflets usually four, bluish green, thick, of medium size, slightly toothed, obtusely pointed; pods sometimes paired, two to two and one-half inches long, nearly straight, round, well filled with four to seven peas of excellent quality. A hardy, productive sort.

Leaflets two to six.

William I., Hort., (No. 60.)

Vines of medium strength, three to three and one-half feet high, sometimes branched, color light-bluish green; leaflets two to six, rather obtuse, and slightly toothed; pods two and one-half to three and one-half inches long, by one-half to five-eighths of an inch wide, curved, single, or rarely in pairs; peas four to seven, of good quality.

CC. *Second-early varieties.*

Cleveland's Long Island Mammoth, Cleveland, (Nos. 88 and 89.)

Vines strong, coarse, three to four feet high, long jointed, branching, color light green; leaflets two to six, rather broad and obtuse, and distinctly toothed; pods single or paired, three to four inches long, curved a little either forward or backward, or straight; peas six to eight, of good quality, but small for the size of the pod.

Telegraph, Cleveland, (No. 119.) Culverwell's Telegraph, Henderson (No. 92.)

Vines four or five feet high, coarse, long jointed, not branched; leaflets two to six, rather obtuse, nearly entire; pods sometimes paired, three to four inches long, by seven-eighths inch broad, flat, straight; peas six to eight, of good quality,

CCC. *Late Varieties.*

Common Blue Field, Hort., (No. 91.)

Vines rather slender, much branched, three to four feet high, color light bluish-green; leaflets two to six, rather acute and faintly toothed; pods usually paired, two to two and one-half inches long, nearly straight, round and full; peas, six to eight.

Blue Prussian Field, (No. 82.)

As grown by us this is not sufficiently distinct to warrant separation from the above.

Fillbasket, Hort., (No. 69.)

Vines three to four feet high, branching at the ground, of medium strength, color light green; leaflets two to six, of medium size and breadth, nearly entire; pods two and one-half to three inches long, curved, slim, round, often paired; peas four to seven, of medium quality.

BB. Seeds yellow.

C. *Early varieties.*

Under this division we find a number of varieties, so called, which agree in so many points and possess so few characteristics by which they may be distinguished, even when grown side by side, that one name seems ample for all, and that of *Extra Early*, under which two or three of them were received, would seem to be the correct one. The following description will answer for all:

Vines rather slender, from twenty to thirty inches high, not branching; leaflets never more than four, smooth, entire or slightly toothed, light or medium green in color; pods single or rarely paired, straight, two to two and a half inches long, round and usually well filled; peas four to six or seven, of medium quality. These gave first edible peas in forty-eight to fifty days from planting, half of the peas being in edible condition five days later, and first ripe pods in about sixty-two days, the entire crop ripening and vines dying with much uniformity.

The above includes Buist's Premier Extra Early, (No. 11;) D. M. Ferry & Co.'s Extra Early, (No. 17; Everitt's Extra Early Reliance, (No. 21;)

Hancock, (No. 26;) Henderson's First of All, (No. 27;) Huntington's First All, (No. 28;) Iowa Challenge, (No. 29;) Landreth's Extra Early, (No. 35;) Maud S., (No. 39,) and Extra Early Maud S., (No. 40;) Cleveland's Rural New Yorker, (No. 49;) N. B. & G. Co.'s Summit, (No. 53;) Thorburn's Extra Early Market, (No. 55;) Very Dwarf Early Frame, (No. 58;) Philadelphia Extra Early, (No. 45.)

Small French, Thorburn, (No. 52.) Plate VII, 52.

Much like the foregoing, but distinct; a smaller leaflet more distinctly toothed, and short pods slightly curved backward. Vines slender, not branched, color light green; leaflets one to three or four, often odd with tendril, rather obtuse, small and distinctly toothed; pods single, slightly curved backward, one and one-half to two inches long, not evenly filled; peas two to five, of fair quality.

Carter's First Crop, Cleveland, (No. 13.)

Vines of medium strength, two to three feet high, light green; leaflets usually four, smooth, entire; pods single, one and one-half to two and one-half inches long, nearly straight, well filled; peas four to seven, of good quality.

Bergen Fleetwing, Gregory, (No. 8.)

Vines slender, eighteen to twenty-four inches high, not branching; leaflets two to four, slightly bluish-green, smooth, entire, rather obtuse; pods single or sometimes paired, one and one-half to two and one-half inches long, of medium breadth, curved backward or straight, round and well filled with three to seven peas.

First and Best, (Cleveland No. 24 and Hort. No. 25.) Ferry's First and Best, Hort., (No. 23.)

Vines slender, twelve to eighteen inches high, often forked, color medium green; leaflets small, usually four, entire or obscurely toothed; pods single, one and one-half to two inches long, straight; peas four to six, filling the pod, of medium quality.

Caractacus, Cleveland, (No. 12.)

Vines slender, two or two and one-half feet high, often branching, leaflets usually four, rather broad, faintly toothed, obtuse; pods rarely paired, two to two and one-half inches long, curved forward or straight; well filled with five to seven peas.

Kent, Extra Early, Hort., (No. 30 and Cleveland, No. 31.) Plate VII, 30.

Vines rather coarse, branching, two to three feet high; leaflets two to six, more elongated than usual, often obscurely toothed, color a rather-dark green; pods more often paired than single; peas four to seven, not of best quality. Seeds clearly mixed, one vine of curved pods, purple as they ripen.

Buist's Early Morning Star, Buist, (Nos. 19 and 44.) Plate VII, 4.
Vines of medium strength, two to two and one-half feet high, slightly branching, color medium green; leaflets usually four, rather broad and obtuse, smooth and entire; pods single, two to two and one-half inches long, straight, smooth; peas four to six, of good quality.

Daniel O'Rourke, Hort., (No. 15 and Cleveland, No, 16.)
Vines of medium strength or rather coarse, sometimes branching; leaflets two to six, entire or faintly toothed, rather long; stipules large; pods single, two to two and one-half inches long, straight or curved forward ; peas four to eight, of good quality.

Beck's Gem, Landreth, (No. 7.) Plate VII, 7.
Vines of medium strength, branching, twelve to eighteen inches high; leaflets two to four, bluish green, slightly curled and toothed; pods often paired, two to two and one-half inches long, rather slender, slightly curved, nearly round and well filled with five to seven peas of medium quality.

Clipper, Farquhar, (No. 14.)
Vines of medium strength, two and one-half to three feet high, but little branched; leaflets usually four, usually smooth and entire, a few obscurely toothed; pods single, two to two and one-half inches long, round, smooth, well filled.

CC. *Second-early varieties.*

Laxton's Long Pod, Farquhar, (No. 107.)
Vines of medium strength, three to four and one-half feet high, branching, joints long, color medium green; leaflets two to six, slightly toothed; pods rarely paired, three to three and one-half inches long by three-fourths of an inch wide, nearly straight; peas four to six, good.

Short Straw Marrow, Landreth, (No. 50.)
Vines rank, succulent, two to two and one-half feet high, often branched, color light bluish-green, mottled; leaflets two to four, large, entire, or often toothed, some with an acute tip slightly coiled like a tendril; pods often paired, two and one-half to three and one-half inches long, three-fourths of an inch broad, rather loose, not evenly filled; peas four to seven, of good quality.

CCC. *Late Varieties.*

These peas all agree in having vines usually branching, and leaflets two to six.

Field Peas.

Canada Field, Cleveland, (No. 84.)
Vines of medium strength, three to five feet high, branching, color medium green; leaflets two to six, of medium size, entire or distinctly

toothed; pods two to two and one-fourth inches long, usually paired, slightly curved, round and full; peas four to eight, of inferior flavor and small size.

Golden Vine Field, Hort., (No. 103.)

Vines stout, three to four feet high, color light green, straw-colored as they ripen; leaflets two to six, rather acute and distinctly toothed; pods often paired, two and one-half inches long, a little curved, round, full; peas six to eight.

Common White Field, Hort., (No. 90.) Plate VII, 90.

Vines four to five feet high, slender, much branched, color medium green; leaflets two to six, rather long, and toothed at apex; pods often paired, two to two and one-half inches long, slightly curved, round, and well filled; peas six to seven.

Long-podded Varieties.

Bishop's Improved Long Pod, Hort., (No. 63.)

Vines two to two and one-half feet high, rather stout, dark green; leaflets two to six, medium, rather narrow and acuminate, acutely pointed; joints short; pods two to two and three-fourths inches long, round, slender, often paired, not all well filled; peas four to eight, of good quality.

French Canner, Landreth, (No. 101.) Plate VII, 101.

Vines of medium strength, three and one-half to four feet high, branching at ground to three or four laterals of same height, joints long; leaflets two to six, acute, color light green; pods often paired, two and one-half to three and one-fourth inches long, by one-half to seven-sixteenths of an inch wide, curved, well filled; peas six to nine, small, round, smooth, light yellow; an average vine yields thirty pods.

Superlative, Hort., (No. 118.)

Vines of medium strength, three to four feet high, branching freely, joints long, color light green; leaflets two to six, rather small, narrow and acute, faintly toothed; pods often paired, whitish as they ripen, three to three and one-half inches long by five-eighths of an inch broad; peas four to six, of medium quality.

Marrowfat Peas.

Black-Eyed Marrowfat, (Nos. 79, 80, and 110.) Plate VIII, 79.

Vines three to five feet high, branching, light green, long jointed; leaflets two to six, of medium to large size, acutely pointed; pods single, three to four inches long, slightly curved, round and usually well filled; peas six to nine, of good quality.

White Marrowfat, (Nos. 106, 121, 122, and 123.)

Vines rank, three to five feet high, branching, color light green; leaflets two to six, medium-sized, obtuse, toothed; pods single or in pairs, three inches long, slightly curved, well filled; peas four to six, of good quality and large size. A productive and valuable variety.

Royal Dwarf Marrowfat, Hort., (No. 114.)
Vines stout, two to three feet high, joints short, much branched, foliage bluish green ; leaflets two to six, medium sized, acute, some with a tendril-like apex one-half inch long; pods often paired, two and one-half to three inches long, a little curved, round and plump when filled; peas four to seven.

Brown's New Dwarf Early Marrowfat, Gregory, (No. 64.)
Vines three to four feet high, of medium strength, long jointed, medium or light green; leaflets four to six, rather large, oval, nearly all entire; pods two and one-half to three and one-fourth inches long, not all well filled; peas four to seven, of good quality.

AA. Seed wrinkled.

B. Seed green.

C. *Early varieties.*

Vines not branched; leaflets two to four, color light green.

Alpha, Extra Early, Hort., (No. 5.)
Vines rank, eighteen to twenty-four inches high; leaflets smooth, of medium size, acute, and sometimes slightly dentate; pods two and one-half to three inches long, slightly curved, sometimes paired, round and well filled with five to seven peas of fair quality.

Ferry's Extra Early Tom Thumb, Hort., (No. 57.)
Vines stout, four to six inches high, not branched; leaflets small, two to four, rather obtuse, distinctly toothed; pods one and one-half to two inches long, straight, round; peas three to six, of medium quality; not worth planting.

Vines branching; leaflets two to four, bluish-green.

Premium Gem, (Nos. 46, 47, and 48.)
Vines stout, twelve to eighteen inches high, often branching, color bluish green; leaflets two to four, rather thick, broad and obtuse, plainly toothed; pods single, two to two and three-fourths inches long, slightly curved; peas three to six, of good quality.

Vick's King of the Dwarfs, Vick, (No. 59.)
Vines stout, twelve to eighteen inches high, branching, color dark bluish green; leaflets two to four, entire or slightly toothed; pods single or rarely paired, two to two and one-half inches long; peas four to seven, of good quality.

Little Gem, Vaughan, (No. 38.)

Vines stout, twelve to eighteen inches high, dark bluish green, branched; leaflets two to four, rather obtuse, toothed and curled; pods two to two and one-half inches long, single, on short petiole, well filled, round and slightly curved; peas four to six, of good quality.

McLean's Little Gem, Cleveland, (No. 43.)

This differs from the above in having the pods longer, curved, and often in pairs.

American Wonder, Cleveland, (No. 6.)

Vines small, stocky, six to ten inches high; leaflets two to four, small, thick, bluish green, slightly toothed; pods single, one and one-half to two and one-half inches long, straight or slightly curved, round and well filled with four to six peas of good quality.

CC. *Second Early Varieties.*

Leaflets two to four, light green.

Horsford's Market Garden, Thorburn, (No. 71.)

Vines two to two and one-half feet high, branching, color light green; leaflets two to four, of medium size, obtuse, faintly toothed; pods single, or rarely paired, two and one-half to three inches long, slightly curved; peas four to six, of good quality.

Leaflets bluish green.

McLean's Advancer, Cleveland, (No. 72.) Cleveland's Advancer, Cleveland, (No. 66.)

Vines two to two and one-half feet high, of medium strength, not branched, bluish green; leaflets two to four, rather narrow and acute, faintly toothed; pods often paired, two and one-half to three inches long, round, slender, curved; peas four to seven, of good quality.

Edinburgh Beauty, Cleveland, (No. 95.)

Vines stocky, sixteen to twenty inches high, branching, bluish green, joints very short; leaflets two to four, rather small, narrow; pods two to two and three-fourths inches long, often paired, not evenly filled; peas one to six, of good quality.

Leaflets dark green.

Quality, Hort., (No. 76.)

Vines twenty to twenty-six inches high, branching freely, color dark green; leaflets two to four, rather large, long but not acute; pods often paired, two to two and three-fourths inches long, slightly curved, not evenly filled; peas two to six, of superior quality.

Leaflets two to six, bluish green, vines branching.

Abundance, Cleveland, (No. 61.)

Vines stout, two to two and one-half feet high, and often branched, color light bluish green, joints short; leaflets and stipules rather large and thick, leaflets two to six, usually entire, a few slightly toothed; pods single or paired, two and one-half to three and one-fourth inches long, five-eighths of an inch wide, a little curved; peas six to eight, of good quality.

Quantity, Hort., (No. 113.)

Vines of medium strength, two to two and one-half feet high, color bluish green, branching freely; leaflets two to six, rather small and acute; pods two to two and three-fourths inches long, often paired, not evenly filled, straight, round; peas three to six, of medium quality.

CCC. *Late Varieties.*

Vines more or less branching; leaflets two to four, light green.

Champion of England, (Cleveland, No. 86 and M. L. S. S. Co., No. 87.) Plate VIII, 86.

Vines strong, three to four feet high, forking at ground and sending out laterals, color light green; leaflets two to four, rather obtuse and some faintly toothed; pods single or paired, about three inches long, nearly straight; peas six or seven, of good quality.

Telephone, (Nos. 77 and 85.)

Vines three to three and one-half feet high, but little branched, color light green, joints long; leaflets two to four, large, coarse, obtuse, toothed, and often slightly notched at apex; pods single, or rarelypaired, two and one-half to four inches long by seven-eighths of an inch broad, straight or curved backward, not evenly filled; peas three to eight, of good quality.

American Champion, Henderson, (No. 78.)

Vines three to three and one-half feet high, color light green, but little branched; leaflets two to four, smaller and more acute at apex than in No. 77; pods single, or sometimes paired, three and one-half to four inches long by seven-eighths of an inch wide, curved backward; unevenly filled; peas four to eight, of good quality; closely resembles the Telephone.

Leaflets two to four, dark green.

Pride of the Market, (Nos. 74, 75, and 111.) Plate VIII, 74.

Vines stout, twenty to twenty-four inches high, branching, color dark green, leaflets two to four, broad, obtuse, faintly toothed; pods single or occasionally paired, three to four inches long by seven-eighths of an inch broad, straight or slightly curved, borne on a short stem; peas six to eight, of superior quality.

Foliage bluish green.

Everbearing, (Nos. 96, 97, and 98.)
Vines stout, two to two and one-half feet high, bluish green, branching freely; leaflets two to four, thick, rather long and narrow; pods three to three and one-fourth inches long, rather stout, nearly straight, often paired; peas four to six, of good quality.

Carter's Anticipation, Buist, (No. 65.)
Vines two to two and one-half feet high, stout, sometimes branched, color bluish green; leaflets two to four, large, broad, obtuse, and slightly toothed; pods sometimes paired, three to four and one-half inches long by seven-eighths of an inch broad, nearly straight, not evenly filled; peas four to eight, of excellent quality.

Dr. McLean, Henderson, (No. 93.)
Vines stout, about two feet high, bluish green, usually branched at ground into two or four stalks; leaflets two to four, broad, obtuse, toothed and rather thick; pods three to four inches long by three-fourths of an inch wide, rather flat and a little curved laterally, not evenly filled; peas six to eight, of good quality.

Leaflets two to six, light green.

Hair's Dwarf Marrowfat, Gregory, (No. 70.)
Vines twenty to twenty-four inches high, stout, and much branched, color medium green; leaflets four to six, large, long, obtusely pointed; pods two and one-half to three inches long, sometimes paired, a little curved; peas four to seven, of good quality.

Sander's Marrow, Henderson, (No. 115.)
Vines rank, three to five feet high, branching, color light green, marbled; leaflets two to six, broad, obtuse, faintly toothed, joints short; pods sometimes paired, though but few well developed, and all poorly filled, three to three and one-half inches long by five-eighths of an inch wide, a little curved.

Forty Fold, Cleveland, (No. 100.)
Vines of medium strength, four to five feet high, with three or four branches from ground of equal height, joints long, color light green; leaflets two to six, of medium size, a little toothed; pods rarely paired, on long stalks, two and one-half to three inches long by one-half to seven-sixteenths inch wide, round and plump, a little curved; peas six to eight, filling the pod. An average vine bore fifty pods.

G. F. Wilson, Henderson, (No. 102.)
Vines stout, two to three feet high, a little inclined to branch, color light green; leaflets two to six, broad, thick and fleshy, faintly toothed; pods

often paired, three to three and one-half inches long by seven-eighths of an inch broad, nearly straight, not evenly filled, flat; peas four to seven, of medium quality.

Leaflets bluish green.

Stratagem, (Nos. 116 and 117.)

Vines stocky, eighteen to thirty inches high, branching freely, joints short, color bluish green; leaflets two to six, broad, obtuse, faintly toothed, thick, fleshy; pods rarely paired, three to four and one-half inches long by seven-eighths of an inch broad, green like leaf; peas six to eight, excellent; often a large bract at base of pod stalk.

Veitch's Perfection, Cleveland, (No. 120.)

Vines stocky, much branched, two to two and one-half feet high, color bluish green, joints short; leaflets two to six, rather obtuse and faintly toothed; pods sometimes paired but poorly developed and few, three to three and one-half inches long by three-fourths of an inch wide, nearly straight; peas six to eight, of good quality.

Dwarf Blue Imperial, Cleveland, (No. 94.)

Vines stout, two feet high with strong laterals, color bluish green; leaflets two to six, thick, rather narrow and long, some a little toothed; pods numerous, often paired, two and one-half to three inches long by five-eighths of an inch wide, a little curved, not entirely filled; peas four to six, somewhat compressed, of medium quality.

Large Blue Imperial, Hort., (No. 105,) varies but slightly from this, and should no doubt be regarded a synonym.

Delicious, Gregory, (No. 67.)

Vines strong, two to two and one-half feet high, somewhat branching, color bluish green; leaflets two to six, large and obscurely toothed; pods single, two to three and three-fourths inches long by three-fourths of an inch broad, not evenly filled; peas four to seven, of excellent quality. Not productive.

BB. SEED YELLOW.

C. *Early varieties.*

Vines branched; leaflets two to six, bluish green.

Epicure, Henderson, (No. 20.)

Vines stocky, eight to twelve inches high, usually with two strong laterals near the ground; leaflets four to six, or three to five, the odd one paired with a tendril, small, bluish green, often slightly toothed; pods single or paired, one and one-half to two inches long, slightly curved; peas four to six, of excellent quality.

Sunrise, Hort., (No. 54.)

Vines rank, two to three feet high, often branched at the ground, color bluish green; leaflets two to six, often three to five, rather broad and obtuse, thick, entire, or often slightly toothed: pods single or rarely paired, slightly curved, two and one-half to three and one-half inches long, by five-eighths of an inch broad, unevenly filled; peas three to seven, of good quality.

CC. *Second Early varieties.*

Branching; leaflets two to four, light green.

McLean's Wonderful, Cleveland, (No. 73.)

Vines two to three feet high, branching freely, of medium strength, color light green; leaflets two to four, of medium size, faintly toothed; pods two and one-half to three and one-half inches long, or sometimes paired, curved, not evenly filled; peas three to six, of good quality.

Not branched; leaflets two to four, bluish green.

Eugenie, Cleveland, (No. 68.)

Vines two to two and one-half feet high, of medium strength, color light bluish green, not branching; leaflets two to four, rather broad and obtuse, sometimes faintly toothed; pods single, three to three and one-half inches long by three-fourths of an inch broad, on a rather short stem; peas four to six, of excellent quality.

Branching; leaflets two to six.

Henderson's Midsummer, Henderson, (No. 104.) Plate VIII, 104.

Vines strong, three to three and one-half feet high, branching; joints medium, leaflets two to six, rather broad and obtuse, distinctly toothed; pods often paired, three to three and one-half inches long, a little curved, unevenly filled; peas three to six, of excellent quality. An unusually productive and promising late pea.

CCC. *Late varieties.*

Vine branching, leaflets two to six, light green.

Ne Plus Ultra, Cleveland, (No. 108.)

Vines rank, four to five feet high, long jointed, branching, light green; leaflets two to six, broad, obtuse, often distinctly toothed; pods three to three and one-half inches long by five-eighths of an inch broad, curved, not well filled; peas four to six, of good quality.

Prince of Wales, Hort., (No. 112.)

Vines stout, branched, two to two and one-half feet high, short jointed, color medium green; leaflets two to six, rather small; pods often paired, three to three and one-half inches long, a little curved; peas six to eight, of good quality.

Payne's Conqueror, Henderson, (No. 109.)

Vines rank, four to five feet high, long jointed, but little branched; leaflets two to six, nearly round, obtuse, toothed; pods few, single, two and one-half to three inches long, by three-fourths of an inch broad, straight, flat; peas four to six, of good quality; calyx lobes very large and broad.

Leaflets bluish green.

Yorkshire Hero, Cleveland, (No. 125.)

Vines stout, two to two and one-half feet high, much branched, (more than No. 124,) color bluish green; leaflets two to six, more commonly six than in No. 124; pods often paired, bear a striking resemblance to those of No. 124.

Yorkshire Gem, Henderson, (No. 124.)

Vines stout, two to two and one-half feet high, branching, color light bluish green; leaflets two to four and rarely six, rather small, obtuse and faintly toothed; joints short; pods often paired, two to three inches long by three-fourths of an inch broad, not evenly filled; peas four to six, large, and of good quality.

Evolution, Hort., (No. 99.)

Vines two to three feet high, stout, and with shorter branches from near ground, bluish green; leaflets two to six, thick, broad, distinctly toothed, or sometimes nearly lobed; pods few, single, three to four and one-half inches long by five-eighths of an inch broad, curved, flattened, not evenly filled; peas six to ten, of only medium quality.

A COMPARATIVE TRIAL OF POTATOES.

MAIN PLANTING.

The main planting of potatoes was made April 23d and 24th, a pound of seed being used from every variety on our list; the variety in some cases duplicated when we had the same from more than one source. The test was entirely a varietal one, a careful record being kept, not only of amount and quality of product, but of the date of blossoming and color of bloom, appearance, color and habit of the tops, with time of ripening, and a careful description of the mature potato, to which are added notes on the condition and keeping qualities of each variety, with character of sprouts as found after being in storage through the winter. The ground planted was rich bottom land of the same field as that used in 1888, and had been in blue-grass sod for some time previous to breaking, in the summer of 1887. It was thoroughly plowed and harrowed, and furrowed out for rows about three and a half feet apart.* No fertilizers of any sort were used.

Each pound of seed was cut to single-eye pieces and the number of eyes noted, the variation in the number of eyes furnished by a pound being very marked in the different sorts and ranging from fifteen eyes of McFadden's Favorite (No. 124) to two hundred and four of Lady Finger and two hundred and forty-five of Akron.

The seed was dropped at an average of ten inches apart, the length of row occupied by each sort varying accordingly with the number of eyes. The comparison of yields from a pound of seed planted would therefore be manifestly unfair, and we have made the comparison on the basis of the estimated yield to the acre by using as factors the product and the length of row planted. The objection that the same variety in another part of the field might have given a very different yield is a valid one, but would apply with equal force to any other method of comparison, while the actual product from an acre of ground of all varieties, prolific or otherwise, shows that the estimates are not exaggerated.

The total product of the main planting, including the two hundred and twenty-five sorts found on the tabular list and twenty-eight seedlings which we have on trial not listed, was 267¾ bushels on 171 square rods of ground.

Those varieties which gave an estimated yield of 200 bushels and upwards to the acre will be found in the pages following the table, arranged in the order of productiveness and accompanied by brief notes as to appearance and quality, while varieties not on trial previous to the season just closed have been described in full.

*Averaging 3 feet 5 and a fraction inches, as determined by dividing the width of the plantation by the number of rows.

MAIN PLANTING.

No.	Source.	VARIETIES.	Eyes planted.	First appearance.	Date of blossom.	When ripe.	Length of row feet.	Weight marketable tubers—pounds.	Weight poor tubers—pounds.	Total weight—pounds.	Per ct. marketable.
				*Days.**	*Days.**	*Days.**					
1	Hort. '88†	Advance	150	17	71	122	101.5	26	5	31	87
2	Hort. '88......	Agnoth's Favorite	58	17	67	145	44.5	94	8	102	92
3	Hort‡........	Alexander's Prolific.............	65	17	46	160	46.5	105	7	112	94
4	I. Seed Co ‖ ...	Almo	39	17	69	136	30.5	49	5	54	92
5	Hort. '88......	Akron	245	17	....	136	127	31	10	41	76
6	Hort. '88......	American Giant.................	56	17	55	160	59	69	4	73	94
7	Hort	American Giant.................	74	17	51	136	46.5	48	18	66	73
8	Hort. '88......	Beauty of Beauties..............	51	17	....	136	38	65	4	69	94
9	Hort. '88......	Beauty of Beauties..............	....	17	78	136	37.5	62	16	78	79
10	Hort	Beauty of Hebron...............	62	17	46	101	44	60	4	64	94
11	Hort. '88......	Beauty of Hebron...............	91	17	55	101	68	30	4	34	88
12	Hort. '88......	Beauty of Sheba................	45	17	55	160	33	51	6	57	89
13	Hort. '88......	Belle..........................	46	17	51	136	35.5	41	2	43	95
14	Hort. '88......	Bermuda........................	59	17	69	136	49.5	78	3	81	96
15	Hort. '88......	Bermuda, Pink Blossom..........	106	17	50	136	99.5	29½	3	32½	91
16	Wilson	Boley's Northern Spy	44	17	55	122	33.5	25	6	31	81
17	I. Seed Co	Bonanza	51	17	48	136	37.5	64	11	75	85
18	Hort. '88......	Boston Cracker..................	90	17	55	122	66.5	30	9	39	77

19	Hort. '88	Boston Market	49	17	57	122	38.5	71	5	76	93
20	Hort. '88	Bontons	28	17	....	136	25	44	3	47	94
21	Hort. '88	Brigham's Seedling	75	17	63	160	36	66	6	72	92
22	Hort. '88	Burbank's	79	17	63	160	60	73	3	76	96
23	Hort	Burbank's Seedling	64	17	65	136	50	62	5	67	92
24	Burpee	Burpee's Superior	63	18	59	136	77.5	55	8	63	87
25	Burpee	Burpee's Seedling No. 37	59	17	46	122	44	43	4	47	92
26	Hort. '88	California Rose	64	18	65	136	45.5	70	1	71	98
27	Hort. '88	Canfield's Seedling	64	17	67	136	48.5	81	1	82	99
28	Hort. '88	Cap Sheaf	73	17	73	122	35.5	59	6	65	91
29	Hort. '88	Cayuga	52	17	55	136	40.5	72	2	74	97
30	Hort. '88	Champion of America	46	17	55	136	35.5	63	2	65	97
31	Hort. '88	Charles Downing	45	18	....	136	38	60	7	67	89
32	Hort. '88	Charter Oak	50	17	51	136	40.5	51	5	56	91
33	Hort. '88	Chenango	121	21	69	136	117	103	18	121	85
34	Hort	Chicago Market	67	17	55	122	51	62	6	68	91
35	Hort. '88	Chicago Market	66	17	51	136	53	47	7	54	87
36	Hort. '88	Chicago Sun	47	18	57	136	34.5	51	1	52	98
37	Hort. '88	Clark's No. 1	55	17	55	122	44	50	4	54	93
38	Hort. '88	Cook's Superb	40	17	69	160	32	70	7	77	91
39	Hort. '88	Cowle's Seedling	81	17	51	122	62	57	5	62	92

* Days from planting.
‡ Grown in our grounds previous to 1888.
† Accessions of 1888, grown in Station grounds that year, and in 1889 grown from seed of our own raising.
‖ Iowa Seed Co., Des Moines.

MAIN PLANTING—CONTINUED.

No.	Source.	VARIETIES.	Eyes planted.	First appearance.	Date of blossom.	When ripe.	Length of row—feet.	Weight marketable tubers—pounds.	Weight poor tubers—pounds.	Total weight—pounds.	Per ct. marketable.
				*Days.**	*Days.**	*Days.**					
40	Hort. '88......	Coy's Seedling..................	59	17	55	136	46.5	31	1	32	97
41	Wilson	Coy's Seedling..................	51	18	57	136	42.5	53½	½	54	99
42	Hort. '88......	Cuyahoga	61	17	51	122	48.5	61	7	68	89
43	Hort. '88......	Dakota Red	81	17	63	136	61.5	71	14	85	83
44	Hort	Dakota Red	62	17	55	136	46	90	2	92	98
45	Hort. '88......	Davis's Seedling	92	17	69	165	73	112	17	129	87
46	Hort. '88......	Dictator........................	50	17	71	136	39	106	4	110	96
47	Hort. '88.....	Dunmore..............	49	17	69	160	38	90	6	96	93
48	Hort. '88.... .	Durham.........................	60	17	51	122	48	66	4	70	94
49	Hort. '88......	Earliest and Best	80	17	55	136	90.5	76	11	87	87
50	Vaughan......	Early Albino	64	17	46	122	48.5	60	5	65	92
51	I. Seed Co	Early Amber	66	17	46	122	63	51	5	56	91
52	Hort. '88......	Early Electric..................	75	17	....	101	81	19	4	23	83
53	I. Seed Co	Early Gem	61	17	46	136	46.5	52	8	60	87
54	Hort. '88......	Early Hancock	72	17	55	136	58	89	10	99	89
55	Hort	Early Harvest	87	17	51	122	64.5	61	7	68	89
56	Hort. '88......	Early Harvest	98	17	55	136	75.5	72	10	82	87
57	Hort. '88......	Early Howard	78	17	55	122	60	69	5	74	93

58	Hort	Early Maine......................	103	17	46	122	77	96	8	104	92
59	Vick..........	Early Market......................	57	17	55	122	42	44	1	45	98
60	N. B. & G. Co.,†	Early Minnesota................	44	17	51	122	41	38	6	44	86
61	Hort. '88......	Early Modena	82	17	....	122	63.5	51	8	59	86
62	Hort. '88......	Early Ohio	93	17	....	101	77	55	4	59	93
63	Hort. '88......	Early Ohio, (Iowa seed,)..........	68	18	....	101	54.5	28	5	33	85
64	Hort. '88......	Early Ohio, (Kansas seed,)........	67	17	....	101	54	46	5	51	90
65	Hort. '88......	Early Ohio, (Dakota seed,)........	118	18	69	122	97.5	36	9	45	80
66	Hort	Early Ohio	64	17	....	101	50	42½	3½	46	93
67	Hort. '88......	Early Perfection.................	34	21	55	122	29	18½	3½	22	84
68	Hort. '88......	Early Queen.............	57	17	55	136	44	30½	5½	36	85
69	Hort. '88......	Early Rose	43	17	51	122	32	35	4	39	89
70	Vaughan......	Early Standard	56	17	51	122	40	45	3	48	93
71	Hort. '88......	Early Sun	84	17	51	122	62	64	10	74	86
72	Hort	Early Sunrise....................	54	17	46	136	42.5	84	8	92	91
73	Hort. '88......	Early Sunrise....................	42	17	55	122	33	40	4	44	91
74	Hort. '88......	Early Washington................	79	17	....	122	61.5	81	6	87	93
75	Hort. '88......	El Paso	77	17	55	136	63.5	102	13	115	88
76	Hort. '88......	Empire State....................	89	17	55	122	70.5	36	5	41	88
77	Hort	Empire State....................	65	17	55	136	66	107	13	120	89
78	Hort. '88......	Eureka..........................	73	17	....	160	54.5	57	10	67	85

* Days from planting. † Northrup, Braslan & Goodwin Co., Minneapolis, Minn.

MAIN PLANTING—CONTINUED.

No.	Source.	VARIETIES.	Eyes planted.	First appearance.	Date of blossom.	When ripe.	Length of row—feet.	Weight marketable tubers—pounds.	Weight poor tubers—pounds.	Total weight—pounds.	Per ct. marketable.
				*Days.**	*Days.**	*Days.**					
79	Hort. '88	Farina	91	17	57	136	66.5	64	18	82	78
80	Hort. '88	Fearnaught	44	20	65	160	34	62	2	64	97
81	Frogner	Frogner's Seedling, No. 18	43	17	51	122	36	31	6	37	84
82	Frogner	Frogner's Seedling, No. 50	44	17	51	122	36	38	6	44	86
83	Frogner	Frogner's Seedling, No. 64	26	17	51	122	21	22	5	27	81
84	Hort. '88	Garfield	47	17	....	136	37	40	11	51	78
85	Wilson	Gen. McClellan	36	17	71	136	28.5	75	5	80	94
86	Hort. '88	Gilead Red	80	17	55	136	62.5	66	5	71	95
87	Hort. '88	Globe	82	17	55	122	61	50	9	59	85
88	Burpee	Golden Flesh	60	21	71	160	35	26	11	37	70
89	Vaughan	Golden Kidney	51	17	67	122	41	13	4	17	76
90	Hort	Great Eastern	38	17	51	136	33.5	58	5	63	92
91	Hort. '88	Great Eastern	51	17	69	136	40.5	54	7	61	88
92	Hort	Hale's Early Peachblow	92	17	57	136	72	24	10	34	71
93	Hort. '88	Hampden Beauty	99	17	55	122	78	59	15	74	79
94	Vaughan	Harlequin	55	17	....	136	71.5	0	½	½	0
95	Hort. '88	Hawkeye	71	17	67	136	57.5	45	6	51	88
96	Hort. '88	Improved Irish Cup	65	17	55	136	49.5	66	12	78	84

97	I. Seed Co.	Iowa Beauty	50	17	51	122	56	50	13	63	79
98	Hort. '88	Irish Cup	59	17	65	165	39	74	10	84	88
99	Vaughan	James Rigault	41	18	57	101	33	5	2	7	71
100	Hort. '88	Jordan's Prolific	60	17	55	136	47.5	$100\frac{1}{2}$	$4\frac{1}{2}$	105	95
101	Hort. '88	Jumbo	52	17	55	136	39.5	$87\frac{1}{2}$	$5\frac{1}{2}$	93	94
102	Wilson	June Eating	54	17	55	122	43.5	$54\frac{1}{4}$	$8\frac{3}{4}$	63	86
103	Hort. '88	Junkis	48	17	57	136	38.5	65	6	71	91
104	Hort. '88	Knapp's Snowbank	39	18	67	145	34	82	6	88	93
105	Hort. '88	King's Excelsior	63	18	67	160	52.5	95	2	97	98
106	Hort. '88	Ladies' Favorite	60	17	....	122	76	71	10	81	89
107	Hort. '88	Lady Finger	204	17	78	136	148	37	17	54	68
108	Hort. '88	LaFayette	77	21	55	136	58	31	4	35	88
109	Hort. '88	Late Beauty of Hebron	69	17	46	145	56	$121\frac{1}{2}$	$11\frac{1}{2}$	133	91
110	Hort. '88	Late Ohio	35	17	51	136	30	60	1	61	98
111	Hort. '88	Late Snowflake	46	17	....	136	35	57	8	65	87
112	Hort. '88	Lee's Favorite	55	17	55	122	44	32	10	42	76
113	Hort. '88	Lion	99	18	69	136	68	42	13	55	76
114	Hort. '88	Lombard	38	17	....	136	33	52	8	60	86
115	Hort. '88	Magic	77	17	51	101	57	34	9	43	78
116	Hort. '88	Magnum Bonum	37	17	55	136	28	31	7	38	81
117	Wilson	Maine Rose	57	17	55	136	42	57	5	62	92

* Days from planting.

No.	Source.	VARIETIES.	Eyes planted.	First appearance.	Date of blossom.	When ripe.	Length of row—feet.	Weight marketable tubers—pounds.	Weight poor tubers—pounds.	Total weight—pounds.	Per ct. marketable.
				*Days.**	*Days.**	*Days.**					
118	Hort. '88......	Mammoth Pearl	47	17	71	136	37.5	69½	6½	76	91
119	Hort. '88......	Mammoth White Chief.........	52	17	....	136	37.5	40¼	10¾	51	79
120	Bouk.........	Mammoth White Chief.........	24	17	78	136	23	52½	4	56½	92
121	Hort. '88......	Matchless.....................	50	17	55	136	41.5	29	18	47	62
122	Hort. '88......	Mayflower....................	49	17	69	136	41	17	14	31	55
123	Bouk.........	McFadden's Earliest............	24	17	55	136	23	31½	2½	34	93
124	Bouk.........	McFadden's Favorite...........	15	17	51	136	14	21	1	22	96
125	Hort. '88......	McFadden's Favorite...........	52	18	59	122	39.5	12½	2½	15	83
126	Hort. '88.....	Moore's Dakota Seedling........	93	18	69	122	84	2¾	2¼	5	55
127	Hort. '88......	Morning Star	69	17	63	136	50.5	55	6	61	90
128	Hort. '88......	Murray's Goldflake.............	56	17	....	136	29.5	26	7	33	79
129	Hort. '88......	Mug White....................	46	17	55	160	34.5	65	5	70	93
130	Vaughan	New Badger State..............	60	17	....	101	47.5	23	5	28	82
131	Hort. '88......	New Eximus...................	46	17	73	160	37	70	13	83	84
132	Hort. '88......	New Queen....................	70	17	57	122	54	50	7	57	88
133	Bouk.........	New Queen....................	23	17	46	122	20	20½	3½	24	85
134	Hort. '88......	Newton	54	18	55	136	43	41½	6	47½	87
135	Hort. '88......	New York State................	75	17	55	145	56.5	110	8	118	93

136	Hort. '88	New Zealand	75	21	....	122	85	26½	1½	28	96
137	Hort. '88	Ohio Fancy	63	17	51	136	47	55	12	67	82
138	Hort. '88	Ohio Junior	63	17	....	122	46	24	4	28	86
139	Hort. '88	O. K. Mammoth	49	17	....	160	37	61	11	72	84
140	I. Seed Co.	Parson's Prolific	36	17	63	136	30	67	13	80	84
141	Hort. '88	Peachblow	76	17	63	136	57.5	62	10	72	86
142	Bouk	Peachblow Seedling	34	17	55	136	29	48	1	49	98
143	Hort	Pearl of Savoy	66	17	51	122	50	67½	6½	74	91
144	Hort. '88	Pearl of Savoy	59	17	51	136	45.5	66	5	71	93
145	Hort. '88	Perfect Peachblow	42	17	55	136	33	43½	9½	53	82
146	Hort	Polaris	74	17	55	122	69	76½	6½	83	92
147	Hort. '88	Pootatuck	58	17	51	122	42	22	9	31	71
148	Hort. '88	Prairie Farmer	64	17	....	136	44.5	43	21	64	67
149	Bouk	Prairie Queen	39	17	63	160	31	46½	9½	56	83
150	Hort. '88	President Cleveland	60	17	51	160	46.5	60	8	68	87
151	Hort. '88	Pride of Ireland	61	17	55	160	45	47	15	62	76
152	Hort. '88	Pride of Japan	92	17	59	136	67	59	10	69	85
153	Hort. '88	Pride of Nebraska	99	17	63	136	74	12¼	4¾	17	72
154	Bouk	Pride of Nebraska	28	17	55	122	23.5	2½	½	3	83
155	Wilson	Pride of the Field	39	17	51	136	36.5	46½	1½	48	97
156	Hort. '88	Pride of the West	46	17	....	136	36	40	16	56	71

* Days from planting.

MAIN PLANTING — CONTINUED.

No.	Source.	VARIETIES.	Eyes planted.	First appearance.	Date of blossom.	When ripe.	Length of row—feet.	Weight marketable tubers—pounds.	Weight poor tubers—pounds.	Total weight—pounds.	Per ct. marketable.
				*Days.**	*Days.**	*Days.**					
157	Taft	Pringle's Seedling, No. 1	49	17	51	160	36	48	9	57	84
158	Taft	Pringle's Seedling, No. 2	37	17	55	136	38	17½	9	26½	66
159	Taft	Pringle's Seedling, No. 5	56	17	55	122	46	30	15	45	66
160	Taft	Pringle's Seedling, No. 6	43	17	51	160	36	27	4	31	87
161	Hort. '88	Purple Blush	54	17	....	122	46	42¾	6¼	49	87
162	Hort	Queen of the Valley	40	17	55	136	32	46	10	56	82
163	Hort. '88	Queen of the Roses	47	17	55	136	39	47	12	59	79
164	Hort. '88	Red Astrachan	54	17	63	136	45.5	20½	9½	30	68
165	Hort. '88	Red Elephant	54	17	65	160	45	74	16	90	82
166	Hort. '88	Early Telephone	42	21	55	122	43.5	32	4	36	89
167	Hort. '88	Red Star	25	17	51	136	25.5	17½	2½	20	86
168	Hort. '88	Rochester Favorite	54	17	51	136	42.5	36½	5½	42	87
169	Hort. '88	Rocky Mountain Rose	62	17	51	101	46.5	49	9	58	84
170	Hort. '88	Rogers's No. 14	74	17	67	136	58.5	98	13	111	89
171	Hort. '88	Rose's No. 4	70	17	55	136	53	51	13	64	79
172	Hort. '88	Rose's No. 76	72	17	55	160	54.5	39	13	52	75
173	Hort. '88	Rose's Seedling	29	17	51	136	22	43½	5½	49	89
174	Wilson	Rose's Seedling	38	18	51	160	32	62	3	65	95

175	Hort. '88	Rundel Rose	57	17	51	136	46	87	9	96	91
176	Hort. '88	Rural Blush	53	18	55	160	40.5	62	3	65	95
177	Hort. '88	Rural New Yorker No. 2	40	21	78	136	30	50	8	58	86
178	Hort. '88	Scotch Grey	68	21	67	160	44.5	43	14	57	75
179	Hort. '88	Seek no Further	70	18	…	101	59	27	3	30	90
180	Hort. '88	Seneca Chief	89	17	57	136	71	96	6	102	94
181	Hort. '88	Snowdrop	42	18	67	136	37	47	9	56	84
182	Hort. '88	Snowflake	133	17	…	122	110	88	18	106	83
183	Hort	Snowflake	63	21	57	136	61	94	6	100	94
184	Hort. '88	Stanton	74	18	57	136	62.5	87	11	98	88
185	Hort. '88	State of Maine	51	18	55	160	44.5	88	2	90	98
186	Hort. '88	Sterling	86	17	55	136	71	44	24	68	64
187	Hort. '88	St. Patrick	91	18	69	136	76	49½	4½	54	92
188	Hort. '88	Summit	77	18	57	136	69.5	104	9	113	92
189	Hort. '88	Sunlit Star	56	18	55	122	54	34	10	44	77
190	Hort. '88	Sunrise	75	18	55	136	67.5	72	13	85	84
191	Hort. '88	Superb Beauty	95	18	57	122	81.5	68	15	83	82
192	Hort	The Thorburn	87	17	51	122	77	79	10	89	89
193	Hort. '88	Tremont	55	18	69	136	49.5	77	10	87	86
194	Hort. '88	Tunxis	122	18	59	136	111	112	30	142	79
195	Hort. '88	Vanguard	70	18	55	122	64	69	6	75	92

* Days from planting.

MAIN PLANTING—CONCLUDED.

No.	Source.	VARIETIES.	Eyes planted.	First appearance.	Date of blossom.	When ripe.	Length of row—feet.	Weight marketable tubers—pounds.	Weight poor tubers—pounds.	Total weight—pounds.	Per ct. marketable.
				*Days.**	*Days.**	*Days.**					
196	Hort. '88	Vermont Champion	108	18	51	122	96	108	20	128	84
197	Hort	Vick's Extra Early	57	18	....	136	60.5	85	12	97	88
198	Hort. '88	Vick's Gem	48	18	69	136	40.5	47	10	57	82
199	I. Seed Co.	Vick's White Rose	38	18	....	136	36	43	8	51	84
200	Hort. '88	Victor	59	18	71	136	53.5	93	10	103	90
201	Hort. '88	Wall's Orange	106	21	59	136	94.5	107	18	125	86
202	Hort. '88	Watson's Seedling	52	18	46	136	48	63	8	71	88
203	Wilson	Watson's Seedling	50	18	55	136	47.5	62	9	71	87
204	Hort. '88	Weld's No. 1	37	21	55	136	33	56	3	59	95
205	Hort. '88	Weld's No. 40	45	21	55	145	46	67½	7½	75	90
206	Hort. '88	Well's Seedling	116	20	55	136	101	85	21	106	80
207	Hort. '88	Well's No. 14	71	18	57	136	63.5	113½	4½	118	96
208	Hort. '88	White Beauty of Hebron	105	21	55	136	93	80	13	93	86
209	I. Seed Co.	White Beauty of Hebron	48	18	57	122	42.5	43½	5½	49	89
210	Hort. '88	White Elephant	68	18	55	145	63	105	14	119	88
211	Hort	White Elephant	57	18	55	136	63.5	94	16	110	85
212	Hort. '88	White Lily	81	18	71	136	69	35	7	42	83
213	Hort. '88	White Mercer	143	21	71	122	124	33	9	42	78

214	Hort. '88	White Prize	54	20	55	122	45.5	53	4	57	9[illegible]
215	Hort. '88	White Prolific	56	21	69	145	49	54	10	64	84
216	Hort. '88	White Seedling	209	21	65	136	88	66	7	73	90
217	Hort. '88	White Star	70	18	65	136	61	64½	6½	71	91
218	Hort. '88	White Whipple	71	20	59	136	61	110	11	121	91
219	I. Seed Co	Wide Awake	66	21	63	122	58	71¾	3¼	75	95
220	Hort. '88	Winston's Seedling	89	20	55	136	77	138	6	144	97
221	Hort. '88	Wood Ants	57	21	....	122	49.5	42	10	52	81
222	Hort. '88	Woodbury's White Sport	61	20	55	136	35.5	99	6	105	94
223	Hort. '88	Yankee Notion	132	21	65	145	111	88	32	120	74
224	Hort. '88	Yosemite	59	18	55	136	52.5	79	20	99	79
225	I. Seed Co	Eyeless	39	21	55	136	37	48	4	52	92

*Days from planting.

POTATOES— COMPARISON ACCORDING TO YIELD.

ESTIMATED YIELD PER ACRE, 500 BUSHELS OR OVER.

No. 222, *Woodbury's White Sport,* . . . . . . 627 bu.
Large, irregular; quality good.

No. 46, *Dictator,* . . . . 598 bu.
Large, roundish or oblong; excellent.

No. 85, *General McClellan,* . . . . 595 bu.
Medium to large, irregular; good.

No. 140, *Parson's Prolific,* . . . . 565 bu.
Large, rough and uneven; not desirable.

No. 104, *Knapp's Snowbank,* . . . . 549 bu.
Large, roundish or oval, smooth; desirable.

No. 47, *Dunmore,* . . . . 522 bu.
Medium to large, oval or oblong; of good quality.

No. 120, *Mammoth White Chief,* . . . . . . 521 bu.
Large, roundish or angular; excellent.

No. 3, *Alexander's Prolific,* . . . . 516 bu.
Large, oblong, rather rough.

No. 45, *Davis's Seedling,* . . . . 514 bu.
Large, dark red, handsome; of only second quality on table.

No. 38, *Cook's Superb,* . . . . 510 bu.
Large, roundish, even; valuable.

No. 109, *Late Beauty of Hebron,* . . . . . 503 bu.
Large, irregular.

ESTIMATED YIELD PEE ACRE, 400 TO 500 BUSHELS.

No. 101, *Jumbo,* . . . . 499 bu.
Large, branched; coarse in quality.

No. 2, *Agnoth's Favorite,* . . . . 491 bu.
Medium to large, oblong; of. fair quality.

No. 173, *Rose's Seedling,* . . . . 481 bu.
Large, oblong, but quite rough and irregular.

No. 131, *New Eximus,* . . . . 475 bu.
Large, roundish, or oblong; excellent,

No. 100, *Jordan's Prolific,* . . . . 473 bu.
Large, oblong, irregular; of second quality.

No. 98, *Irish Cup,* . . . . 468 bu.
Medium to large, dark red; somewhat rough, but excellent,

No. 72, *Early Sunrise,* . . . . 453 bu.
Large, oblong, irregular.

No. 135, *New York State,* . . . . 443 bu.
Medium-sized, oval, even; good.

No. 175, *Rundel Rose,* . . . . 442 bu.
Medium-sized, oval, irregular.

No. 9, *Beauty of Beauties,* . . . . 441 bu.
Large, slightly irregular; a valuable sort.

No. 110, *Late Ohio,* . . . . 431 bu.
Large, oblong; value impaired by deep eyes.

No. 129, *Mug White,* . . . . 430 bu.
Large, roundish or angular, even; valuable.

No. 118, *Mammoth Pearl,* . . . . 429 bu.
Large, roundish or oblong; a valuable sort.

No. 185, *State of Maine,* . . . . 429 bu.
Large, long oval, slightly irregular; valuable.

No. 21, *Brigham's Seedling,* . . . . 427 bu.
Medium-sized, oblong, irregular.

No. 17, *Bonanza,* . . . . 426 bu.
Large, oblong; of only third quality.

No. 165, *Red Elephant,* . . . . 424 bu.
Large, uneven, branching; second-rate.

No. 44, *Dakota Red,* . . . . 422 bu.
Medium-sized, irregular; second-rate.

No. 218, *White Whipple,* . . . . 420 bu.
Medium-sized, elongated; of fair quality.

No. 19, *Boston Market,* . . . . 413 bu.
Large, oval, somewhat irregular; quality second-rate.

No. 139, *O.K. Mammoth,* . . . . 412 bu.
Large, oblong, even ; a trifle coarse in flesh.

No. 177, *Rural New Yorker, No. 2,* . . . . . . 410 bu.
Medium-sized, oval, regular; not of first quality.

No. 200, *Victor,* . . . . 408 bu.

No. 90, *Great Eastern,* . . . . 405 bu.
Tubers large, oval or oblong, rough and uneven.

No. 170, *Roger's No. 14,* . . . . 400 bu.
Medium-sized, fairly even; of good quality.

No. 210, *White Elephant,* . . . . 400 bu.
Large, long, branching and uneven; watery and coarse.

No. 224, *Yosemite,* . . . . 400 bu.
Medium to large, ovate, regular, even; of excellent quality.

ESTIMATED YIELD, 300 TO 400 33 BUSHELS PER ACRE.

No. 80, *Fearnaught,* . . . . 399 bu.
Large, long, irregular; of fair quality.

No. 20, *Bontons,* . . . . 398 bu.
Large and of good form, but scurfy and coarse.

No. 220, *Winston's Seedling,* . . . . 396 bu.
Medium to large, oval, irregular.

No. 28, *Cap Sheaf,* . . . . 394 bu.
Large, oval or oblong; of excellent quality.

No. 30, *Champion of America,* . . . . 394 bu.
Medium to large, oval, somewhat irregular; of good quality.

No. 111, *Late Snowflake,* . . . . 394 bu.
Large, oval or oblong, even; an excellent sort.

No. 207, *Well's No. 14,* . . . . 394 bu.
Medium-sized, oval, irregular; quality fair.

No. 103, *Junkis,* . . . . 391 bu.
Medium to large, oval, irregular; rather coarse.

No. 105, *King's Excelsior,* . . . . 391 bu.
Medium-sized, branching, irregular; quality poor.

No. 48, *Durham,* . . . . 390 bu.
Medium to large, oval; of good quality.

No. 77, *Empire State,* . . . . 385 bu.
Medium-sized, ovate; of good form and quality.

No. 114, *Lombard,* . . . . 385 bu.
Large, roundish or oval; a trifle watery.

No. 75, *El Paso,* . . . . 384 bu.
Medium to large, roundish or oblong; a valuable sort.

No. 149, *Prairie Queen,* . . . . 383 bu.
Medium to large, oval or oblong, even; excellent.

No. 29, *Cayuga,* . . . . 382 bu.
Large, irregular, branched; of poor quality.

No. 204, *Weld's No. 1,* . . . . 379 bu.
Medium-sized, oblong, irregular; of fair quality.

No. 193, *Tremont,* . . . . 377 bu.
Medium-sized, oblong, even; of good quality.

No. 4, *Almo,* . . . . 375 bu.
Large, oval, rough and uneven, many scurfy.

No. 31, *Charles Downing,* . . . . 371 bu.
Medium-sized, oval, uneven; of medium quality.

No. 62, *Queen of the Valley,* . . . . 371 bu.
Large, irregular; of good quality.

No. 12, *Beauty of Sheba,* . . . . 366 bu.
Large, irregular, rough and poor.

No. 27, *Canfield's Seedling*, ... 362 bu.
Medium-sized, oblong, even; of good quality.

No. 54, *Early Hancock*, ... 362 bu.
Medium-sized, oval, irregular; of good quality.

No. 142, *Peachblow Seedling*, ... 358 bu.
Uneven in size, coarse, with very deep eyes.

No. 14, *Bermuda*, ... 349 bu.
Medium sized, roundish, smooth; good.

No. 183, *Snowflake*, ... 347 bu.
Medium-sized, oval, even; excellent.

No. 188, *Summit*, ... 345 bu.
Medium-sized, oval, regular; of fair quality.

No. 145, *Perfect Peachblow*, ... 340 bu.
Medium-sized, very round and even; of second table quality.

No. 176, *Rural Blush*, ... 340 bu.
Medium to large, oval, irregular.

No. 197, *Vick's Extra Early*, ... 340 bu.
Small to medium, oblong, irregular; second quality.

No. 96, *Improved Irish Cup*, ... 337 bu.
Medium to large, smooth; of fine quality.

No. 157, *Pringle's Seedling No. 1*, Taft, ... 335 bu.
Very uneven and poor in form; of little value.

No. 124, *McFadden's Favorite*, ... 333 bu.
Large, oval, flattened, irregular, but of good quality.

No. 184, *Stanton*, ... 332 bu.
Medium-sized, irregular; of second quality.

No. 144, *Pearl of Savoy*, ... 331 bu.
Large, ovate, inclined to be rough and uneven.

No. 156, *Pride of the West*, ... 330 bu.
Medium-sized, roundish, even; flesh dark and poor.

No. 26, *California Rose*, ... 327 bu.
Medium to large, long, deep red; of good quality.

No. 36, *Chicago Sun*, ... 324 bu.
Medium to large, irregular; quality second-rate.

No. 205, *Weld's No. 40*, ... 323 bu.
Medium to large, irregular and uneven.

No. 163, *Queen of the Roses*, ... 321 bu.
Medium-sized, oblong, irregular and uneven.

No. 181, *Snowdrop*, ... 321 bu.
Large, regular; of excellent quality.

No. 203, *Watson's Seedling*, ... 317 bu.
Large, oblong, irregular; sometimes hollow.

No. 117, *Maine Rose*, ... 313 bu.
Medium to large, oblong; a valuable sort.

No. 150, *President Cleveland*, ... 310 bu.
Medium to large, irregular; quality poor.

No. 10, *Beauty of Hebron*, ... 308 bu.
Medium-sized, oval, even; of fine quality.

No. 102, *June Eating*, ... 307 bu.
Medium to large, oval, regular; a fine early sort.

No. 148, *Prairie Farmer*, ... 305 bu.
Medium-sized, irregular, uneven.

No. 7, *American Giant*, ... 304 bu.
Large, oblong, irregular; rather coarse.

No. 123, *McFadden's Earliest*, ... 304 bu.
Medium to large, oval; of good quality.

No. 180, *Seneca Chief*, ... 304 bu.
Small to medium, oval; of fair quality.

No. 137, *Ohio Fancy*, ... 302 bu.
Large, long, irregular; of medium quality.

No. 42, *Cuyahoga*, ... 300 bu.
Medium to large, oval; of good quality.

No. 74, *Early Washington*, ... 300 bu.
Medium to large, oval, regular; of good quality.

No. 199, *Vick's White Rose*, ... 300 bu.
Small to medium, irregular; of poor quality.

ESTIMATED YIELD, 200 TO 300 BUSHELS PER ACRE.

No. 67, *Early Perfection*, ... 299 bu.
Large, irregular; of inferior quality.

No. 198, *Vick's Gem*, ... 298 bu.
Medium-sized, oblong, regular; of second quality.

No. 225, *Eyeless*,. . . . . 298 bu.
Medium-sized, irregular, ovate; of second quality.

No. 32, *Charter Oak*, ... 297 bu.
Of medium size and good form, but coarse and watery.

No. 84, *Garfield*, ... 292 bu.
Large, oblong, irregular; of poor quality.

No. 151, *Pride of Ireland*, ... 292 bu.
Medium to large, irregular; of second quality.

No. 116, *Magnum Bonum*, ... 287 bu.
Medium to large, round; a fine, attractive lot.

No. 58, *Early Maine*, ... 286 bu.
Medium to large, oval or pear-shaped; an excellent sort.

No. 196, *Vermont Champion*, ... 283 bu.
Large, oval; of good form and excellent quality.

No. 34, *Chicago Market*, ... 282 bu.
Medium-sized, oblong, somewhat irregular; of fair quality.

No. 50, *Early Albino*, ... 282 bu.
Large, oval, even; of good quality.

No. 201, *Wall's Orange*, ... 280 bu.
Medium-sized, ovate, regular; of good quality.

No. 155, *Pride of the Field*, ... 279 bu.
Medium to large, oval; of good quality.

No. 215, *White Prolific*, ... 279 bu.
Medium-sized, oval or oblong, uneven.

No. 53, *Early Gem*, ... 277 bu.
Medium to large, oval, quite even; a trifle coarse.

No. 219, *Wide Awake*, ... 274 bu.
Medium to large, elongated, quite even; of good quality.

No. 83, *Frogner's Seedling No. 64*, ... 272 bu.
Medium-sized; of good form and quality.

No. 178, *Scotch Gray*, ... 271 bu.
Large, roundish, regular, and even; a trifle coarse.

No. 194, *Tunxis*, ... 271 bu.
Medium to large, irregular; somewhat rough.

No. 41, *Coy's Seedling*, ... 270 bu.
Large, long, somewhat irregular; not of first quality.

No. 22, *Burbank's*, ... 268 bu.
Large, elongated, irregular; of second quality.

No. 190, *Sunrise*, ... 267 bu.
Large, oblong; of good form and quality.

No. 141, *Peachblow*, ... 265 bu.
Medium to large, elongated, irregular.

No. 214, *White Prize*, ... 265 bu.
Medium to large, oval, even; excellent.

No. 169, *Rocky Mountain Rose*, ... 264 bu.
Medium-sized, oblong; of fair quality.

No. 57, *Early Howard*, ... 261 bu.
Medium-sized, ovate or oblong; of good quality.

No. 79, *Farina*, ... 261 bu.
Long, smooth, cylindrical; of fine quality.

No. 13, *Belle*, ... 260 bu.
Medium to large, irregular; of poor quality.

No. 37, *Clark's No. 1*, ... 260 bu.
Medium to large, irregular; of good quality.

No. 78, *Eureka*, ... 260 bu.
Medium to large, oval; of good quality.

No. 82, *Frogner's Seedling No. 50*, ... 259 bu.
Tubers rather uneven, oblong; of good quality.

No. 69, *Early Rose*, ... 258 bu.
Medium to large, inclined to be irregular and rough.

No. 171, *Rose's No. 4*, ... 256 bu.
Large, oval or pear-shaped; of good form and quality.

No. 146, *Polaris*, ... 255 bu.
Medium to large, rather irregular, and of poor quality.

No. 70, *Early Standard*, ... 254 bu.
Medium or large, oval, even; of excellent quality.

No. 127, *Morning Star*, ... 254 bu.
Medium size, oval or oblong, rather uneven; quality good.

No. 133, *New Queen*, ... 254 bu.
Medium to large, oval; a handsome, desirable lot.

No. 71, *Early Sun*, ... 253 bu.
Medium to large, oblong, irregular.

No. 195, *Vanguard*, ... 248 bu.
Medium to large, oval or oblong, regular; excellent.

No. 217, *White Star*, ... 246 bu.
Medium or large, cylindrical; of good quality.

No. 192, *Thorburn*, ... 245 bu.
Medium size and good quality.

No. 209, *White Beauty of Hebron*, ... 244 bu.
Medium to large, oval or oblong; of fine, attractive appearance.

No. 97, *Iowa Beauty*, ... 243 bu.
Medium to large, oval; of fine appearance, and good quality.

No. 86, *Gilead Red*, ... 241 bu.
Large, roundish or oblong; rather coarse.

No. 121, *Matchless*, ... 241 bu.
Medium-sized; of good form but poor quality.

No. 128, *Murray's Goldflake*, ... 237 bu.
Medium to large, uneven; not profitable.

No. 134, *Newton*, ... 234 bu.
Medium to large, rough; of good quality.

No. 223, *Yankee Notion*, ... 229 bu.
Medium-sized, oblong, irregular; of fair quality.

No. 56, *Early Harvest*, ... 227 bu.
Medium-sized, of good form and quality.

No. 59, *Early Market*, ... 227 bu.
Large, of good form and fair quality.

No. 60, *Early Minnesota*, ... 227 bu.
Small, uneven, and unprofitable.

No. 25, *Burpee's Seedling No. 37*, ... 226 bu.
Medium-sized and good form; quality good.

No. 106, *Ladies' Favorite*, ... 226 bu.
Medium-sized, oval; quality fair.

No. 161, *Purple Blush*, ... 226 bu.
Of medium size and regular form, but quality poor.

No. 23, *Burbank's Seedling*, ... 224 bu.
Of medium size, elongated, irregular.

No. 88, *Golden Flesh*, ... 224 bu.
Small to medium, of good form; flesh deep yellow.

No. 221, *Wood Ants*, ... 223 bu.
Medium to large, oblong, irregular; rather coarse.

No. 206, *Well's Seedling*, ... 222 bu.
Small, irregular; second rate.

No. 33, *Chenango*, ... 219 bu.
Small to medium, oblong; of good quality.

No. 81, *Frogner's Seedling No. 18*, ... 218 bu.
Medium to large; of good form and quality.

No. 152, *Pride of Japan*, ... 217 bu.
Small to medium, uneven and irregular.

No. 191, *Superb Beauty*, ... 216 bu.
Of medium size, but uneven.

No. 39, *Cowles's Seedling*, ... 212 bu.
Medium to large, irregular, oval; of good quality.

No. 168, *Rochester Favorite*, ... 209 bu.
Large, oblong, irregular; of fair quality.

No. 159, *Pringle's Seedling No. 5*, Taft, ... 207 bu.
Medium to large, irregular, uneven.

No. 87, *Globe*, ... 205 bu.
Of medium size, but inferior quality.

No. 93, *Hampden Beauty,* . . . . 204 bu.
Large, somewhat uneven; of good quality.

No. 49, *Earliest and Best,* . . . . 203 bu.
Medium to large, quite regular; of good quality.

No, 186, *Sterling,* . . . . 203 bu.
Small to medium, oval; of fair quality.

No. 112, *Lee's Favorite,* . . . . 202 bu.
Medium-sized, a little uneven; of good quality.

No. 172, *Rose's No. 76,* . . . . 202 bu.
Of medium size, but good form and quality.

No. 64, *Early Ohio,* . . . . 200 bu.
Of medium size, oval, uneven; of good quality.

POTATOES — DESCRIPTIONS OF SORTS NOT BEFORE ON TRIAL.

Almo, Iowa Seed Co., (No. 4.)

Vines two and a half to three feet high, rank, spreading with many strong laterals, stems green; leaflets small or medium in size, dark colored, rough; bloom white; tubers roundish or oblong, inclined to angular; skin yellow, smooth, or often scurfy; eyes of medium size and number, shallow; flesh white, firm, and fine grained. A rather rough and uneven lot as a whole,

Boley's Northern Spy, Wilson, (No. 16.)

Vines two to two and one-half feet high, laterals not equal to leader, stems green; leaves long; leaflets small to medium, rather thin and smooth, light green; bloom pale lilac; tubers medium to large, oval, rather angular and rough, color pale rose, with eyes a shade deeper; eyes few, of medium size, rather deeply set; flesh white, coarse grained. Some of the lot rotted in the fall. The entire product rough and unattractive.

Bonanza, Iowa Seed Co., (No. 17,)

Vines two and a half to three feet high, with numerous slender laterals, stems green, a very rank growth; leaflets small, rather acute, flat, medium or dark green in color; bloom white, small; tubers of medium size, oval or oblong, a little flattened; skin rough, rose-colored; eyes of medium size and number, rather shallow; flesh white, coarse and watery. An inferior lot; not more than third rate.

Burpee's Superior, Burpee, (No. 24.)

Vines of medium strength, two to three feet long, but few laterals, stems green; leaflets small to medium, rather narrow, light green, on young growth folded and wrinkled; bloom small, white; tubers medium to large, cylindrical, elongated, irregular; skin russety yellow; eyes rather numerous, small and shallow; flesh white, fine grained, firm. So uneven and irregular in shape as to be undesirable.

Burpee's Seedling No. 37, Burpee, (No. 25.)

Vines rather slender, eighteen to twenty-four inches long, laterals weak, stems green; leaflets of medium size, light green; bloom white; tubers of medium size, ovate or oblong, skin smooth or a little checked, dull and red; eyes medium in size, number, and depth; flesh firm, a little watery.

Early Albino, (No. 50.)

Vines eighteen to twenty-four inches long, stout, with few laterals; leaflets small, smooth, thin; bloom white; tubers large, oval, flattened; skin smooth, pale rose; eyes few, large, shallow; flesh firm, white.

Early Gem, (No. 53.)

Vines two feet long, rather slender; laterals few and small; leaflets light green, rather thick and rough; bloom white; tubers medium to large, oval or elongated, quite regular; skin smooth, pale rose; eyes few, of medium size and depth; flesh white, a little coarse.

Early Market, (No. 59.)

Vines two feet high, stout, with few laterals, semi-erect; leaflets small to medium, thin, often rolled upward, smooth, light green; bloom small, white; tubers large, oval or oblong, a little flattened; skin smooth, pale rose; eyes of medium number and size, shallow; flesh rather coarse.

Early Minnesota, (No. 60.)

Vines of medium strength, two to two and a half feet long, with a medium number of laterals, spreading, stems green, with a trace of purple at joints; leaflets small to medium, rather flat, dark green; bloom white; tubers small, oval, flattened; skin rough, and often scurfy; eyes of medium number and size; flesh firm, white, fine grained. An uneven and unprofitable lot.

Early Standard, (No. 70.)

Vines two feet long, of medium strength, spreading, few laterals; leaflets small to medium, smooth, light green; bloom white; tubers medium to large, oval, a little flattened, skin smooth, yellow; eyes of medium size and number, rather deep; flesh firm, white, fine grained. An even, attractive lot.

Frogner's Seedling No. 18, (No. 81.)

Vines eighteen to twenty-four inches long, rather stout, with few laterals, stems with a slight purplish tint; leaflets small or medium, light green; bloom white; tubers medium to large, oval, flattened, a little angular; skin slightly rough, pale rose; eyes few, small or medium, shallow; flesh firm, white, of good quality. The lot a trifle uneven.

Frogner's Seedling No. 50, (No. 82.)

Vines rather slender with few laterals, eighteen to twenty-four inches long, stems green with a purplish tint; leaflets rather small, thin, flat, light to medium green, bloom white; tubers oval or oblong, a trifle flattened; skin smooth, pale rose; eyes of medium size and number, rather deep; flesh white, fine grained.

Frogner's Seedling No. 64, (No. 83.)
Vines quite similar to No, 81; bloom white; tubers of medium size, oval, flattened; skin a little rough, pale rose; eyes of medium number, rather small and shallow; flesh white, fine-grained, firm; some tubers are rather scurfy.

General McClellan, (No. 85.)
Vines very heavy, three to three and a half feet long, spreading, with many laterals; leaflets small to medium, rather strongly veined and rough, medium to dark green; bloom white; tubers medium to large, roundish or oval, quite irregular; skin rough, yellow; eyes of medium size and number, shallow; flesh firm, white.

Golden Flesh, (No. 88.)
Vines two and a half to three and a half feet long, rank, spreading, with many laterals, stems with a shade of purple; leaflets rather broad, intermediate small pairs nearly round, obtuse; bloom deep lilac; tubers small to medium, oval or elongated, flattened; skin smooth, deep red, eyes few, rather small and shallow; flesh firm, decidedly yellow.

Golden Kidney, (No. 89.)
Vines twelve to eighteen inches long, slender, spreading, with few laterals; stems purplish; leaflets small, narrow, curved, dark green; bloom violet; tubers small, oval or kidney-shaped, flattened; skin russety yellow; eyes few, small, shallow; flesh firm, white, fine grained.

Harlequin, (No. 94.)
Vines eighteen inches high, erect, branching, stems green; leaflets small, oval, curled and rolled, pea-green and white mottled; no bloom; tubers small, ovate, pale rose; eyes numerous, small. Product of no value, simply a curious novelty, and a great favorite with the Colorado potato-beetle.

Iowa Beauty, (No. 97.)
Vines eighteen to twenty-four inches long, slender, spreading, with few laterals, stems with a purplish tint; leaflets of medium size, rather flat, a trifle rough, light green; bloom white; tubers medium to large, oval, flattened; skin russety; eyes few, small, shallow; flesh white, firm, quality good.

James Rigault, (No. 99.)
Vines twelve to eighteen inches long, very slender, with few laterals; leaflets small, light green; stems faintly purplish; bloom pale lilac; tu-

hers small, oval or kidney-shaped, a little irregular; skin smooth, bronze yellow; eyes few, very small and shallow; flesh deep yellow, fine grained.

June Eating, (No. 102.)

Vines eighteen to twenty-four inches long, slender, with few laterals; leaflets two to four pairs, flat, light to medium green; bloom white; tubers medium to large, oval or ovate, flattened; skin smooth, pale rose; eyes few, rather large and a trifle deep; flesh firm, white. One of the most attractive early potatoes.

Maine Rose, (No. 117.)

Vines stout, more erect than spreading, two and one-half feet long, stems green, purplish at joints; leaflets small to medium, strongly veined, rather flat, of medium green color; bloom white; tubers medium to large, oval or oblong, rather angular; skin a little russety, deep rose; eyes rather numerous, of medium size and depth; flesh firm, fine grained, a little yellowish.

McFadden's Earliest, (No. 123.)

Vines eighteen to twenty-four inches high, stout, with few laterals, stems green, purplish at joints; leaflets small to medium, a little curled, light to medium green; bloom white; tubers medium to large, oval, a little flattened; skin slightly rough, pale red; eyes of medium number, size and depth; flesh of good quality, firm, and white.

Moore's Dakota Seedling, (No. 126.)

Vines one foot long, slender, spreading, with few laterals, stems with a purplish tint; leaflets very small, rough, curled, light green; bloom lilac; tubers small, cylindrical; skin rose-colored, cracked, rough, scurfy. No tubers of market value.

New Badger State, (No. 130.)

Vines slender, twelve to sixteen inches high, with few laterals, stems slightly purplish; leaflets small, thin, medium green; no bloom; tubers medium-sized, oval, slightly flattened, obtuse at ends; skin smooth, pale rose; eyes of medium number and size, shallow; flesh white, fine grained. This variety has a strong resemblance to the *Early Ohio,* both in vine and tuber, and may be identical with that. As grown by us it does not agree with Vaughan's description of the potato.

Peachblow Seedling, (No. 142.)

Vines stout, two and a half to three and a half feet long, with a medium number of laterals, stems marked with dark purple; leaflets of the Peachblow type, small or medium, narrow, curled, dark green; blossoms blue and white; tubers large, elongated, tapering toward the stem; skin coarse, yellow, splashed with purple across the eyes, which are numerous, of medium size and deeply sunken, giving the tuber a rough, knotty appearance. Product uneven and many tubers inferior.

Pride of the Field, (No. 155.)

Vines two and a half to three feet long, stout, spreading, with only a medium number of laterals; leaflets small or medium, rather acute, a little curled, medium or light; bloom pale lilac; tubers medium to large, irregular, oval, flattened; skin smooth, pale rose; eyes few, rather large, and sometimes deep; flesh fine grained, white.

Pringle's Seedling No. 1, (No. 157.)

Vines very rank, three to four feet long, spreading with numerous slender laterals, sometimes erect, stems purplish; leaflets small, narrow, flat or a little curled, strongly veined, dark green; blossoms light purple, petals tipped with white; seed balls numerous, heart-shaped, compressed laterally; tubers of medium size, elongated, tapering and curled in many grotesque forms; skin russety, deep rose; eyes of medium number, size and depth; flesh firm, white. Though well–formed seed was planted, the product was entirely worthless for table use on account of irregularity in form.

Pringle's Seedling No. 2, (No. 158.)

Vines stout, spreading, three to three and a half feet long, with a medium number of laterals, which are often erect, stems purplish; leaflets similar to those of No. 157 in shape and texture but light green in color; blossoms white, faintly lilac; tubers small, or medium-sized, oblong, angular, color pale rose, deepening to purple around the eyes, which are few, but deep; flesh a trifle yellowish, with dark streaks, watery. Product not even or desirable.

Pringle's Seedling No. 5,. (159.)

Vines two and a half to three and a half feet long, stout, spreading or semi-erect, stems purplish; leaflets small to medium, narrow, strongly cordate, distinctly light green; bloom pale lilac; tubers medium to large, cylindrical, very much elongated, quite irregular and uneven in size, one specimen weighing 20 oz.; skin smooth, yellow; eyes of medium number, but very small and shallow; flesh white, fine grained and firm.

Pringle's Seedling No. 6, (No. 160.)

Vines stout, three to three and a half feet long, with only a medium number of laterals; leaflets of medium size, strongly veined, rough, a little curled, medium or dark green; blossoms small, purplish; seed balls nearly spherical; tubers medium to large, irregularly ovate, flattened, somewhat angular; skin a little russety, yellow; eyes few, of medium size, terminal ones rather deep; flesh white, fine grained, firm. Much the most promising of the four Pringle's Seedlings.

Vick's White Rose, (No. 199.)

Vines two to three feet long, slender, spreading, with a medium number of laterals; leaflets small, rather narrow and acute, usually a little rolled or folded, light or medium green; no blossoms; tubers small to medium, irregular ovate, flattened; skin russety yellow; eyes few, very small and shallow; flesh often watery and coarse.

Wide Awake, (No. 219.)

Vines of medium strength; blossoms small, lilac; tubers medium to large, elongated, a little flattened; skin smooth, dull yellow; eyes rather numerous, of medium size, shallow; flesh white, firm.

Eyeless, (No. 225.)

Vines of medium strength; blossoms deep purple; tubers of medium size, irregular, ovate, flattened; skin russety yellow; eyes few, very small and shallow; flesh a trifle yellowish and watery.

A TEST OF SOME EARLY POTATOES.

In our climate, uncertain in the time and amount of summer rainfall, early-ripening potatoes are often of greatest profit; and with the intent of testing the value of certain promising sorts from the crop of last year (1889), two pounds each of a selection of fifty-six varieties were planted on the 15th of March, the tubers cut in pieces of 3 or 4 eyes each, and these dropped eighteen inches apart in every third furrow after the plow, by which they were covered about four inches. The weather followed cold after the planting, the vines were slow in starting, and a frost on April 4th killed the tops of the most forward plants, which were then two or three inches high. The soil in which the potatoes were planted was good bottom loam, old ground, in fine condition, and the only cultivation consisted in keeping the ground free from weeds, and mellow. On June 18th, or ninety-five days from planting, two hills of each variety were dug and weighed. Those giving from these two hills a product of two pounds and over, of smooth even potatoes of edible quality, are indicated in small capitals in the accompanying table, which also shows the date of first blooming, the date of final digging of each variety as the vines ripened, total weight from the two pounds planted, and the estimated yield per acre.

While this estimate is valuable only as showing, approximately, the relative productiveness of the different varieties tested, the actual yield of 43.4 bushels from 24 square rods of ground, or .15 acre, gives a yield of $289\frac{1}{3}$ bushels per acre, which accords well with the averages of the different lots.

The potatoes as dug were weighed and assorted, and ten pounds of each placed in a shallow box of dry sand, and stored in a cool cellar, where they were not disturbed until March 1st, when they were sprouted, weighed, and the condition noted as to sound or rotten, firm or shriveled. These points will be found in the tabular statement, and will be a valuable indication of the keeping qualities of the sorts tested.

A SECOND CROP.

On July 11th two hills each were dug from the best-ripened varieties of this early crop, and planted the same day on ground cleared of early peas, without re-plowing; thirty feet of row being devoted to each. The varieties were Vick's Extra Early, Durham, Rochester Favorite, New Queen, White Prize, Vanguard, Early Ohio, Ladies' Favorite, Early Harvest, Hampden Beauty, Thorburn, Charles Downing, Ohio Junior, Early Washington, Early Electric, and Cuyahoga.

The Early Ohio, Ohio Junior, and Ladies' Favorite failed to appear, and the others were slow in starting; their tops were small, and the stand more or less uneven, They were dug November 2d, and gave a product of from one pound of Vick's Extra Early to six of Durham, eight each of Thorburn and Early Washington, and ten each of Early Harvest and Cuyahoga.

These were stored to test their keeping qualities, in comparison with the stock from which they were grown. While on March 1st all of the product of the first crop was found to be more or less sprouted and shriveled, but three varieties of the second-crop list, Durham, Early Washington, and New Queen, showed signs of sprouting, and in these it was confined to a few small, immature tubers.

TABLE OF EARLY POTATOES.
RIPENING IN JULY.

VARIETIES.	First bloom, days from planting	Weight of tubers, pounds	Estimated yield per acre	MARCH 1, 1890. Per cent. of shrinkage	Condition of tubers	Extent of sprouting	Remarks.
Early Sunrise	71	42½	418	19	c	2	———
Early Maine	75	78	385	36	c	2	Some decayed.
Vick's Extra Early	......	32	370	15	c	2	———
Watson's Seedling	80	60	366½	11	b	1	———
Hampden Beauty	71	30½	353	24	b	2	———
Polaris	71	65	349	59	b	2	Many decayed.
Durham	71	36	335	27	b	2	———
Early Harvest	68	42	313½	28	c	2	———
Vanguard	80	56	305	20	c	2	———
Sunrise	80	66	301	20	b	2	———
White Prize	71	65	299	20	c	2	———
Magic	80	43½	296	17	c	2	———
Thorburn	80	67	293	29	b	2	Some decayed.
Early Howard	75	55	274	17	b	2	———

TABLE OF EARLY POTATOES — CONTINUED.
RIPENING IN JULY — *concluded.*

VARIETIES.	First bloom, days from planting.	Weight of tubers, pounds.	Estimated yield per acre.	MARCH 1, 1890. Per cent. of shrinkage.	Condition of tubers.	Extent of sprouting.	Remarks.
Early Perfection	80	31	213	.....	.....	.....	———
NEW QUEEN	80	43	212½	18	c	2	———
Mammoth Pearl	......	33½	199	11	c	1	———
RUNDEL ROSE	68	37	185	19	c	2	———
New Zealand	......	30	165	.....	.....	.....	———
Lee's Favorite	75	39	162	12	.....	.....	———
Earliest and Best	75	30	145	20	b	2	———
EARLY OHIO	......	29	140	26	b	2	———
Early Washington	75	18	133	28	c	2	———
OHIO JUNIOR	80	26	122	16	b	2	———
Mammoth White Chief	......	13	59½	28	b	1	———
Early Electric	......	22	269	17	c	2	———
Early Telephone	75	34	254	20	b	2	Some decayed.
Beauty of Hebron	75	45	244	20	c	2	———
Ladies' Favorite	......	27	242	15	b	1	———
ROCHESTER FAVORITE	71	44	242	22	c	2	———
Cowle's Seedling	75	45	239	22	b	2	———
Clark's No. 2	75	52	238½	19	b	2	———
Cuyahoga	71	60	233½	24	c	2	———
RIPENING IN AUGUST.							
Yosemite	80	99	396	17	c	2	———
White Whipple	81	73	369	17	c	2	———
BURBANK'S SEEDLING	80	42	353½	10	c	1	———
Early Kings	......	53	322	11	b	1	———
Rogers' No. 14	......	85	312	10	b	2	———
Charles Downing	......	75	306	7	a	1	———
Red Star	80	54	297	9	a	1	———
Fearnaught	89	64	287	5	a	1	———
Snowflake	81	56	262	8	a	1	———
Hale's Early Peachblow	75	26	253	9	c	1	———

TABLE OF EARLY POTATOES — CONCLUDED.

RIPENING IN AUGUST — *concluded.*

VARIETIES.	First bloom—days from planting	Weight of tubers—pounds	Estimated yield per acre	MARCH 1, 1890. Per cent. of shrinkage	Condition of tubers	Extent of sprouting	REMARKS.
Cayuga	......	49	248	9	b	1	———
Early Hancock	75	22	236	17	c	2	———
Belle	80	47½	232	9	a	1	———
Early Queen	80	44	229	6	a	1	———
Empire State	80	49	224½	7	b	1	———
Early Sun	75	44	217½	11	b	1	———
El Paso	75	45	183	11	b	2	———
La Fayette	80	16	76	9	c	2	———
RIPENING IN SEPTEMBER.							
Cook's Superb	......	85	445	8	a	1	———
Vick's Gem	......	76	387	7	a	1	———
May Flower	80	48	240	9	b	1	———
White Prolific	......	41	209½	7	a	1	———

NOTE.—In the foregoing table the data in the sixth and seventh columns indicate as follows: The condition of tubers — "a" firm, or little shriveled, "b" shriveled, "c" much shriveled; the extent of sprouting — "1" little or no sprouting, "2" much sprouted.

A COMPARISON OF VARIETIES OF THE TOMATO.

Of the tomatoes on the following list, 100 seeds each were sown in boxes in the propagating-house, April 10th, and the percentage germinating noted. When of proper size a dozen strong plants of each were transplanted to four-inch pots, and June 1st, six plants, uniform in size and vigor, were transferred to the open ground, where they were set in rows six feet apart, the plants five feet apart in the row. The soil was rich bottom–land in fine condition, and no fertilizers were used. The land was kept clean and well stirred, and the vines were duly clipped back to allow ready passage between the rows. As the fruits ripened they were gathered, weighed, counted, and the average weight ascertained. Full data will be found in the following table, to which is appended a descriptive list of sorts of present or permanent interest.

COMPARATIVE TABLE OF THE DIFFERENT VARIETIES.

No.	Source.	VARIETIES.	No. of plants from 100 seeds.	First bloom.	First fruit set.	First ripe.	Total number of ripe fruits.	Total weight of ripe fruit.		Average weight—ounces.	Weight of green fruit at frost.
				Days.*	Days.*	Days.*		Lbs.	Oz.		Lbs.
1	Cleveland	Acme	79	88	93	135	154	74	6	7.7	88
2	Thorburn	Alpha	60	83	85	113	402	113	5	4.5	44
4	Gregory	Arlington	68	83	85	123	251	101	11	6.5	68
5	Landreth	Bermuda Extra Early	43	83	85	127	522	133	13	4.1	59
6	Cleveland	Canada Victor	82	83	88	120	304	106	11	5.5	75.5
7	Livingston	Canada Victor	75	83	83	120	539	119	1	3.5	95
8	Livingston	Cardinal	78	85	88	120	316	104	11	5.3	88
9	Cleveland	Cardinal	49	83	85	131	201	79	9	6.3	84
10	Cleveland	Dwarf Champion	51	83	85	120	200	54	11	4.4	19.5
11	Livingston	Dwarf Champion	70	85	88	123	209	58	15	4.5	26.5
12	Livingston	Early Advance	80	79	81	109	859	143	6	2.7	66.5
13	Cleveland	Early Conqueror	62	83	88	127	249	92	11	5.9	107
14	Cleveland	Early Large Smooth Red	59	85	88	127	302	92	5	4.9	69.5
15	Wilson	Early Mayflower	46	85	88	131	240	71	2	4.7	60
16	Taft	Eiformige Dauer	94	83	90	121	1691	124	4	1.1	53.5
17	Livingston	Essex Hybrid	78	83	85	125	449	115		4.1	40
18	Ferry	Extra Early Hundred Day	78	83	85	123	702	117	4	2.4	26.5
19	Farquhar	Faultless Early	63	83	85	121	359	103	3	4.6	85.5

COMPARATIVE TABLE OF THE DIFFERENT VARIETIES—CONTINUED.

No.	Source.	VARIETIES.	No. of plants from 100 seeds.	First bloom.	First fruit set.	First ripe.	Total number of ripe fruits.	Total weight of ripe fruit.		Average weight—ounces.	Weight of green fruit at frost.
				*Days.**	*Days.**	*Days.**		*Lbs.*	*Oz.*		*Lbs.*
20	Landreth	Feejee	42	85	88	117	161	71	4	7.1	76
21	Cleveland	Feejee Island	86	83	85	121	254	84	8	5.3	73
22	Gregory	Fulton Market	29	83	85	121	447	108	3	3.9	28.5
23	Cleveland	General Grant	61	83	85	125	401	92	15	3.7	47.5
24	Henderson	Golden Rod	75	85	88	128	253	78	11	5	95.5
25	Henderson	Golden Sunrise	59	83	85	124	433	131	1	4.8	74
26	Cleveland	Golden Trophy	45	85	88	117	628	92	10	2.3	58.5
27	Thorburn	Green Gage	84	79	81	127	326	46	10	2.3	90
28	N. B. & G. Co.,†	Hain's No. 64	63	88	88	127	235	62	2	4.2	97.5
29	Livingston	Hathaway's Excelsior	53	83	85	127	309	68	15	3.6	39
30	Cleveland	Hathaway's Excelsior	55	83	85	128	338	91	11	4.4	84
31	Thorburn	Hovey, The	83	79	81	117	441	110	1	3.8	88.5
32	Vick	Hubbard's Curled Leaf	37	79	83	121	621	112	12	2.9	40.5
33	Taft	Ignotum	....	....	....	....	168	31		3	69.5
34	Thorburn	Large Yellow	86	81	85	120	579	82	12	2.3	40
35	M. L. S. S. Co.,‡	Livingston's Beauty	52	81	83	125	268	98	2	5.9	49.5
36	Cleveland	Livingston's Beauty	65	83	85	123	254	89	11	5.6	68.5
37	Livingston	Livingston's Beauty	70	79	83	120	351	119	12	5.5	86
38	Livingston	Livingston's Early Advance	80	83	85	111	366	103		4.5	53

39	Cleveland	Livingston's Favorite	85	85	88	120	276	78 11	4.5	51.5
40	Livingston	Livingston's Favorite	78	88	88	127	203	78 12	6.1	43.5
41	Livingston	Livingston's Golden Queen	90	83	85	118	311	93 13	4.8	54
42	Wilson	Livingston's New Beauty	78	83	88	125	273	97 10	5.7	76.5
43	Cleveland	Livingston's Perfection	72	75	83	123	304	115 8	6.2	90
44	Livingston	Livingston's Perfection	28	81	83	120	397	120 1	4.8	57.5
45	Henderson	Lorillard, The	25	81	83	117	312	103	5.2	56
46	Burpee	Matchless, The	53	85	88	127	353	115 10	5.2	50.5
47	Cleveland	Mayflower	41	85	88	127	194	73 11	6.1	66
48	Vick	McCullom's Hybrid	27	85	88	124	251	76 11	4.9	72
49	M. L. S. S. Co.,‡	Mikado	56	77	85	123	240	115 9	7.7	63
50	Livingston	Mikado	50	83	88	135	176	76 10	6.9	89
51	Cleveland	Mikado	48	85	88	113	162	63 4	6.2	56
52	Gregory	New Bronzed-Leaved	46	81	85	127	229	107 15	7.5	59
53	Henderson	New Dwarf Champion	43	85	88	120	219	57 15	4.2	29.8
54	Thorburn	New Jersey	15	85	88	128	290	100 4	5.5	93.8
55	Cleveland	New Queen	45	88	88	131	277	91 5	5.2	79.8
56	Nichol	Nichol's Stone	34	83	85	127	310	116 13	6	85
57	Cleveland	Optimus	....	88	90	127	145	43 2	4.7	46
58	Livingston	Optimus	....	95	97	137	197	60 12	4.9	34
59	Livingston	Paragon	68	77	83	113	323	104 14	5.2	71
60	Cleveland	Paragon	65	81	83	120	326	96 11	4.8	75

* Days from planting. † Northrup, Braslan & Goodwin Co. ‡ Michigan Lake Shore Seed Co.

COMPARATIVE TABLE OF THE DIFFERENT VARIETIES—CONCLUDED.

No.	Source.	VARIETIES.	No. of plants from 100 seeds.	First bloom.	First fruit set.	First ripe.	Total number of ripe fruits.	Total weight of ripe fruit. Lbs.	Total weight of ripe fruit. Oz.	Average weight—ounces.	Weight of green fruit at frost.
61	Livingston ...	Peach, The New	37	*Days.** 88	*Days.** 88	*Days.** 131	637	72	2	1.8	99.5
62	Livingston ...	Potato Leaf	56	75	79	118	463	133	12	4.6	77.5
63	Farquhar	President Cleveland	75	74	79	118	381	104	5	4.4	81.5
64	Thorburn	Puritan	29	77	79	118	466	102	8	3.5	72.5
66	Ferry	Red Apple	18	77	85	123	522	146	2	4.5	95
67	Livingston ...	Red Cherry	83	75	77	116	‡......	69	9	.2	65
68	Livingston ...	Red Currant	54	65	71	105	‡......	‡..........		.04	‡.....
69	Livingston ...	Red Trophy	57	79	85	121	178	82	14	7.5	55
70	Henderson	Shah, The †	28	75	85	118	237	101	6	6.8	42.5
73	Henderson	Sunrise, Yellow	45	60	79	113	442	133	1	4.8	102.5
74	Buist	Tildin, selected	....	81	85	120	343	102		4.7	78
75	Cleveland	Trophy, selected	....	95	97	133	161	54	4	5.4	51
76	Livingston ...	Turner's Hybrid	....	97	100	....	83	39		7.5	61
77	Livingston ...	Volunteer	....	97	100	137	187	64	2	5.4	59
78	Cleveland	Volunteer	....	91	95	137	200	66	14	5.3	80.5
79	Cleveland	Yellow Plum	....	67	77	109	‡......	59	3	.76	114.5
80	Livingston ...	Yellow Plum †	....	77	79	109	‡......	57	11	.51	71
81	Gregory	Yellow Victor	....	81	85	120	375	93	5	4	29.5

TOMATOES.—DESCRIPTIVE NOTES.

The varieties in the following descriptive list are included as not before described in our reports, or on account of special merit, as shown in our gardens. Those of the latter class are indicated by a*.

Arlington, Gregory, (No. 4.)

Strong vines, foliage scarcely of the average density; leaflets rather short and broad, nearly entire, dark green; fruit oval or somewhat angular, flat–tened, slightly ribbed; skin badly cracked; flesh thick, but coarse and soft; seed cells six to ten; color light red; product uneven and rather inferior.

**Dwarf Champion,* CI., (No. 10.) Dwarf Champion, Livingston, (No. 11.) New Dwarf Champion, Henderson, (No. 53.)

Plant stocky, about two feet high; branches stiff and tree-like; leaf stout, leaflets thick, strongly toothed and wrinkled, dark green; fruit borne closely in on the main stalks, irregular, oval, flattened, recurved, stem deeply set; flesh thick, firm; seed cells six; skin bright purplish red, inclined to crack. While not giving a heavy yield to the vine, this will bear much closer planting than the standard varieties, and hence may be desirable in small gardens.

Eiformige Dauer, Taft, (No. 16.)

Vines strong, spreading, having a distinct foliage, light green, dense, leaflets rather evenly and distinctly toothed; fruit small, round or slightly pointed; flesh thin; seed cells four or sometimes five or six. Productive throughout the season, but its small size prevents its being profitable. Of interest as the probable original of the "Ignotum."

Faultless Early, (No. 19.)

Vines rather spreading, foliage not dense; leaflets of medium size, coarsely toothed; fruit roundish oval, oblate, smooth, even; seed cells six; skin purplish red, a good deal inclined to crack. One of the Acme type.

Fulton Market, Gregory, (No. 22.)

Vines similar to those of Hundred Day and General Grant; fruit of that type also, oval, flattened, strongly ribbed; thin. fleshed; seed cells six to ten; skin light red, tough.

**Golden Rod,* Henderson, (No. 24.)

Vines rank, with rather dense, rough foliage; leaflets of medium size, lobed and strongly toothed; fruit of fine size, oval, flattened, smooth, golden yellow. The latest and largest of the type, but falling below the others in yield.

**Golden Sunrise,* Henderson, (No. 25.) Yellow Sunrise, Henderson, (No. 73.)

Vines similar to above; fruit roundish or oval, somewhat flattened; seed cells three to six or seven; flesh of good thickness; color reddish yellow. The most productive of the yellow tomatoes, and of fine quality.

Golden Trophy, Cleveland, (No. 26.)
Vines slender and spreading, foliage scanty, leaflets small; resembles the Hundred-Day type; fruit irregular oval, much flattened, six to eight lobed; flesh thin, seeds not filling the cells; color deep yellow. A poor and unsalable lot.—Large Yellow, Thorburn, (No. 34,) gives a fruit which cannot be separated from this.

Green Gage, Thorburn, (No. 27.)
Vines spreading, with dark-green foliage of medium density; leaflets rather small; fruit nearly round, slightly depressed, smooth, light yellow; seed cells four.

Haines's No. 64, N. B. & G. Co., (No. 28.)
Vines strong, compact, foliage dense, medium green; fruit oval, flattened, sharply six to eight lobed, flesh rather thin, skin tough, light red.

* *The Hovey,* Thorburn, (No. 31.)
Vines of medium strength, spreading, foliage not dense; leaflets obtusely toothed, rather thick; dark green; fruit oval, a little depressed, smooth, but inclined to crack when fully ripe; flesh thick, firm; seed cavities five or six; color bright crimson red.

Ignotum, Taft, (No. 33.)
Vines of spreading habit and medium green color; leaflets deeply lobed; fruit exceedingly variable, a larger form, something like the Acme in form, but bright red, mixed with smaller fruit of the type of Eiformige Dauer. These plants being grown later than the list, the data given in the table do not furnish a fair comparison.

**Livingston's Beauty,* M. L. S. S. Co., (No. 35.) Cleveland, (No. 36.) Livingston, (No. 37.) Livingston's New Beauty, Wilson, (No. 42.)
Vines spreading and foliage rather thin, of medium green color; leaflets of medium size, moderately lobed or toothed. Fruit roundish oval, somewhat flattened, smooth and solid; flesh thick and firm; seed cells normally six, but breaking up into ten or twelve; skin deep crimson red, inclined to crack.

* Acme, Cleveland, (No. 1.) Livingston's Early Acme, Livingston, (No. 38.)
Plants cannot be distinguished from those of the Livingston's Beauty. Fruit of Acme is smaller on the average, as will be seen by the table, and more nearly round. Color not different. As shown in the table, the date of first-ripe fruit is in favor of the Acme, but in 1888 there was no material difference.

* *Livingston's Perfection,* Livingston, (No. 44.)
Vines of similar habit to those of Livingston's Beauty; fruit roundish

oval, a little flattened, smooth and even, bright orange red; stem rather deeply set; flesh of medium thickness; seed cells six.

The Lorillard, Henderson, (No. 45.)

Plants similar to those of Beauty or Perfection; fruit roundish oval, slightly flattened, stem not deeply inserted; flesh of outer wall of medium thickness, septa thick, making a solid-fleshed fruit; seed cells six; skin a little cracked around stem, many. fruits with a small navel mark; color bright deep red.

Mikado, M. L. S. S. Co., (No. 49.) Livingston, (No. 50.) Cleveland, (No. 51.) Turner's Hybrid, Livingston, (No. 76.)

Vines spreading, angular, with moderately thick foliage; leaf eight to twelve inches long, with one or two pairs of lateral leaflets, and a very large, broad terminal leaflet, often lobed; fruit a very irregular oval, unevenly lobed and distorted, recurved, with stem deeply set; most specimens with a large navel mark; flesh and septa thick, but with many hard, green spots; color purplish red. Lot No. 50 gave one specimen weighing 20 ounces, which was of fine, regular form and unusually solid; flesh without green streaks.

**New Jersey,* Thorburn, (No. 54.)

Vines rank, with dense foliage and rather large, coarse leaflets; fruit roundish, rather flattened, more or less ribbed; stem shallow; seed-cells five or six, with thick septa; outer wall of medium thickness; skin cracks slightly; color light orange red.

* *Nichol's Stone,* Nichol, (No. 56.)

Vines with foliage of medium density, slightly bluish green in color; fruit oval, somewhat angular, a little flattened, very heavy and thick fleshed; color light red. One of the best of the later varieties.

* *Paragon,* Livingston, (No. 59.) Cleveland, (No. 60.)

Vines with dense, rather coarse foliage; fruit roundish, somewhat flattened, slightly ribbed, usually smooth and of fine appearance; seed cells four to eight, with thick septa; color a fine orange red. A very desirable sort.

**Potato Leaf,* Livingston, (No. 62.)

Plants of the Mikado type; fruit resembling the Acme or Livingston's Beauty; oval, oblate, smooth, with shallow stem; cracks badly; thick-fleshed; seed cells four to six; color purplish red.

* *Red Apple,* Ferry, (No. 66.)

Vines rank, spreading, with quite dense foliage; fruit round or oval, much flattened, slightly ribbed; later fruits better than the earlier ripened. Fruit uneven in quality, but the six vines the most productive of the list.

The Shah, Henderson, (No. 70.)
Vines of the Mikado type; fruit oval, flattened, recurved, sharply ribbed around stem, which is "deeply set; flesh firm; seed cells numerous; color lemon, with a rosy tint.

SOME INSECTS INJURIOUS TO THE BEAN.

THE BEAN WEEVIL.

Bruchus obsoletus Say.

(Plate IX, figures 1,2,3, and 4,)

We have known of the work of the bean weevil in Kansas for over fifteen years, yet we have not heretofore seen it in such troublesome abundance as it has occurred with us the past season in the Station garden. The insect seems to be local in its attacks, and so far as we have learned it cannot be said to be generally distributed through our State— at least, in injurious numbers. If correct in our memory of its appearance in this vicinity, it has been abundant only within the last four or five years.

The species was first studied by the pioneer Western naturalist, Thomas Say, and is described in his paper on North American Curculionides, bearing date July, 1831, where he states that it inhabits Indiana, and that he obtained many specimens from the seeds of an *Astragalus,* in August. Since the date of Say's paper the insect seems to have received little public notice until the publication, in 1870, of the American Entomologist, in the second volume of which occur numerous references to this species and its work. An important account of the insect and its habits, with references to associated questions of interest, appears on page 52 of the Third Annual Report of C. V. Riley, the State Entomologist of Missouri, where the species is described as new, under the name of *Bruchus fabæ.**

REFERENCES.

Those who are interested in the history and distribution of the bean weevil will find matter of more or less importance cited in the references here following:

Bruchus obsoletus n. sp. Say. Collected writings, edited by Le Conte, Vol. I, p. 261. "Many specimens from the seeds of an Astragalus in August."

Bruchus obsoletus Say. Rathvon, "A New Bean Weevil," in The American Entomologist, Vol. II, p. 118, (February, 1870.) He says this beetle "has developed in Lancaster county [Pa.] within the last five years." Refers to Say's description of the beetle, and gives a brief description of the larva. Suggests the destruction of the weevils and their larvæ and eggs by subjecting the infested seeds to a heat sufficient to kill the insects with-

* We have followed Dr. Horn, our leading specialist in the Coleoptera, in the question of the synonymy of the bean weevil. It should be stated that Professor Riley, on page 70 of his "General Index and Supplement to the Nine Reports on the Insects of Missouri," published in 1881 as Bulletin No. 6 of the U. S. Entomological Commission, still considers his *Bruchus fabce* specifically distinct from the *Bruchus obsoletus* of Say.

out impairing the germination of the bean; and further, "It is also recommended that immediately after gathering the beans they should be thrown into boiling water, and left in for one minute, as the young larvæ may then, by this means, be killed." Notes their occurrence in the " Cran–berry," the "Agricultural" and the "Wren's Egg" beans.

Bruchus obsoletus Sa. Riley, in The American Entomologist and Botanist, Vol. II, 1870, identifies the species for correspondents; on page 125, for James Angus, West Farms, N. Y., who states that with him the *Early Mohawk,* the *Yellow Six - Weeks* and the *Dutch Case-Knife* were all badly damaged; on page 182, naming the beetle sent from Alton, I11., and referring to its abundance at Jefferson City, Mo.; on pages 302 and 307, for A. S. Fuller, Ridgewood, N. J., who found the beetle in *Lima Beans;* and on page 374, from Pike county, Pennsylvania.

Bruchus obsoletus Say. T. Glover, in Report of the Entomologist, U. S. Department of Agriculture, for 1870, p.72: " . . . very destructive to the field beans of this country, sometimes five to ten being found in one bean."

Bruchus fabæ n. sp. Riley, in Third Annual Report upon the injurious and other insects of the State of Missouri, 1871, p. 52. Bruchus fabæ n. sp. is by the author considered as distinct from B. obsoletus, Say, and this position is maintained in the critical and descriptive portions of the article. In addition, the distribution and habits of the insects are fully discussed. "I have always found the germ either untouched or but partially devoured even in the worst infested beans, so that when but two or three weevils inhabit a bean, it would doubtless grow; but where the meat is entirely destroyed, as it often is, the bean would hardly grow, though the germ remained intact, and it would certainly not produce a vigorous plant." (p. 54.)

Bruchus obosletus Say. Horn, Revision of the Bruchidæ of the United States, in Transactions of the American Entomological Society, Vol. IV, 1872-3, p. 337: " This is the most abundant species of Bruchus over the region east of the Rocky Mountains."

Bruchus obsoletus Say. Le Baron, in "Fourth Annual Report" as State Entomologist of Illinois, 1874, p. 129. Brief reference.

Bruchus obsoletus Say. Popenoe, in Transactions of the Kansas Academy of Science, Vol. V, 1877, p. 34, " Lawrence and Topeka."

Bruchus obsoletus Say. Thomas, in sixth report of the State Entomologist of Illinois. [1877 ?.] p. 128. Brief note on habits, with characters of the adult. He says: " This species has seldom been troublesome in this State, and does not appear to be generally distributed."

Bruchus fabæ Riley. Packard, in Ninth Annual Report of Hayden's U.S. Geological and Geographical Survey of the Territories, 1877, p. 767, describes the stages, and figures the larva; and as a preventive measure, recommends burning infested beans, and soaking the apparently uninjured seeds "for a minute in boiling-hot water," that no beetles may be overlooked.

Bruchus varicornis Lec. Packard, in Guide to the Study of Insects, 1878, pp. 484 and 711; plate XIV, figure 8, infested bean, and figure 8*a*, pupa; refers probably to B. obsoletus, of which, according to Horn, (1. c.) varicornis Lec. is a synonym.

Mylabris obsoletus Say. Zesch and Reinecke's list of the Coleoptera of the vicinity of Buffalo, N. Y.

Bruchus fabœ. "American Bean Weevil:" in Canadian Entomologist, 1880, p. 50. Brief reference, with copy of Riley's figure of the beetle. We find no reference to this species as indigenous to Canada, either in the Canadian Entomologist or in the Reports of the Entomological Society of Ontario.

Bruchus fabœ. Lazenby, in The First Annual Report of the Ohio Agricultural Experiment Station, 1883, p. 80. Brief reference.

PRACTICAL OBSERVATIONS.

During the summer of 1889 there were grown on the Station grounds a collection of varieties of the garden bean, numbering over ninety sorts, each occupying thirty feet of row. Most of the sorts devloped and matured seeds, but of some, these were so abundantly attacked by the weevil as practically to be destroyed. The exceptions to the general infestation occurred among the limas, the English beans, and the French asparagus bean, all of which belong to different species from the common bean, and are practically exempt from attack so far as we have observed. In a few cases weevils were found to have developed in the beans of the large white lima.

To those who are familiar with the work of the pea weevil only, the fact may be of interest that the bean weevil, unlike its relative, does not limit its attacks to a single one for each seed, but instead, places in each bean several eggs, so that the full-grown larvæ, hatching from these, are often literally crowded together in the bean, which is their common home and food. (See figure 4.) This crowding often results in the entire destruction of the seed except the outer skin, which remains unbroken, thus totally misleading the observer, who notes no external indication of the injury except a few very minute scattered white punctures where the insect first entered the bean. In the Dutch Case-Knife bean, the laræ were abundant, a single seed containing, by actual count in one instance, as many as twenty-eight, while in other varieties, as, for example, in the Large Yellow Six Weeks and in the Date Wax, the actual number per bean was only less because the beans were too small to contain so many.

The amount of destruction, as determined by a careful estimate based upon a count and examination of a few hundred beans for each variety, ranges from one per cent. to sixty per cent., the greater number of sorts showing a damage of from seven to fifteen per cent. A comparison of earlier and later-ripening seed does not establish a relative variation in the degree of damage, though there is apparent evidence in the case of some varieties that the seed earlier matured is the worst infested.

Where the early-matured product of several varieties of beans was prepared for exhibition at a fair, early in September, and the bottles, stopped with loose corks, were left uncared for until the date of this note,* there

*January, 1890.

seems to be evidence that the beetles continue to breed and develop in dry beans, as in numerous instances we find beans with larvæ of all sizes, pupæ, and adult weevils, as well as the empty cells whence adults have escaped earlier. This observation points to the desirability of the earlier treatment of seed beans for the destruction of the weevils, instead of waiting until planting-time in spring, as is often done.

Our studies of infested sorts to discover the reasons for the insect's preference, if any, for particular characters, resulted rather in showing the absence of any relation between the color, texture, or surface of the pod, or height of the plant, and the degree of infestation of the bean.

It is sometimes stated that the bean weevil rarely attacks the germ, and that for this reason the probability of germination is not much less for infested seed, the only danger being that the plantlet's food being partially eaten out, the growth of the seedling will be feeble. With the view of testing the truth of this belief, a large number of infested beans of different varieties were carefully examined, and the proportion of cases noted where the vital part of the seed had suffered material injury. This examination showed many cases where the plumule was entirely cut through, at different points, and again others where the radicle was partially or totally eaten up, and the cotyledons eaten from their attachments. In the greater number of such cases the injury was sufficient to preclude healthy germination. On the average in the different sorts examined, the germinating power was thus destroyed in 47 per cent. of the beans attacked by the weevil. These facts of course demand a different estimate of the value of weeviled beans for seed, even after the weevils have been killed by some of the suggested methods. It seems to us that in seasons when the weevil is abundant, it is better not to rely upon home-grown seed, but to purchase a fresh supply from a locality where this pest is not present. We have rarely found weeviled seed among the lots we have bought of reliable seedsmen in the East and North.

Our study of the methods of destruction of this insect has been limited to modes of killing them in the stored beans. We have at different times tried several of the modes suggested in the references above quoted, but for our purpose find most convenient and effectual the use of carbon bisulphide, a volatile liquid with a pungent odor, readily evaporating into a poisonous gas, which is by the way highly explosive when ignited. This gas, or vapor, quickly suffocates the weevils and their larvæ and pupæ when a portion of the liquid is poured into the vessel containing the beans. In order to prevent the too rapid escape of the gas, and to make sure of securing itsfull effect, the infested beans should be placed for treatment in a vessel that may be tightly closed. The use of this liquid is not dangerous when due care is taken to prevent the access of the gas to a light, or fire, nor does it in any way injure the beans for seed, if necessary to make such use of them. As the insect winters in the infested seed it is important to prevent the escape of the beetles, either in spring, or, if the beans are stored in a warm place, in the winter, in order that the number of parent weevils may be diminished. The better plan is to take means for killing the insects when the beans are first stored. If this precaution were taken by all growers in a neighborhood, the injury from this pest would be much less considerable.

DESCRIPTION OF THE INSECT.

The insect may be recognized by the characters here given in connection with the figures upon the accompanying plate.

Adult. General shape oval, narrowed before (fig. 1). Head hidden from above by the projecting prothorax. Color of body above black, or brownish black, obscured by short hairs of a yellowish or grayish brown, mostly uniform on the thorax, but mottled on the wing-covers with darker, in oblong spots, as in figure 1. Head hairy above; a slight ridge down the front; lower part of face, and mouth parts, brownish black. Antennæ (fig. 1a) eleven-jointed, with joints one to four and the terminal joint testaceous, or red; joints five to ten brownish black; all the joints covered with fine, short, gray hairs; seen from in front, the joints after the fourth are wider to the tip. Body below dark brown, or black, clothed with hairs like those on the upper side, the terminal segment of the abdomen entirely, and the other exposed segments more or less widely, testaceous, or red, especially in the upper and lateral surface. Legs testaceous, or red, except the under side of the thighs in the middle and hind legs, which is of the darker body-color; tips of feet dark brown. A prominent tooth followed by two minute ones, on the inner under side of the femur, near the tip (fig. 16). Length of large form, .12 to .14 inch; of small form, .10 inch.

Larva. In form thick, curved, with prominent transverse segments (fig. 2), the three anterior, or thoracic, more distinct; footless. Color waxy white, tips of mouth parts (fig. 2a) reddish brown. Length .12 to .15 inch.

Pupa (fig. 3) of corresponding size, thick, oblong, the abdomen swollen, especially when newly transformed. Color at first entirely waxy white; later, the tips of the mandibles become brown. The eyes are at first light brown, afterward dark brown, showing under the microscope as a crescent-shaped area of colored dots.

THE BEAN LEAF-BEETLE.

Cerotoma caminea Fabr.

Among the important enemies of the bean plant must be included the beetle above named, a species, that while sometimes very destructive, seems never to have been recognized by a common name. It maybe designated the bean leaf-beetle, in recognition of its most important habits. This beetle belongs to the great family of leaf-beetles, the *Chrysomelidæ*, and in this family to the same tribe *(Galerucini)* with such other important pests as the parent of the corn-root-worm *(Diabrotica longicornis),* the imported elm-leaf beetle *(Gal-*

eruca calmariensis), the striped and 12-spotted cucumber-beetles *(Diabrotica vittata* and *12-punctata).* Its resemblance to the last-named is such that superficial observation might confuse the two forms, yet a second glance shows distinctions that may be easily recognized. Our figure (Plate IX, figure 13,) shows the more important structural features, and indicates the pattern of coloration, the shaded parts being nearly black, and the lighter parts of the figure a clay yellow, or testaceous. Individuals vary in the width of the black markings, specimens being sometimes found in which the black, or dark brown, is the prevailing color, while others are even lighter than the individual figured.

The bean leaf-beetle occurs from April to July on the leaves of the bean, affecting principally the low-growing or bush varieties, on the leaves of which it works. The injury consists in the destruction of the leaf tissues, the beetle usually eating the parenchyma away in large irregular holes, but sometimes stripping the leaves to their veins and midrib. When alarmed by the approach of the observer, or by the shaking of the vine, this insect follows the habit of its relatives, dropping to the ground, and if not further disturbed, soon reascending the plant, or flying away.

Our first recognition of the injurious habits of this insect was in 1875,* when it was found in Shawnee county, this State, in great numbers, eating the leaves of dwarf garden beans to such an extent as to destroy the plants. We have since noticed it, in certain seasons, in greater or less abundance, and in different localities. A few specimens occur, to the collector, on prairie herbage, but the exact plant which it affects in such situations we have not yet detected.

References to this beetle in the literature of economic entomology are not numerous, and we have found but a single recorded observation upon its injurious habits. In the report of the Entomologist of the U. S. Department of Agriculture for 1887, page 152, is a note by F. M. Webster, upon the occurrence of the species in great numbers in Louisiana, attacking the garden bean and the cow-pea in the manner we have described above. This observer reports it also from Gibson county, Indiana, from Illinois, from Minnesota, and from New York. The species is also included in Zesch and Reinecke's List of the Coleoptera of the vicinity of Buffalo, New York, and in Schmelter's List of the *Chrysomelidæ* of the neighborhood of New York City. (Bulletin Brooklyn Entomological Society, I, page 55.)

DESCRIPTION OF THE BEETLE.

Length, .17 inch. Colors, black and pale yellow, or testaceous. The head, antennal joints 5-11, the anterior coxae, the tibiæ and the apical portion of the femora on the middle and posterior legs, the underside of the thorax excepting the prothoracic segment, the abdomen, the scutel, and on each of the wing-covers a broad, irregular, submarginal vitta uniting across the base with a triangular scutellar spot common to the two wing-covers,

ee a brief reference in the Transactions of the Kansas Academy of Science for 1876, page 35.

two broad discal spots, and a smaller subapical spot, black; other parts testaceous. The distal blotches on the elytra often blend, forming two broad vittæ that extend along the suture. The upper surface of the head and the prothorax are finely rugous transversely, and the elytra are coarsely punctured in irregular striæ.

REMEDY.

While the beetles are readily destroyed by the arsenites, Paris green, or London purple, the use of these dangerous poisons for such purpose on garden beans, after the pods are set, is of course inadmissible. Fresh pyrethrum powder puffed over the plants is in ordinary weather a measurable check to the work of the insects.

TWO BEAN PLANT-BUGS.

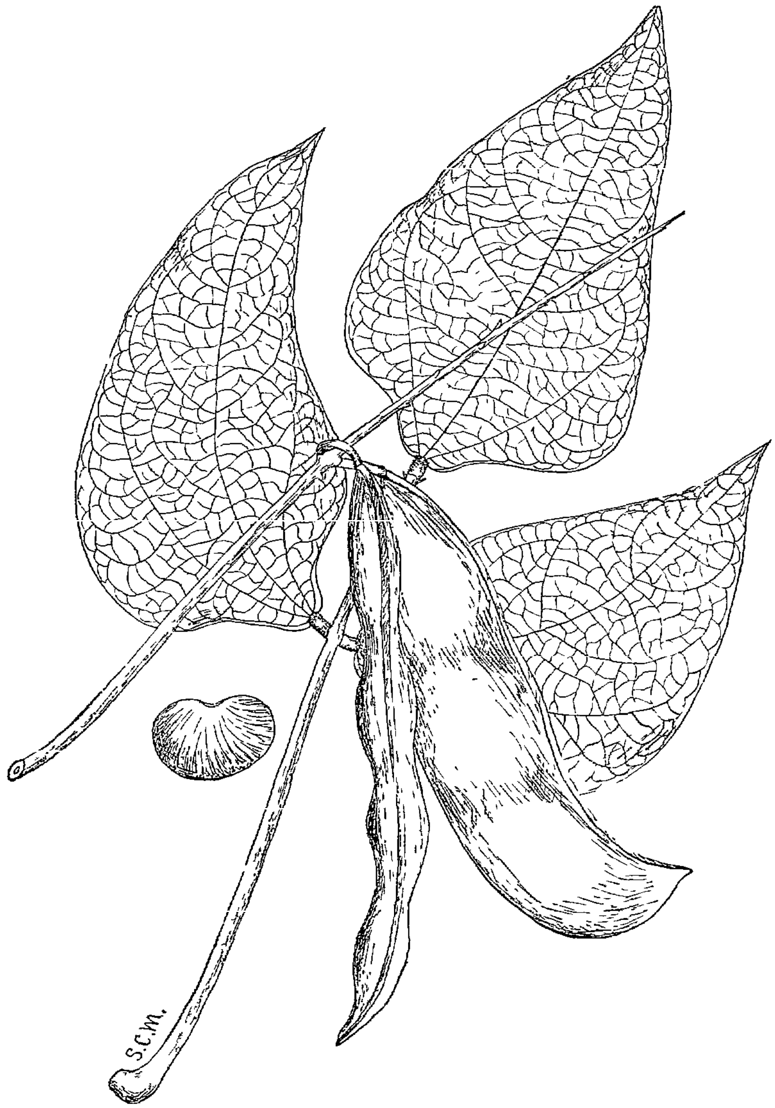
We have the past season observed two species of *Capsidæ*, or plant-bugs, living in great numbers on the underside of the leaves of the garden bean, puncturing the tissues and sucking the sap, and by these punctures causing the death of the tissues in small, irregular patches that appear upon the upper surface of the leaf as white spots. These two species are so nearly alike, so far as habits are concerned, that they may be noticed together. They operate mostly near the ground, and upon weak, low-growing sorts they sometimes do appreciable injury to the plant. The insects of both species are able to jump many times their own length, and when disturbed they hop from the leaves like flea-beetles. They have also been observed to feed upon red clover in the manner and with the effect described above.

The species figured on the left side of the plate (figures 5–9) is known to entomologists as *Agalliastes bractatus* Say;* and in figure 5 is represented full length from above, greatly enlarged, the actual size being indicated by the hairline at the right. In figure 6 are shown important structural characters; in figure 7, the head and beak from the front; while figures 8 and 9 show the upper and under wing respectively. The colors of the insect are shining black, with dull white markings as follows: the knees, the tibiæ and the feet, excepting the claim; the basal joint of the antennæ, a broad ring around the middle of the second joint, and the third and fourth joints entirely. The membranous tips of the upper wings are transparent smoky.

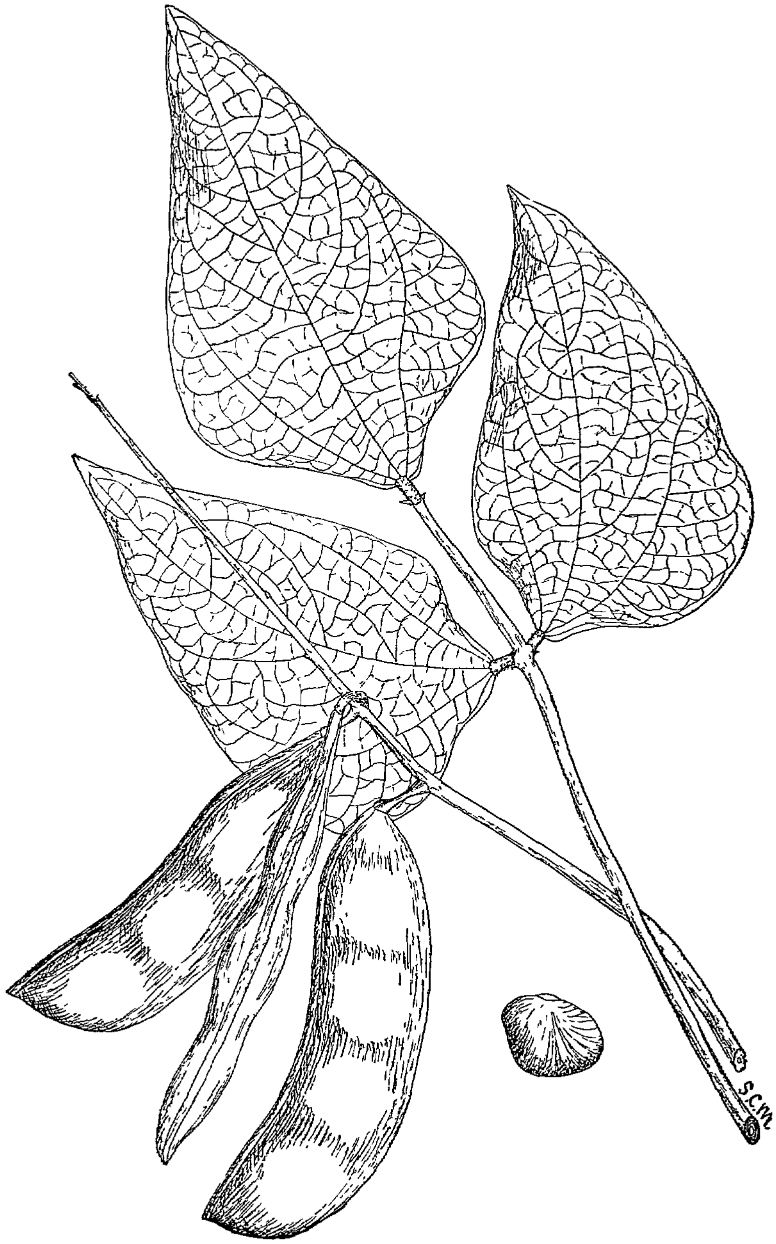
The species at the right (figures 10–12) is the *Halticus minutus* Uhler ms.,* and is shown full length, greatly enlarged, at figure 10, the actual size indicated by the hairline at the right. Figure 11 gives important structural details, and figure 12 shows the head and beak from the front. The insects of this species are unable to fly, the under wings being entirely wanting. In color it is quite closely like the preceding, except that the transparent smoky area formed by the tips of the wings is lacking, as appears in figure 10. In each of the species, short white hairs in small groups show under a good lens as white dots upon the upper surface.

Our studies of these insects have not yet reached practical conclusions. These we hope to reach the coming season.

* For the specific determinations, we are indebted to the kindness of Professor P. R. Uhler.

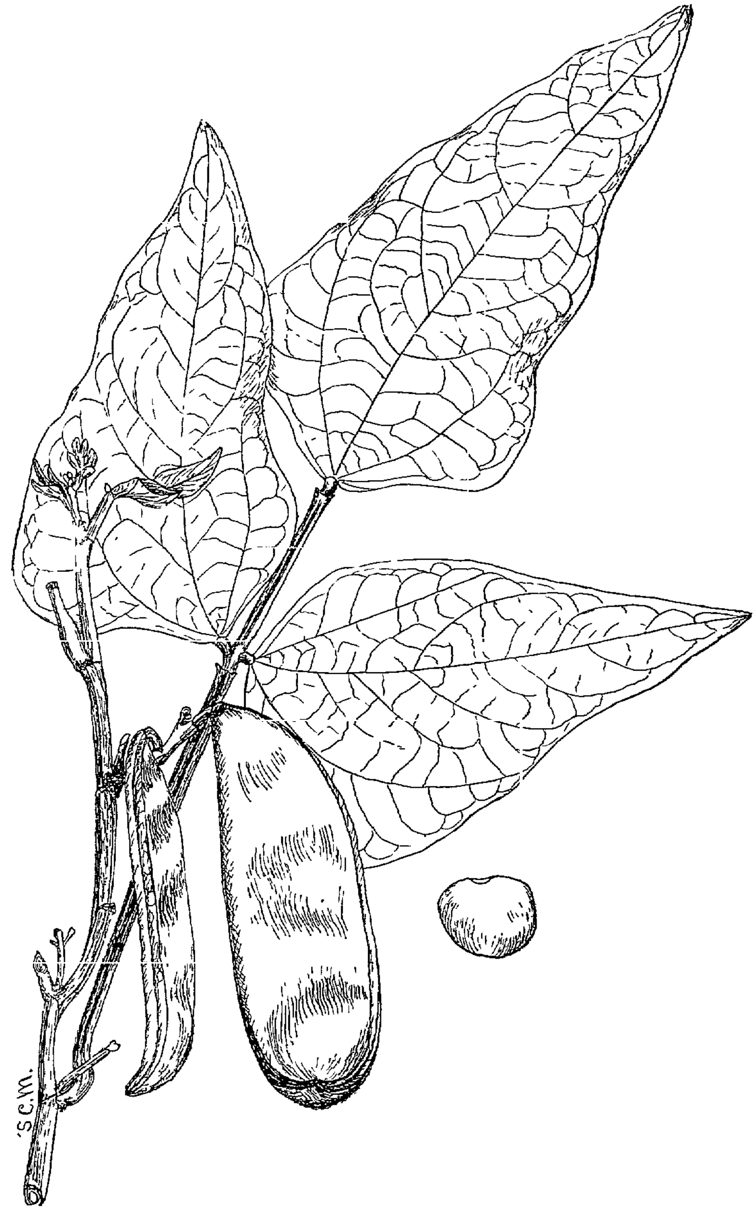


LARGE WHITE LIMA. (Two-fifths natural size.)

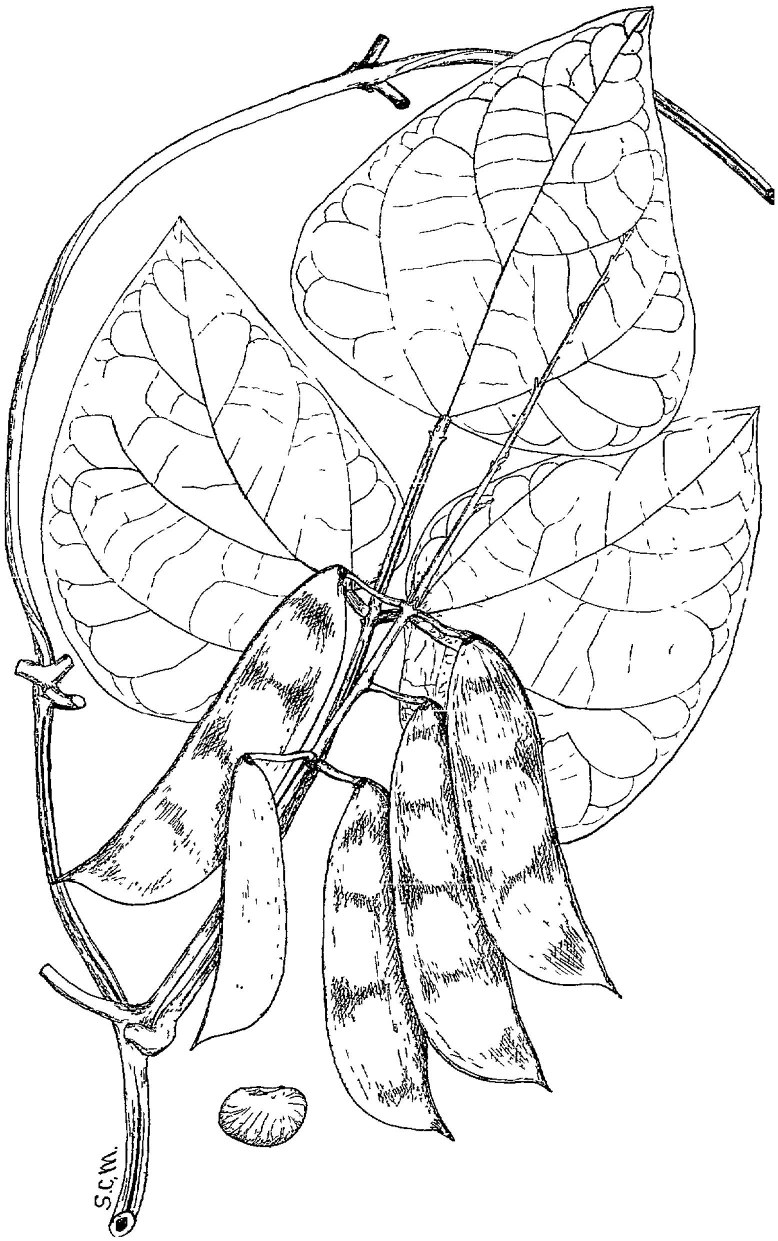


DREER'S IMPROVED LIMA. (Two-thirds natural size.)

PLATE III.

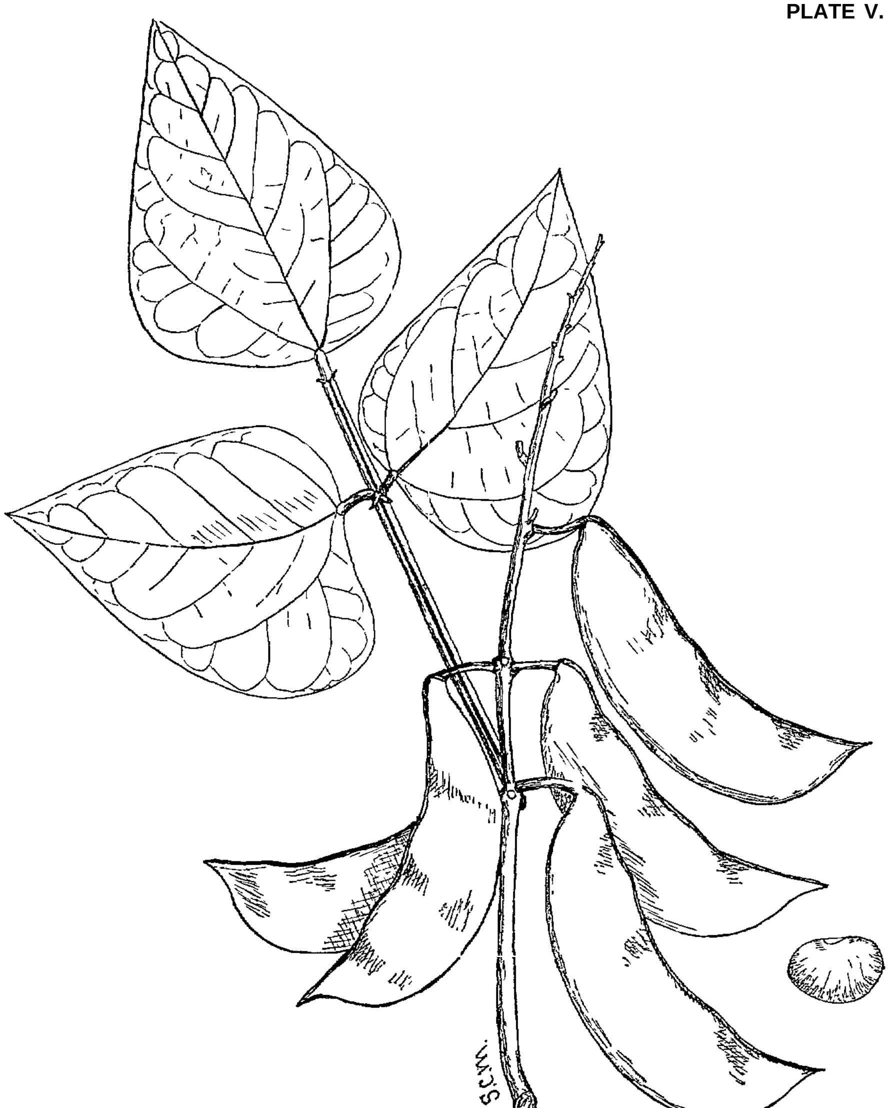


KUMERLE'S DWARF LIMA. (Two-thirds natural size.)

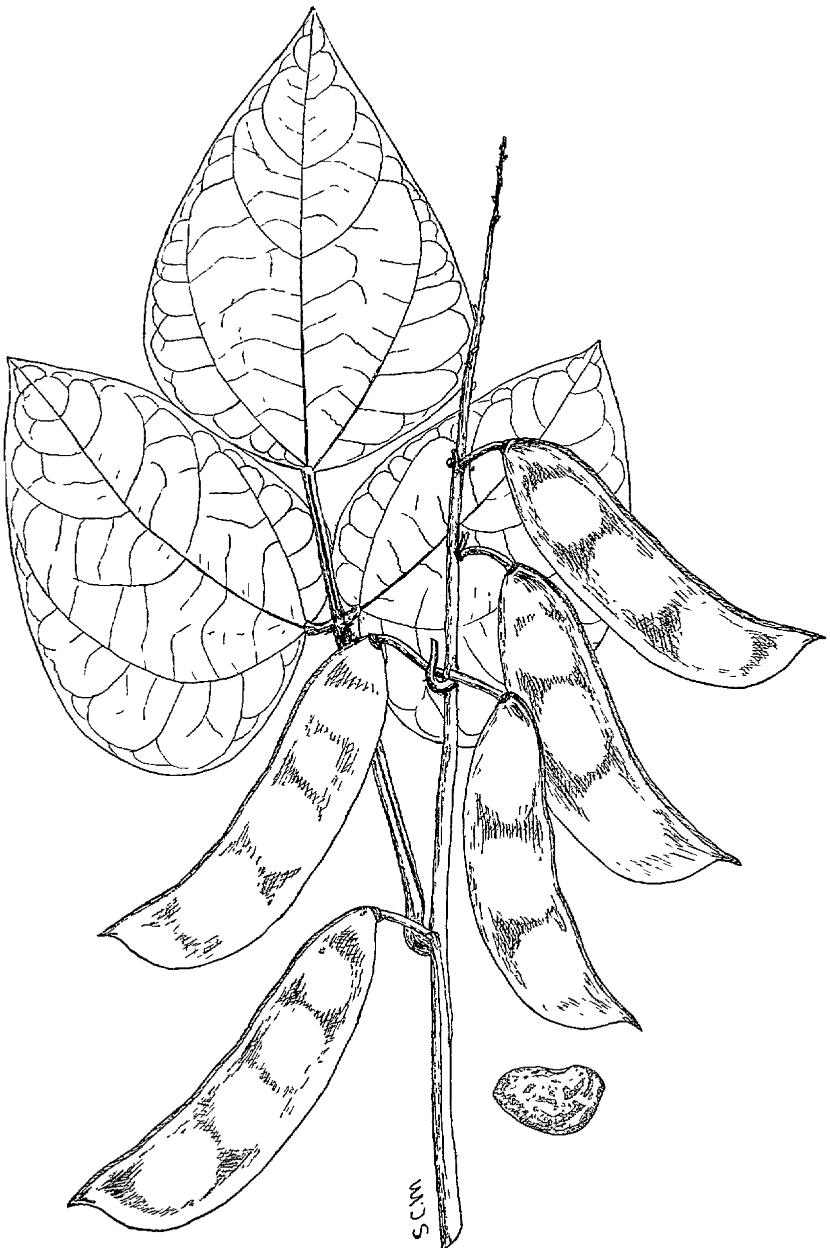


SMALL LIMA, OR CAROLINA. (Two-thirds natural size.)

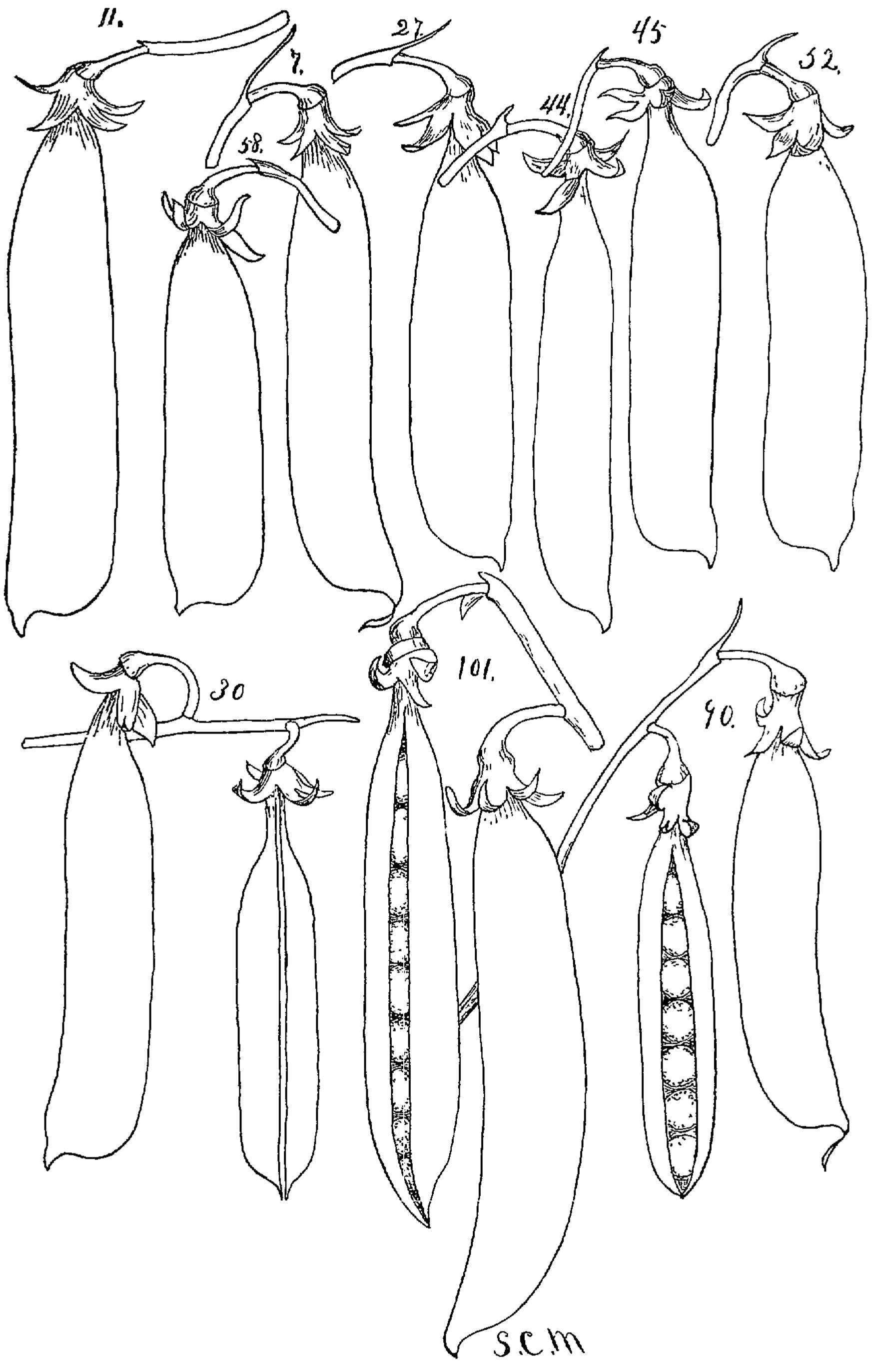
PLATE V.



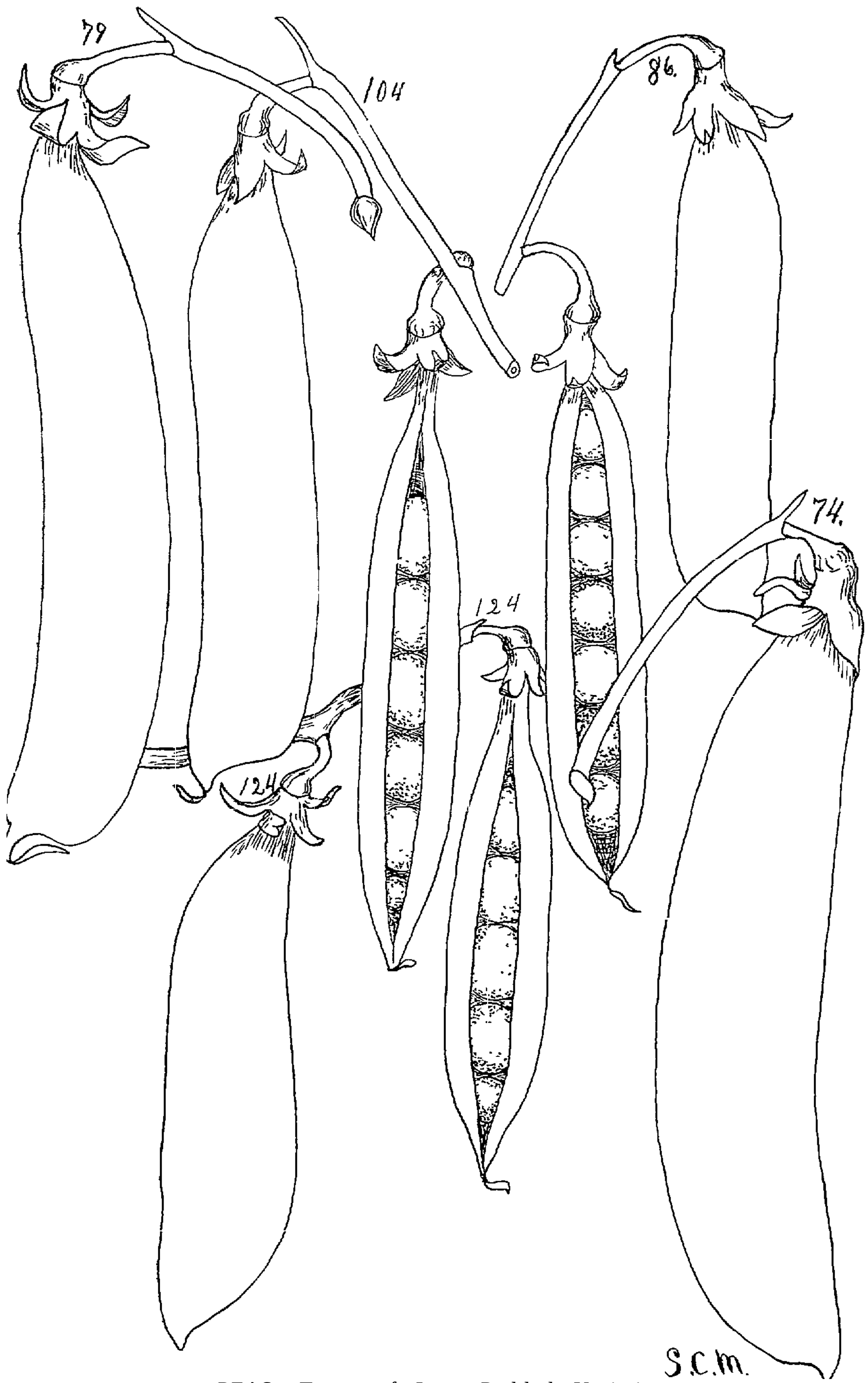
HENDERSON'S BUSH LIMA. (Two-thirds natural size.)



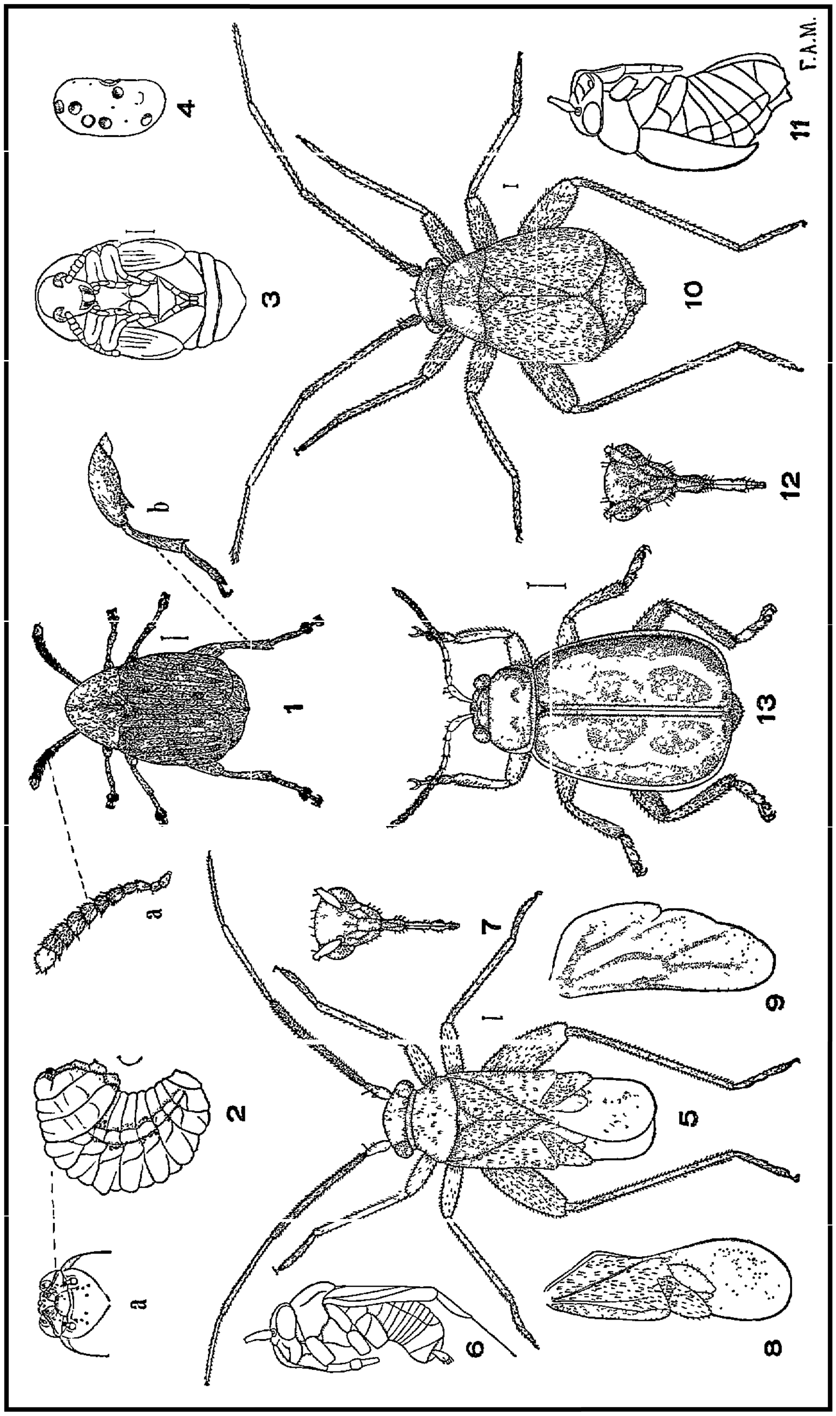
DWARF CAROLINA. (Two-thirds natural size.)



PEAS: Types of Yellow Smooth-Seeded Varieties
The numbers refer to the list as printed in the table of peas.



PEAS: Types of Large-Podded Varieties.
The numbers refer to the list as printed in the table.



INSECTS INJURING THE GARDEN BEAN.

REPORT OF THE BOTANICAL DEPARTMENT.

W. A. KELLERMAN, PH.D., *Botanist.*
W. T. SWINGLE, *Assistant Botanist.*

REPORT ON THE LOOSE SMUTS OF CEREALS.

The loose smuts are four closely allied species found on oats, wheat, and barley. Wheat is sometimes attacked by other smuts, which are, however, quite different. All the loose smuts are, as their name indicates, of a powdery nature. All attack the heads or panicles of the cereal, and usually destroy them more or less completely. They are not confined to the grain, as is the case with the stinking smut of wheat. The black powdery mass consists of the reproductive bodies called *spores,* which correspond in function to the seeds of the common plants. The vegetative portion of the parasitic fungus is wholly concealed within the tissue of the plant that is attacked. It does not cause immediate death, nor marked abnormal growth. Its presence is not easily recognized till it begins the production of its spores, forming the conspicuous black mass where the grains should have been formed.

Although the loose smut of oats is the most important, and is the only one that has been experimented with, an account will be given of the loose smuts of wheat and barley also. All of the four species described are so nearly alike, that until a few years ago they were considered but one species, to which the name *Ustilago segetum* (Bull.) Ditt., or *U. Carbo* (DC.) Tul., was applied. It has recently been shown by Jensen that the smut of oats, wheat and barley were unable to infect any of the cereals except that on which they grew. We have found a considerable difference in the manner of germination in these species, making it doubly certain that these forms are really distinct species. The importance of this fact is obvious: farmers need not fear that their oats will become infected from neighboring wheat or barley fields, and *vice versa*.

The life-history of these smuts is, as far as known, as follows: The loose spores are blown about by the wind, (or during the threshing,) and attach themselves to the grains. In the case of oats and barley, only those spores which are inside the husks are able to infect the plants to any appreciable extent. The smut being ripe during the flowering-time, the spores blown about by the wind fall upon the young grains, and are inclosed with it by the husks.

When the seed is planted, in spring, the spores of the smut germinate and send out minute germ threads, which enter the young plant only through the first delicate leaf sheath. Only for a few days is the smut able to enter this leaf, and after the second leaf breaks through this sheath the plants are free from further infection. Assuming that the minute germ threads of the smut did enter the sheathing leaf at the proper time, the fungus develops as follows: The minute thread entering the sheathing leaf penetrates to all the parts of the stem and branches; its growth keeps pace with that of the host plant, till, at length, just before the time of flowering, the fungus forms a mass of thick threads in the young forming head, and inside of these threads the spores are produced. As the spores grow, the threads become gelatinous, and finally, when the spores are ripe, they disappear entirely, leaving a loose mass of spores.

This is essentially the course of development in all the species, though the manner of infection may vary somewhat from that here described, especially in case of the loose smuts of wheat and barley.

The following key shows in brief the characters of the different loose smuts:

1. Spores smooth, 2.
1. Spores minutely spiny, or warty, 3.
    2. Spores dark brownish in mass, contents often granular. *Ustilago Avenæ* var. *levis,* (I.)
    2. Spores black in mass, contents not granular. *Ustilago Hordei,* (III.)
3. Producing sporidia readily. *Ustilago Avenæ,* (I.)
3. Not producing sporidia readily, if at all, 4.
    4. Promycelia long, very much branched in nutrient solution; ends, however, not swollen. *Ustilago Tritici,* (II.)
    4. Promycelia shorter, sparingly branched or simple, ends of branches very often becoming swollen. *Ustilago nuda,* (IV.)

I. *Ustilago Avenæ.* Oat smut.

Spores in mass, dark dusky-brownish, variable in size, oval subglobose or elliptical in shape; epispore minutely spiny Promycelium producing in nutrient solution many sporules, little branched, but growing out readily as the cultures become exhausted, into very long germ threads; producing in water sporules and a few germ threads; spores forming a very loose mass. *Ustilago Avenæ,* var. *levis,* as above, but spores slightly darker in mass, and furnished with a smooth epispore.

II. *Ustilago Tritici.* Loose smut of wheat.

Spores in mass, dark brownish with a shade of olivaceous, rather constant in size, oval, or less often subglobose or elliptical in shape; epispore marked with minute spines or warts. Promycelia in nutrient solution much branched, and branches often many segmented, not producing sporules (?); in water producing no sporules or germ threads. Spores forming a very loose mass.

III. *Ustilago Hordei.* Covered smut of barley.
Spores in mass perfectly black, constant in size, globose or subglobose; epispore perfectly smooth. Promycelia in nutrient solution little or much branched, producing countless sporules, but not commonly germ threads; producing in water sporules but very few germ threads. Spores in mass somewhat firm.

IV. *Ustilago nuda.* Naked smut of barley.
Spores in mass dark brownish, with an olivaceous shade, rather constant, oval or less often elliptical or subglobose. Promycelia in nutrient solution not very much branched, never producing sporules, branches often swollen at tips; in water producing no sporidia, but many germ threads.

In the following pages each of these smuts is separately described; and at the end of the report is a short account of the stinking smut of wheat, and of the natural enemies of the smuts. Eight plates illustrate the smuts, and one their natural enemies. Unfortunately the plates are much too small to show all the forms obtained by germination of the spores. They must therefore be considered as showing only some of the many forms actually seen and described.

OAT SMUT, Ustilago Avence (Persoon) Jensen.

HISTORICAL.

The early authors —Pliny, Theophrastus, and others, probably knew of the oat smut, but in their writing all smuts are confused with the stinking smut of wheat, which they certainly knew. We find no further mention of oat smut till 1552, when Tragus mentioned it under the name *Ustilago,*[1] and gave a figure of it. Lobelius, in 1591, mentioned it, and gave a figure of it, under the name *Ustilago Avenæ*.[2] C. Bauhin, in 1596;[3] described it under the name *Ustilago avenaria.* Tabernæmontanus, early in the seventeenth century, mentioned it.[4] Probably all of these authors considered the smut, not as a plant, or parasite, but as a diseased condition of the host. Even Linnæus, in 1767, held the smut for infusoria,[5] under the names *Chaos Us*-tilago; and *Reticularia Ustilago*[7]*;* others, as Aymen and Girod-Chantrans, considered them small animals. Linnæus finally recognized them as plants, as did Oeder, in Flora Danica, and Bulliard, who, in 1791, described the smuts of all cereals under the general name *Reticularia segetum*[8].

1 Tragus. De stirpium Nomencl. prop. lib. III, p.666, with figure. See. F. v. Waldheim.
2 Lobelius. Icones stirpium s. plantarum tam exoticum quam indigenarum. Antverpiæ, 1591, p. 36, with figure.
C. Bauhin. Phytopinax seu enumeratio plantarum ab herbariis nostro saeculo descriptarum. Basileae, 1596, p. 52.
4 Fide Wallroth. Flora cryptogamica Germ., p. 217, No. 1672g.
5 Linné. Syst. nat. ed. XIII, Vindob,, 1767, I, p. 1327, fide De Bary.
6 Linné. Syst. nat. ed. XII, Holm, 1767., p. 1356.
7 Linné. Syst. nat. II, p. 1472, fide Streinz; ed. XIII, 1796,II, p. 1472, sec. F. v. Waldheim.
Bulliard. Histoire des champignons de la France I, p. 90, tab. 472, fig. 2.

Bonner, in 1750, Duhamel, in 1752, Tillet, in 1755, Aymen, in 1760, and Tessier, in 1783, noticed the loose smuts of cereals. Tessier speaks of the smut of oats separately.[1] Bulliard is the first botanist who gave it a distinctive name as a fungus, but his name cannot now be used, since he characterized all loose smut equally by it, and recognized no varieties. Persoon, in 1801, recognizes the smuts as fungi, and while adopting Bulliard's name for the species — *Uredo segetum* — he makes varieties on barley, wheat, and oats. The variety on oats is called *g Uredo Avence.*[2] This being the earliest scientific name used to designate the oat smut, it is here used. In 1813, Ditmar placed the loose smut of oats in the genus Ustilago, calling it *Ustilago segetum.*[3] De Candolle, in 1815, gives the same varieties as Persoon, but calls the species (to include all the loose smuts) *Uredo Carbo.* He then carefully distinguished the loose smuts from the stinking smut of wheat. *(Tilletia.)* Wallroth, in 1833,[4] still retaining the same varieties, called the species, including them, *Erysibe vera.* Phillippar called the form on oats *Uredo Carbo-Avence*[5] Tulasne, in 1847, recognized essentially the same varieties under var. *vulgaris* of *Ustilago Carbo.* The form on oats he called b *Avenacea*[6]

Recent writers have called the loose smuts of wheat, oats, barley and wild grasses indiscriminately *Ustilago segetum* (Bull.) Dittm., or Ustilago *Carbo* (DC.) Tul.; as such authors, Kühn, Fischer von Waldheim, Hoffman, Winter, Wolff Schroeter, Saccardo and others might be named. The only difference recognized by any of the writers is in the relative abundance on the different hosts. Jensen, in 1888, named the oat smut *Ustilago segetum,* var. *avenæ,*[7] and separated from it the form on wheat, var. *tritici,* and two forms on barley, var. *nuda* and var. *tecta.* In July, 1889, he recognized the form on oats as a species, "*Ustilago avence (Jensen).*"[8] The name *Avenæ, of* Persoon, was the earliest, and Jensen first put the species in the genus Ustilago; therefore the name and synonymy are as follows:

USTILAGO AVENUE (Persoon) Jensen.

1591 *Ustilago Avenæ* Lobelius, Icon. stirp., p. 36.
1596 *Ustilago Avenaria* Bauhin, Phytopinax, p. 52.
1767 *Chaos Ustilago* Linné, Syst. nat., ed. XII, II, p. 1356. p. p.[9]
1791 *Reticularia Ustilago* Linné, Syst. nat., ed. XIII, II, p.1472. p. p.
1791 *Reticularia segetum* Bulliard, Hist. des champ., I, p. 90, tab. 474. Poiret, in Encyc. méth. de bot., VI, p. 181. Withering, Bot. Arr. IV., p. 356.

[1] Tessier. Traité sur les malades des grains, Paris, 1782, pp. 310-336, with plate. Sec. F. v. W. & De Bary.
[2] Persoon. Synopsis methodica fungorum, pars prima. Gottingae, 1801, p. 224, " Effusa fluctans."
[3] Dittmar, in Sturm Deutschlands Flora III Band, 3 Heft, S. 36, t. 33.
[4] Wallroth. Flora cryptogamica Germaniae pars posterier (Comp. F1. Germ., sectio II, tomus IV). Norimbergae, 1833, p. 217, No 1672.
[5] Phillippar. Traité organogr. et phys. — agr. sur la Carie, le Charbon, Versailles, 1837, p. 92, pl. II.
[6] R. et Ch Tulasne. Memoir sur les Ustileginées comparées aux Uredinées, in Ann. Sci. Nat., 3e série, t. VII, 1847, p. 80.
[7] J. L. Jensen. The Propagation and Prevention of Smut in Oats and Barley. In Journal of the Royal Agricultural Society of England, XXIV, s, s,, part II, p. 11.
[8] J. L. Jensen. Le Charbon des Ceréales, Copenhague, July, 1889, p. 4.
[9] p. p. = in part.

Johnston, Flora of Berwick-on-Tweed, II., p.203. Greville, Fl. Edin., p.442. p.p.

1797 *Uredo segetum* Persoon, Disp. meth. fung., p.56; Synop. meth. fung., p.224. p. p.

1801 *Uredo (Ustilago) segetum g Uredo Avenæ* Persoon, Syn. meth. fung., p. 224.

1809 *Cæoma segetum* Link, obs., I, p.4; Sp. pl. Wild., T. VI, P. II, p.1. p.p.

1813 *Ustilago segetum* [Bulliard] Dittmar, in Sturm Deutschl. Fl., III, 3, S. 67, T. 33. Fries, S. M., III, p. 518. Berkeley, in Smith's English Flora, V, pt. II, 1847, p. 374; Outl. Br. Fung., p. 335. Cooke, Micro. F. 4th ed., p. 229. Loudon, Encyclopedia of Plants, London, 1872, pp. 1044, 1045, No. 16657. P. A. Karsten, Mycologia Fennica, pars IV, in Bid rag till kännedom af Finlands natur och folk, Trettiondeforsta Häflet, p. 6, No. 1. Winter, Die Pilze, I, p. 90, Nr. 103. Oertel, Beitr. zur Fl. d. Rost. u. Brandp. Thüringens, in Deutsche Bet. Monatsschr., IV, Nr. 3, März, 1886, S. 40, No. 141. Schroeter, Die Pilze Schlesiens, I. S. 267, Nr. 418. Plowright, Br. Ured. and Ust., p. 274. De Toni, in Sacc. Syll., VII, II, p. 461, No, 1676. p. p.

1815 *Uredo Carbo g Avenæ* DeCandolle, Fl. fr., VI, p. 76.

1833 *Erysibe vera g Avenæ* Wallroth, Flora. crypt. Germ., p. 217, No. 1672.

1837 *Uredo Carbo Avenæ* Phillippar, Traité sur la carie et la charbon, p. 92, pl. 2.

1847 *Ustilago Carbo a vulgaris b Avenacea* Tulasne, Mém. sur les. Ust. comp. aux Ured., p. 80.

1871 *Ustilago Carbo* Tulasne, Cooke, Handb. Br. Fungi, II, p. 512, No. 1520. Hazslinszky, Magyarhon üszökgombái és ragyái, in Magy. tud. akad. math. és termész. közlemények, XIV, köt. 1876–7, 1.110. Fischer von Waldheim, Apergu system. des Ustilaginées, p. 12, No. 6; Gholovnevuiya monoghraficheskei ocherk, chast II, str. 13. p. p.

1888 *Ustilago segetum* var. *Avenæ* Jensen, Om Kornsorternes Brand (Anden Meddelelse) S. 61.

1888 *Ustilago segetum* var. *avenæ* Jensen, Prop. and Prev. of Sm. in Oats and Barley, in J. R. A. S. XXIV s. s. P. II, p. 4.

1889 *Ustilago avenæ* Jensen, Le charbon des Céréales, p. 4.

INJURIES TO THE HOST PLANT.

The oat smut resembles the loose smut of wheat and naked barley smut, in converting more or less of the head into a loose, powdery mass of spores, which are readily blown about by the wind. The smut often almost completely destroys the normal tissue of the spikelets, leaving only a black mass of spores penetrated by shreds and plates of tissue. Sometimes this tissue is so abundant as to cause the interior to have a somewhat netted appearance. More often, however, the glumes retain more or less of their normal structure, especially at the tips. At the base they are usually almost destroyed by the smut, while toward the tip the smut may break through the epidermis in isolated pustules. The smutted spikelets are at first covered with a very thin membrane, which, however, soon disappears. It has less of such a membrane than any of the loose smuts of cereals, except perhaps *Ustilago Tritici.*

In a few cases smutted heads have been collected where the smut had destroyed the grain and flowering glumes, while the large outer husks were yet entirely sound. Such a head would scarcely be seen to be smutted unless carefully examined. In plate I, fig. 3, is shown a small head with the spikelets almost completely converted into smut. Figure 2 shows a large head with the tips of the spikelets less smutted. In fig. 1 the tips of the spikelets are more or less attacked, while the top of the head is sound and produces healthy grains. The smutted heads gradually lose their smut under the influence of wind, rain and insects, and sometimes even the shreds of dead tissue fall off, leaving simply a barren stalk with no sign of grain or smut. When the glumes are not very much smutted they do not thus fall away, though they may be completely emptied of smut. The diseased plants usually appear just like healthy ones till about the time of flowering; then the smut shows itself and rapidly ripens, becomes dry and dusty long before the oats ripen. However, when a smutted hill stands somewhat alone, it is seen to have rather stouter stalks *(i. e.*, greater in diameter) than healthy stalks. Usually smutted heads grow up free from the upper leaf like healthy ones, but the smutted heads produced later than normal, and those on plants standing alone often remain partially inclosed by the sheath of the upper leaf. When this is the case the smut is almost certain to be attacked by the smut-eating beetles. Except when diseased, the smut spores always readily escape.

Such heads are not common. Almost all the heads are entirely smutted — that is, all the spikelets are attacked. Usually, also, all of the plants in a hill are attacked. This shows that the infection proceeds from the seed. The same is still further shown by the fact that although the tip of a smutted head is sometimes sound, the base is never so — proving that the infection proceeds from below upward.

The table on page 219 shows the very small per cent. of sound plants appearing in twenty-eight smutted hills growing in the field when count 13 was made (see p. 224).

No. of stalks in bill.	No. smutted.	No. healthy.
1	1	..
1	1	..
1	1	..
1	1	..
1	1	..
1	1	..
1	1	..
2	2	..
2	2	..
2	2	..
2	2	..
2	2	..
3	3	..
3	3	..
3	3	..
3	3	..
3	3	..
3	3	..
3	3	..
4	3	1
4	4	..
4	4	..
4	4	..
4	4	..
4	4	..
4	4	..
5	5	..
5	5	..
76	75	1

DIFFERENT VARIETIES ATTACKED

Usually, when grown side by side, seed of different varieties shows a different amount of smut. J. C. Arthur, in 1884,[1] gave the results of counts of oats grown on the farm of the New York Agricultural Experiment Station, at Geneva, N. Y., and found American Triumph, of 1,237 heads counted, had 10 per cent. smutted; Board of Trade, of 2,352 heads counted, had 8.5 per cent. smutted; New Australia, of 7,623 heads counted, had 9.86 per cent. smutted. Dr. Sturtevant, in 1885: says: " *Smut* was also quite prevalent, although some varieties were not affected though growing side by side with varieties badly infected The black oats were absolutely free from smut, while growing beside them on one side was the American Triumph, of which plants 10 per cent. were smutty, while on the other side grew the Board of Trade, even smuttier than the American Triumph. The two varieties most affected by smut were White Australian and Board of Trade, the former containing nearly twice as many smutty heads as any other, with the exception of Board of Trade. Those not at all affected were: Black Champion,

[1]Third Ann. Rep. N. Y. Ag. Exp. Sta. for 1884. Albany, 1885, p. 382.
[2]Bull. N. Y. Ag. Exp. Sta., quoted from Bessey, Bull. from the Iowa Ag. Coll. Dept. of Botany, 1884, p. 126.

Black Tartarian, Pringle's Excelsior Hulless, Pringle's Hybridized Hulless, Mammoth Russian, Mold's Ennobled, and Race Horse."

Arthur says[1] " the thirty varieties of oats grown in the experimental plats were very unevenly affected by smut, some having almost none, the reason for which was not apparent."

C. S. Plumb, in 1885: in an experiment to determine what influence the character of the seed had upon the progeny," planted five rows of White Australian and five of Race Horse. "The first-mentioned variety, in our 1884 test smutted very badly, while the Race Horse did not smut at all." They were synonyms, but seed was obtained from different sources. Of the 3,225 heads of White Australian produced, 294, or 9.11 per cent., were smutty. Of the 3,152 heads of Race Horse produced, 58, or 1.20 per cent., were smutty.

J. L. Jensen, in 1887, reports the following result to show the proportion of smut in twenty-three varieties of oats during three consecutive years, on the experimental farm of the Royal Agricultural School, near Copenhagen, Denmark:

SMUT IN TWENTY-THREE VARIETIES OF OATS, 1885-1887, COPENHAGEN, DENMARK,[3]

No.	NAMES OF VARIETIES.	PER CENT. OF SMUTTED HEADS.		
		1885.	1886.	1887.
1	Canada	28	30	22+
2	Berlie	1	6	9
3	White Steir Mark	1	7	12
4	Potato Oats	1	3	22
5	Oats from Scone	0	2	6
6	Swedish Cub	1	7	7
7	Forslev Oats	0	7	13
8	*Avena strigosa*	0	0	0
9	Early from Belgium	1	8	14
10	Fionie	0	6	19
11	White Three-Grained	0	0.2	4
12	Great White Tartarian	10	10	37
13	Black Steier Mark	0	9	9
14	Black Swedish	4	5	10
15	Black Tartarian	10	15	20
16	Oats from Grenaa	1	5	14
17	Early Angus	8	7	28
18	Late Angus	2	3	6
19	New Zealand	22	17	21
20	China	5	6	3
21	Blainsly	25	45	75
22	Provsti	1	3	8
23	Experimental Farm	0	4	10
	Average of 22 true oats (excluding No. 8)	5.5	9.32	16.77

[1] Arthur, I.e., p 383.
[2] Fourth Ann. Rep. N. Y. Ag. Exp. Sta, for 1885. Albany, 1886, P.128.
[3] Nye Undersögelser og Forsög over Kornsorternes Brand (Förste Meddelelse). Saertryk af Markfrökontorets Aarsberetning for 1887. S. 10; Propagation and Prevention of Smut in Oats and Barley, p. 6.

E. Bartholomew, of Rooks county, Kansas, says[1]: "The Earlier and colored varieties seemed to suffer more than the white varieties. The common white oats, and the Welcome oats (also white), seemed to suffer very little from this disease, while the Red Texas and black winter oats were affected to quite an extent."

From the experiments of Plumb and Jensen, it would seem almost conclusive that the freedom from smut of any variety is due much to the source of the seed, and that if varieties free from smut are planted adjacent to affected varieties, they will gradually become infected.

AMOUNT OF DAMAGE.

The percentage of the oat heads destroyed by the smut is, in most cases, much larger than is generally supposed, even by observant farmers. Sometimes, however, when the field is very much smutted, the large amount seen perhaps leads to an over-estimate of the amount of damage done. Yet, in fact, the amount of damage has not been realized until very recently, when careful counts have been made. As noted, J. C. Arthur in 1884 found, at Geneva, N. Y., the American Triumph 10 per cent., Board of Trade 8.5 per cent., and New Australia 9.86 per cent. smutted. He says[2]: "The appearances of smut as one passed through the field was no greater than is usually to be seen in any part of the country — at least, east of the Western plains, and the result of the count, showing a total loss of nine and one-half per cent. of smutted grain, is as much a surprise to the writer as it will doubtless be to others. The lighter oats smutted the worse. The smut appears also to bear a direct ratio to the dryness of the soil."

C. S. Plumb in 1886[3] reports the following experiment (in fuller form) with White Russian oats, grown in Geneva, N. Y.:

	Total panicles.	Smutted panicles.	Per cent. of smut.
Plat I: On dry knoll, plants of average height	2905	175	5.98
" II: Situation fairly moist and level, plants taller than the average	3108	299	7.82
" III: Situation fairly moist and level, plants of average height	2635	207	7.71
" IV: Situation in dry, hard part of field, plants smaller and shorter than the average	2253	234	10.28
Total	10901	915	8.4

Plumb says of it: "This field would have appeared very free from smut to au ordinary observer, yet the figures indicate considerable loss. Dryness of soil seems to have no special bearing in the matter of percentage of smut as both the smallest and greatest amounts occurred in parts of the field more elevated and drier than the others."

[1] In letter, July 23, 1889.
[2] Third Ann. Rep. N. Y. Ag. Exp. Sta., p. 382.
[3] C. S. Plumb. Smut in Oats in Fifth Ann. Rep. N. Y. Ag. Exp. Sta. for 1886. Elmira, N. Y., 1887, p., 125, el seg.

Another experiment is reported[1] with very smutty oats from Seneca, N. Y. The variety was American Triumph:

	Total panicles.	Smutted panicles.	Per cent. of smut.
Plat A: Retentive clay loam, plants medium height......	3186	907	28.47
" B: Soil hard, clayey loam, somewhat stony on knoll, plants below medium size....................	296	91	30.74
" C: Clayey loam, plants below medium size	362	43	11.88
" D: Average soil, clayey loam, good; plants of average height................................	678	142	20.94
Total.....................	4522	1183	26.16

The average of the four plats, without regard to the number of plants counted, is given by Plumb as 23.21 per cent. In obtaining this the per cents. in the different rows also were averaged without regard to the number of plants in the row. This is probably the most accurate method, since there was a great variation in the number of plants counted in the different plats.

Plumb, in the same place, gives the following averages of the plats:

	Average No. panicles per plat.	Average No. smutty panicles per plat.	Average per cent. of smut per plat.
Plat A..............................	637.2	181.4	28.81
" B......................................	59.2	18.2	30.86
" C......................................	72.4	8.6	11.68
" D......................................	135.6	28.4	21.49
Average............................	226.1	59.15	23.21

He says: " The loss in the above four plats is very large, as can easily be seen by reference to the figures, even when considering Plat C, where the loss is least. Under such circumstances, where disease seems carried on from generation to generation, to the detriment of both crop and man, a vigorous attempt should be made to secure a practical remedy against such a trouble."

[1] Plumb. Smut in Oats. l. c., p. 128. Per cent. recalculated.

During 1888 and 1889 careful counts were made in the fields of oats about Manhattan, Kansas, with the following results:

COUNT 1.—Grown on a rich, rather low bottom; growth very good; June 21, 1888.

No. of heads counted	No. smutted heads	Per cent. of smutted heads	Remarks.
100	16	16	Plants tall.
100	23	23	Plants tall.
100	13	13	Plants tall.
100	15	15	Plants tall.
100	13	13	Plants tall.
100	16	16	Plants short.
100	16	16	Plants short.
100	12	12	Plants short.
100	9	9	Plants short.
100	18	18	Plants short.
100	33	33	Plts. small, crowded.
1100	183	16.6	

COUNT 2.—Grown on second bench land which sloped gently; growth medium; June 21, 1888.

No. of heads counted	No. smutted heads	Per cent. of smutted heads	Remarks.
100	16	16	Plants med. height.
100	17	17	Plants med. height.
100	13	13	Plants med. height.
300	46	15.3	

COUNT 3.—Grown on level creek bottom land, rich; growth good; June 21, 1888.

No. of heads counted	No. smutted heads	Per cent. of smutted heads	Remarks.
300	26	8.66	Plants counted in as widely different parts of the field as possible.
300	17	5.66	
300	30	10	
100	7	7	
1000	80	8	

COUNT 4.—Grown on second bench land; growth moderate; June 22, 1888.

No. of heads counted	No. smutted heads	Per cent. of smutted heads	Remarks.
100	14	14	
100	15	15	
100	25	25	
100	14	14	
100	10	10	
100	20	20	Plts. short, crowded.
100	19	19	
100	14	14	
100	26	26	
100	39	39	
100	6	6	
100	18	18	
1200	220	18.3	

COUNT 5.—Grown on rather poor upland; growth poor; July, 1888.

No. of heads counted	No. smutted heads	Per cent. of smutted heads	Remarks.
53	3	5.66	One corner of this field was used in an inoculation experiment.
63	12	19.05	
162	18	11.11	
160	30	18.75	
60	4	6.66	
53	6	11.32	
96	7	7.29	
80	7	8.75	
66	13	19.69	
793	100	12.6	

COUNT 6.—Rich sandy river bottom; growth July 1, 1889.

No. of heads counted	No. smutted heads	Per cent. of smutted heads	Remarks.
100	9	9	
100	5	5	
100	26	26	Near margin of field
100	6	6	
100	11	11	
100	9	9	
100	7	7	
100	2	2	
100	7	7	
100	7	7	
1000	89	8.9	

SMUT IN OATS ABOUT MANHATTAN, KANSAS—CONTINUED.

COUNT 7.—Grown same place as Count 2 of 1888; July 2, 1889.

No. of heads counted....	No. smutted heads........	Per cent. of heads smutted....	Remarks.
100	7	7	Plants counted in as widely different parts of the field as possible.
100	15	15	
100	9	9	
100	15	15	
100	6	6	
100	12	12	
100	6	6	
100	16	16	
100	14	14	
100	8	8	
1000	108	10.8	

COUNT 8.—Grown on creek bottom, same as in Count 3; July 2, 1889.

No. of heads counted....	No. smutted heads........	Per cent. of heads smutted....	Remarks.
100	3	3	
100	13	13	
100	9	9	
100	7	7	
100	8	8	
500	40	8	

COUNT 9.—Grown on same land as in Counts 3 and 8.

No. of heads counted....	No. smutted heads........	Per cent. of heads smutted....	Remarks.
106	5	4.71	
76	5	6.58	
125	3	2.40	
160	7	4.37	
163	11	6.74	
630	31	4.9	

COUNT 10.—Grown on same land as in Counts 9 and 10.

No. of heads counted....	No. smutted heads........	Per cent. of heads smutted....	Remarks.
140	8	5.71	
143	6	4.19	
165	7	4.24	
207	8	3.86	
156	16	10.25	
811	45	5.5	

COUNT 11.—Grown on same land as in Counts 8, 9, and 10.

No. of heads counted....	No. smutted heads........	Per cent. of heads smutted....	Remarks.
157	9	5.73	
173	14	8.09	
141	13	9.22	
163	13	7.93	
136	16	11.76	
770	65	8.4	

COUNT 12.—Second-bench land; growth good.

No. of heads counted....	No. smutted heads........	Per cent. of heads smutted....	Remarks.
100	7	7	
100	9	9	
100	10	10	
100	5	5	
400	31	8.8	

SMUT IN OATS ABOUT MANHATTAN, KANSAS—CONTINUED.

COUNT 13.—Rich upland; growth good; July 19, 1889.

No. of heads counted....	No. smutted heads.......	Per cent. of smutted heads.......	Remarks.
100	8	8	Whole field very smutty and unusually late.
100	10	10	
100	10	10	
100	15	15	
100	16	16	
100	17	17	
100	17	17	
100	17	17	
100	18	18	
100	26	26	
1000	154	15.4	

The following table gives in more condensed form the result of the above recorded counts:

Count.	Number of stalks counted, and character of land.	No. of smutted heads.	Per cent. of whole.
1.......	1100 bottom land..............................	183	16.6
2.......	300 second bench............................	46	15.3
3.......	1000 creek bottom............................	80	8.0
4.......	1200 second bench............................	220	18.3
5.......	793 upland..................................	100	12.6
6......	1000 sandy bottom............................	89	8.9
7.......	1000 second bench............................	108	10.8
8.......	500 creek bottom............................	40	8.0
9.......	630 creek bottom............................	31	4.9
10.......	811 creek bottom............................	45	5.5
11.......	770 creek bottom............................	65	8.4
12.......	400 second bench............................	31	8.8
13.......	1000 second bench............................	154	15.4
Total..	10504	1192	11.34+

Aside from these regular counts, made in the fields of oats about Manhattan, many more were made in connection with the experiments in preventing oat smut. Of Red Winter oats grown on untreated soil, 30,000 heads were counted, of which 3,010, or 10.03 per cent., were smutted. Of Badger Queen, out of 1,377 heads, 125, or 9.07 per cent., were smutted. Of black oats, 2,521 heads were produced, of which 470, or 18.64 per cent., were smutted.

The table from Jensen, given on page 220, shows a small percentage for some of the varieties, but a very large per cent. for others.

Jensen states that in Denmark there was an average of 8 per cent. in 1888. From these facts it will be seen, that in nearly every case where fields, or large plats of oats, were counted, a loss of over 8 per cent. was found. It is probable that the per cent. given for the vicinity of Manhattan for 1888 and 1889 ($11^{1}/_{3}$) is a little too large, but it is safe to say that at least 10 per cent. –that is, ONE-TENTH OF THE CROP—is anually destroyed throughout the State.

The value of the oat crop raised in Kansas in 1888 was $12,440,908.35.[1] If 10 per cent. was destroyed by smut, this sum would represent but 90 per cent. of what the full or unsmutted crop should have been. In other words, there was a loss of $1,382,328.31 due to the smut alone. In 1889, the value of the crop was only $7,654,812.83,[2] and the loss $850,534.76. It should be remembered that this loss is almost directly from the *profit* of the crop, since it requires as much space and as much nourishment from the soil to produce a smutted head as a sound one. It costs as much for every operation in growing a smutted crop as a clean one. And finally, it may be said that if this smutted seed is used for the production of another crop, a loss of the same gigantic proportion is likely to follow; for it is a well-established fact that seed from smutted fields will produce a smutted crop, whereas clean seed from a clean field will produce a clean crop.

GEOGRAPHICAL DISTRIBUTION.

Ustilago Avenæ is found all over the world, wherever oats are grown. Apparently the disease is nearly as abundant in one locality as in another, and at any rate its injuries are found to be large wherever carefully investigated.

BOTANIC AND MICROSCOPIC CHARACTERS OF THE SMUT.

Color, shape, and size.

The spores of this species are entirely free from each other, and form a dusty mass of a dark dusky-brownish color, lacking the olivaceous tinge found in the spore mass of *Ustilago Tritici* and *Ustilago nuda.*

In shape the spores are mostly oval, but often only slightly so. Sometimes they are subglobose, and sometimes elliptical, as, for instance, fig. 43 on Plate V. Quite often the spores are more or less angular, and more often than in any other of the loose smuts the spores are irregular, or deformed. Common distortions are shown on Plate V, figs. 51, 53, and 55.

In size of spores, *Ustilago Avenæ* is the most variable of all the loose smuts. There are 5-11x4½-7µ; mostly 6–9x5-7µ, often 7–9x6–7µ. It thus seems to have the largest spores of all, but really the spores of *Ustilago Hordei* average larger, though they do not reach such an extreme length as 11µ. This may be seen by comparing the spores shown in Plate V with those in Plate VII.

Character of wall.

The wall is (as in all loose smuts) composed of two layers: the outer, deeply colored, called the *epispore,* and an inner, pallid one, called the *endospore.* These two layers can sometimes be very plainly distinguished, as in fig. 14 and 15, Plate IV. In other spores the wall, without the use of

[1] Sixth Bienn Rep. St. Bd. Agr., Kansas, 1887-8, part II, p. 19.
[2] St. Bd. Agr., Kansas, Quarterly Rep., Dec. 31, 1S89, p. 12.

special reägents, seems single, as in figs. 5, 8, 10, and 12, Plate IV; 49 and 57, Plate V. Sometimes it is very thin, again quite thick (¾-1½μ). Fischer von Waldheim[1] claims that the spores have a cuticular covering outside of the epispore, and indeed a faint line can be traced; but it is extremely difficult to see, and is not shown in the figures.

The spores are lighter on one side.

A curious fact is, that the spores of all the loose smuts are lighter colored on one side, and that they invariably germinate from this light-colored side. Previous writers do not seem to have noticed this fact, though it may very easily be observed. The light-colored portion of the spore may cover as much as one-half of the whole surface, and, again, constitute not more than one-quarter of it. Very rarely there are two opposite light areas, as in fig. 6, Plate V. In optical sections, the wall can sometimes be seen only on the dark-colored side of the spore, as in fig. 47, Plate V; and in other instances, the two layers can be seen on the dark side of the spore, while only one is visible on the light side (figs. 43 and 60, Plate V).

The epispore is spiny, or warty.

The epispore of oat smut is covered with minute elevations, or warts. They can be seen best in profile, but are also seen in optical section in many figures in Plate IV. The spines or warts are plainly seen on top, though they cannot always be recognized on the side. F. von Waldheim claims [2] that these are simply portions of the epispore less rich in water, and that they do not project at all. This, however, is sometimes not the case, as when the spines were seen plainly to project on the edge (see figs. 4, 6, and 7, Plate IV) or along the crack of a spore whose wall is being dissolved (see fig. 7, Plate V). A more probable view is, that the spines really do project somewhat, but are included more or less by the cuticle. The spines show plainest on the smooth side of the spore, since they contrast more strongly with the light background. There is, however, a small area on the light-colored side free from spines, most likely where the germ tube arises.

The contents of the spore.

The contents of the spore are homogeneous, and only very rarely granular. The spores sometimes swell up somewhat in nutrient solution, and become lighter colored. (See figs. 1 and 14, Plate V.)

Action of reagents.

The spores are variously acted upon by reagents. Potassium hydrate scarcely changes their color, but causes the endospore to swell up and appear as a thick ring. The markings can be seen plainly in profile, but scarcely at all on the edge. Glycerine obscures the markings. Acetic acid causes the epispore to swell or renders it distinctly visible without swelling, and shows markings plainly in profile. Hydrochloric acid has little effect.

[1] Fischer von Waldheim. Contr, to Biol. and Hist. of Dev. of Ustilag., in Trans. N. Y. St. Ag. Soc. for 1870, Albany, 1871, p. 323; and Sur la structure des spores dea Ustilaginées, in Bull. de la Soc. Imp. des Natur. de Moscou. 1867, I, p. 245.

[2] F. v. Waldheim. Contr., l. c., p. 223; Sur la structure, l. c., p. 243.

Nitric acid discolors the spore, and causes a general swelling and final disorganization of the spore. Schultze's macerating solution (nitric acid and potassium chlorate) rapidly destroyed the wall, attacking the light-colored side first. The contents resist decomposition longest. Chromic acid acts much the same if strong; it rapidly eats away the light side of the wall, leaving a resistant darker colored segment; at first it shows the cuticle faintly. Sulphuric acid is good to show the markings and the separation between the epospore and endospore. Chloriodide of zinc causes, after some time, the contents of the spores to assume a reddish color. It does not stain the spores readily.

GERMINATION IN WATER.

Historical.

The germination of the loose smut was first observed by Prevost,[1] who saw the spores send out a single, or very rarely a double or triple, promycelium; and saw them produce when floating on the surface of the water aigrelles, or a series of globules.

Tulasne[2] next studied the germination of the *Ust. Carbo,* and saw in old cultures that the segments of the promycelia swell at the ends, and become rounded and deeply constricted at the septa. Kühn[3] in 1868 published a full account with figures of the germination. He saw the formation of sporidia, their budding, and described the "knee-joint" fusions, and the formation of germ threads or simple germ tubes from the old segments. Fischer von Waldheim[4] observed the germination of *Ustilago Carbo* on barley and oats. He describes sporidia, but figures them only in barley smut. Wolff[5] describes quite fully the germination of *Ustilago Carbo,* presumably, in part at least, on oats. He noticed the formation of conidia, the sending out of germ threads, and the emptying of some segments, and a fusion of the segments of the same or of different promycelia by means of germ tubes.

ACCOUNT OF GERMINATIONS MADE.

In all germinations of loose smuts the spores were placed in the liquid used on slides having a central depression. These slides were then put in a perfectly dark damp chamber in an incubator.

After being in water a few hours the spores send out from the light side a small tube called the promycelium. Specimens collected at Manhattan June 2, 1889, had at the end of six hours, at 23° C., often attained a length of 16-18μ. The promycelia were always continuous, and were rather slender. Specimens collected in 1888 did not germinate so quickly. After remaining 24–27 hours the promycelium attained its full length, or nearly so,

[1] Prevost. Memoire sur la cause immediate de la carie ou charbon des blés, et de plusieurs autres maladies des plantes, et sur les preservatifs de la carie. Paris 1807, p. 29, §86.

[2] R. et. Ch. Tulasne. Memoire sur les Ustilaginées comp. aux Uredinees in Ann. sci. nat., 3e serie, t. VII, 1847, p. 33, Pl. 3 f, 10. L. R. Tulasne, Second mém. sur les Ured. et les Ust. in Ann. sci, nat. 4e serie t. II, 1854, pp. 157-158.

[3] Kühn. Krankh. der Kulturgew. 2 Aufl. 1859, S. 66-68. Taf. III, Fig. 11-21.

[4] F. v. Waldheim. Countr. to Biol., l. c., p.333 Plate V, figs. 7-15.

[5] Wolff. Der Brand des Getreides, seine Ursachen and seine Verhütung. Halle, 1874, S. 6-9. Taf. I. A., Fig. 1-20.

and had one to three septa. The promycelia were now 16–50x2-4μ, mostly 19–36x2½–3μ Quite often the segments gave rise to little protrusions on opposite sides of a septum which uniting form a knee-joint fusion. (See Plate IV, figs. 7 and 13.) More rarely at the septa sporidia were produced. No figure of mature conidia is shown in Plate IV, but in Plate V, fig. 19, is shown a form almost exactly like those found in water. These sporidia are mostly narrowly elliptical in shape, more or less pointed at the attached end. They fall off almost as soon as produced, and sometimes bud into secondary sporidia like figs. 12, 36, 9, and 42, Plate V. These sporidia are scarce, however. They are much more abundant in some cultures than in others. Already by 24 hours some of the segments become empty, especially toward the base (see Plate IV, figs. 5 and 13); also many of the promycelia are detached. After this but slight changes occur. More and more of the segments become empty, and those remaining filled swell somewhat (becoming 4-5μ. diam.). No more conidia are produced. Fusions now are somewhat common—often slender tubes arise from the spore just at the base of the promycelium and fuse with one of the upper segments, much as represented in Plate VII, figs. 43 and 45, (Ust. *Hordei.)* These slender tubes may fuse with other promycelia, or with free segments. They also arise from other parts of the promycelia, as from the spore at the base. In general, however, fusion are rare. As the segments swell their ends enlarge most and become rounded in shape, causing a deep constriction at the septum. The knee-joint fusions also open more or less—they have before this become bent in most cases. This is essentially the condition of a good culture after 48 hours. By 4 or 5 days little further changes have occurred, except that occasionally a branch or a knee-joint grows out into a long germ-thread. These are slender tubes filled with protoplasm at the tip, and with an empty many-septate basal portion. These have a continuous tip, and the empty base is shrunken. They are exactly like those shown on Plate V, figs. 28 and 29. These finally cease growing, and then all activity ceases in the culture. Sometimes the promycelia are branched, especially from near the base. (See Plate IV, figs. 1, 5, and 13.) The promycelium emerges from the spore through a small pore, which is plainly shown in optical section in Plate IV, figs. 6, 7, 9, 11, 14, and 15. Rarely in older cultures there is a slight tear in the cell-wall down from this pore.

The germination of *Ustilago Avenæ* in water is peculiar because by reason of the rather short promycelia, very commonly detached, producing sporidia rather sparingly, and by the slightly swollen segments; also for the germ threads which grow from the promycelia in old cultures.

GERMINATION IN NUTRIENT SOLUTION.

Hallier[1] seems to have been the first to employ nutrient solutions in the study of the germinations of *Ustilago Carbo* (species not given, but probably

[1] Phytopathologie Leipzig, 1868, S. 250, 251. Taf. III, Fig. 1, 2, 4, 5.

oat smut or covered smut of barley). He used various substances, such as starch, paste, white of egg, milk, sugar, water, "and so forth." He observed and figured the abundant production of conidia and their germination into tubes, and showed the thick distorted promycelia found in rich nitrogenous. substance. He also showed the fuller expansion of the promycelium into dumb-bell shaped segments. He, however, describes the change of the promycelia into various moulds, no doubt, through impure cultures. Brefeld claims the credit for the discovery, or at any rate, application of nutrient solution for prolonged cultures of fungi.[1] At any rate, though antedated in its first application by Hallier, he was the first to successfully apply nutrient solutions to long-continued, pure cultures of smuts. He describes in 1883, in Hefenpilze I, very fully the germination and growth of oat smut in nutrient solution. He uses mostly for the purpose a decoction of manure carefully sterilized. He emphasizes especially the fact that the culture can be carried on for long periods of time through countless generations by transferring the budding sporidia to fresh nutrient solutions from time to time. Frank[2] in commenting on Brefeld's lecture, states that in his researches it was found that sugar or other carbohydrates is the great stimulus. Especially interesting was the fact, that the addition of a minimum or grape-sugar solution to a decoction of manure immediately greatly accelerated the development of the fungus into yeast-like sporidia[3].

The germination of smut spores, and of many other fungi is greatly accelerated by placing them in a solution containing nitrogenous matter, or better, a mixture of sugar and nitrogenous substances. Finding a simple decoction of manure, nutrient gelatine or solution of pepetone unsatisfactory from the difficulty in preventing the growth of contaminating bacteria and moulds, and finding also a simple sugar solution, though greatly stimulating the growth, to lack nourishing power, a combination of the two was used. The advantage of a solution of fixed and known chemical composition being very great, it was decided to avoid all decoctions, which would almost certainly vary in strength and composition. The following modification of the Cohn nutrient solution was used in nearly all the cultures, both oat smut and the other loose smuts.

Distilled water	42.385	grammes.
Cane sugar	7.000	"
Ammonium tartarate	.250	"
Potassium phosphate	.125	"
Magnesium sulphate	.125	"
Calcium phosphate	.125	"
	50.000	"

[1] Brefeld. Neue Unters, über Brandp. u. Brandt., II Nach. d. Klub d. Landw. z. Berlin, No. 220 S. 1.578, foot-note.

[2] Neue Unters, II. Diskussion. Nachr. d. El. Nr. 222, S. 160I.

[3] "Bei meinen desbezüglichen Versuche ergab sich, class zucker dies *stimudans* ist oder andere Koblenbydrate, was sich besonders interessant bei Mistdekokten zeigte, wo ein Minimum von hinzugesetzter chemisch-reiner Traubenzuckerlösung algbald die Entwicklung der Pilze in Form der hefenartigen Sprossung mächtig beförderte."

This solution had so much sugar that the growth of micro-organisms was largely prevented. This same large amount of sugar greatly stimulated the growth of the smuts. In the text, and in the explanation of the plates, this solution is called modified Cohn solution, or mod. Cohn sol. The cultures in nutrient solution were conducted in exactly the same manner as those in water, viz., in slides having concave centers, placed in a damp chamber in an incubator.

ACCOUNT OF THE GERMINATION IN MODIFIED COHN SOLUTION.

The spores soon germinated, and at first the promycelia appeared very much like those produced in water cultures. Soon, however, they became somewhat different. The promycelia became septate sooner than in water cultures; and soon the sporidia started to sprout out from the segments at the septa. By 24 hours the promycelia had attained a considerable length, in fact had attained nearly their full growth. At this stage they were 24-63x2½-4μ, mostly 25-55x2½-3½μ, curved, or more often, straight. Adjacent segments were very often connected by knee-joint fusions, and from many of the promycelia sporidia arose at the septa. (See Plate V, figs. 1, 3, 8, 9, 11, 12, 17, 21, 22, 25, etc.) These sporidia were somewhat larger than those obtained in water cultures, being especially wider. They were commonly about 9–11x2–3μ. They readily fall off from the promycelia and when freed, or rarely while yet attached, sprout out to form secondary sporidia. (See figs. 1, 2, 8, 9, 22, and 27.) Brefeld[1] says that in his experiments, "No promycelium was to be found without sporidia." In our cultures, however, some of the promycelia did not produce sporidia. This may be because the modified Cohn solution was less favorable for the growth of the smut than the manure solution used by Brefeld, or perhaps because of some difference in the germinative power of the smut spores used. Such differences in the germination of specimens from Canada and Kansas, used by us, were very slight, yet a much less amount of difference than that to be described under *Ustilago Hordei* would fully explain all discordance between our results and those obtained by Brefeld without assuming any marked difference in the nourishing power of the solutions used. It might be that Brefeld dealt with the form we have called var. *levis*, which was observed in every case to germinate with greater vigor than the ordinary form of the species. Prof. Brefeld describes the formation of conidia on the promycelia in the greatest profusion, and figures more conidia arising from a single promycelium than we have ever observed. However, conidia were often very abundant in our cultures, and since very many were floating free in the liquid, it was not possible to determine exactly how many had arisen from a single promycelium. Often the sporidia arising on opposite sides of a septum, crossed as shown in fig. 19; sometimes as many as four sporidia were seen sprouting from the two sides of a single septum. By 20 hours the pro-

[1] Brefeld. Hefenpilze, S. 58.

mycelia sometimes had empty cells, and in some instances the knee-joints had grown out into long tubes. Occasionally the promycelium was branched, especially from near the base. It should be stated that even by this time a considerable number of the promycelia were detached from the spore by breaking away at the base. These detached promycelia produced sporules, and behaved almost like those still attached.

The production of conidia and their budding continued till the solution began to be somewhat exhausted. Then the segments of the promycelium became slightly swollen. (Figs. 2, 4, 15, etc., Plate V.) The buckle-joints open curiously (figs. 37, 38), and the conidia become more rounded, and may sprout out into slender tubes (figs. 5, 13, 24, 32), and very often fuse by means of these. Aside from the conidia, fusions were almost wanting, excepting knee-joints. A great number of the segments of the promycelia now became empty, and the remaining ones rounded off slightly at the septa, and remained filled with granular protoplasm, or long, delicate branches ramified from the segments and bound the whole culture together. These branches are very often of the character of germ threads—that is, slender threads arising from a knee-joint fusion or from an ordinary segment. As they grow they empty the segment of its contents, which pass out to the tip of the thread, while its basal portion is left empty. As growth progresses, the protoplasm forms septa from time to time at its lower end. The tips of these germ threads are continuous, and 50-110x2½-3+½μ. The empty cell of the base nearest the tip has the same width; but when the protoplasm recedes out and this cell becomes second, it contracts so that the basal portion of such germ threads is only 1½–2½.μ in diameter.

Exactly similar germ threads are sometimes produced from conidia like those shown in figs. 28 and 29, the only difference being that these tubes, arising from segments, are in every part stouter than those from conidia. Finally, the growth of the end of the germ tubes ceases, as the solution becomes more nearly exhausted, or when they have attained a length of as much as 200-500μ. The protoplasm contracts slightly from the tip, and the whole swells slightly. This process is the end of all growth. During the rapid growth of good smut spores the culture remains almost entirely pure, but as it gets old a constantly increasing number of bacteria and moulds invade it till they probably assist materially in the final decomposition of the promycelia. If at any early stage the sporidia were transferred to fresh nutrient solutions, they budded with increased vigor, and those so produced grew and themselves budded. Brefeld studied especially this point, and cultivated the sporidia through many generations. He also found that if the sprouting promycelia were transferred to new nutrient solutions, they continued to form sporidia. "Only the want of nutrient material limits the uninterrupted formation of conidia."[1] In 1888 he re-

[1]Brefeld. Hefenpilze, S. 61.

ports the continuous cultivation of these yeast-like spores for 10 months through more than 1,000 generations[1]

INFECTION OF THE HOST PLANT.

HISTORICAL.

Early writers supposed the spores or the granules contained in them to enter the plant, since it was very soon discovered that it was the powdery mass of spores that carried the infection. After the discovery of the germination of the spores, it was supposed that the promycelium entered the plants. DeBary[2] inclined to the opinion that the smut entered the plant through the stomata or breathing pores. Kühn[3] carefully studied the infection of wheat by stinking smut, and found that the host plant was entered through the root joint[4] by the germ tubes of the parasites. F. v. Waldheim was unable to infect either oats or barley with the smut. Hoffman[5], experimenting only with barley, found the parasite entered the first root sheath. Wolff, in 1874[4a], found the smuts to enter wheat, oats and barley through the first, mostly very lightly colored, whitish or yellowish green, glossy sheath leaf which appears first, and is of cylindrical, slightly pointed form. Brefeld has carefully investigated the subject, recently, and finds that the infection of the host plant is easily accomplished by sprouting the plants, washing them, then spraying with a solution containing sporidia still budding, and then leaving the plant several days in a damp atmosphere. The infection was accomplished by means of the germ threads grown out from the sporidia, and if these threads had already been formed before the inoculation was attempted, it failed.

In the following experiments,[6] he used cultures in his nutrient solution containing the budding sporidia of oat smut.

I. The oats were in the first stages of germination. The little roots had already appeared. The plants were sprayed with the fluid containing the sporidia, and left in a damp atmosphere 10 days, at a temperature of 10° C., then sowed. Result: In ten experiments, 17–20 per cent. smutted.

II. Young germinated plants were covered with earth, except the tips of the germinated plants, which alone were sprayed with the fluid containing the sporidia, Result: In seven experiments, not more than 5 per cent. smutted.

III. Same as I, except that the germinated plants were further advanced, having the first leaf ¼-¾ in. long (½–2 cm.), but not yet broken through. Result: In eight trials, 2 per cent. smutted.

1 Neue Unters. II. Nachr. Nr, 220, S. 1582.
2 DeBary. Die Brandpilze, S. 122.
3 Kühn. Die Krankh. der Kulturgewächse. S. 48.
4 Place of juncture of primary root with stem.
4a Wolff. Der Brand des Getreidesseine Ursachen und seine Verhütung Halle, 1874, S. 18-24, Taf. IV, fig. 1.
5 Hoffman, Ueber den Flugbrand, Sep. Abdr. aus Botanische Untersuchungen, Herausgeg. v. H. Karsten, S. 203, 204.
6 Brefeld. Neue Unters. IL Nachr. aus dem Kl. d, Landw. zu Berlin, Nr, 221, S. 1591.

IV. Same as in II, except that the plants whose tips were infected were ½-¾ in. long (½–2 cm.) Result: In three experiments, 1 per cent. smutted; in two experiments, none.

V. The germinated plants had the first leaf broken through. Result: In three trials, 1 per cent. smutted; in two others, none.

VI. Seed sown in infected earth before they had germinated. Result: In five trials 4-5 per cent. smutted.

VII. Ungerminated seed sown in an infected mixture of field soil and fresh horse dung. Result: In three trials 40–46 per cent. smutted; in three others, where the sowings had not been placed in a cool room, 27-30 per cent. smutted.

VIII. An experiment using sporidia which had been cultivated in nutrient solutions ten months, and after the exhaustion of the nutrient solution would no longer grow out into germ threads; otherwise as in I. Result: In one trial 1 per cent. smutted; in another, 2 per cent.; in two others, none.

IX. An experiment with large plants by infecting from without and in the growing point. Result: No smutted plants.

In all these nine experiments barley was treated in exactly the same way, but, being treated with oat smut instead of barley smut, remained entirely sound.

Brefeld finds the plants are free from infection after the growing leaves have pushed one centimeter through the sheath leaf. The temperature at which the trial was conducted was found to exert an important influence on the result. An experiment as in I, except at a temperature of 15° C., gave 3 per cent. smutted; when the temperature was higher, only 1–2 per cent. or none at all were smutted. He considers from VII, where the seed sown in infected manure and soil mixed gave such a large per cent. smutted, that the disease is very likely carried to the fields in the manure, and especially since the manure is often mixed with straw containing spores of the smut.

Jensen[1] denies that the spores in barn-yard manure are able to infect to any appreciable extent oats or barley. He says:[2] "While it may be quite true that barn-yard manure when applied to fields causes the crop to have more smut in it than is the case in unmanured fields, yet this arises from the manure increasing the fertility of the land, and not from the introduction of smut spores. Nor does it matter in what way the fertility is increased, whether by farm-yard or by artificial manure, or by the system of cropping, the result is the same."

Jensen reports[2] the following observation in support of his claim: A

[1] Jensen. Nye Undersögelser og Forsög ever Kornsorternes Brand (Förste Meddelelse) Saetryk af Markfrökontorets Aarsberetning for 1887, S. 7; Smut *(Ustilago segetum)* in Oats and Barley, in Gard. Chron., vol. III, 3d series, No. 71, May 5, 1888, p. 555; Om Kornsorternes Brand (Anden Meddelels), S. 3; Prop. and Prev. of Smut, J. R. A. S. XXIV, s.s. II, p. 3; Le charbon des cërëales, p. 7; Ueber die Verhütung des Kornbrandes, S. 5.

[2] Jensen. Nye Undersög. og Forsög, S. 8; Prop. and Prev. of Smut, p. 4.

portion of a plot which had been manured for 25 years, and was every year seeded to barley, produced a considerably larger percentage of smutted ears than those other portions of the same plot where the crop was poorer from the soil either being unmanured or treated with artificial manure from which some essential part of plant-food was excluded. The manured portion was not, however, more smutted than the other plot, on which barley had been grown every fourth year for 25 years, and which had never during this time been manured with farm-yard manure, though a good crop of barley was produced, owing to the good system of cropping employed.

When manured by a compound artificial manure, the comparison was as follows:

	1885.	1886.
Barn-yard-manure plot.	42 smutted heads.	1.2 per cent, smutted.
Artificial-manure plot . .	35 " "	1.0 " "

The portion manured with farm-yard manure was a little more luxuriant.

Our experiments made in 1888 and 1889 with oats at Manhattan, showed in the manured portion a very much more vigorous growth but no increased amount of smut, even when smut had been purposely mixed in *considerable quantity with the manure when it was applied.*

Plumb, in 1885, planted oats, and with each grain of some rows placed one or more grains of smutted oats (variety Race Horse).

The following shows the result:[1]

Row 1: One grain + one grain of smut . . . . . .total panicles... 632	Smutted . . . 13	Per cent. of smut.. 2.05
Row2: " + two grains of smut..	" ...644	" ...17	" " ...2.63
Row3: " + four grains of smut...	" ...554	" ...16	" " ...2.88

Jensen[2] took oats from a field where more than 40 per cent. was smutted, and washed a quantity with water to which was added fine sand. Each grain was then found on examination to have on an average 50 spores adhering to it. Portion A was thus planted. B was planted without any preparation, and on an average 8,000 spores adhered to it. C was dusted with smut, and about 40,000 spores adhered to each grain. The germinative power of the spores was tested, and it was found that each grain in A had 25 living spores on it, in B 4,000, and in C 12,000. The result was as follows:

A 25	living spores on each grain produced	29 per cent. smutted ears.
B 4000	" " "	37 " "
C 12000	" " "	36 " "

Jensen[3] has shown that the disease is produced in the crop by spores inside of the husks, and if the husks be removed the grain can be infected by simply dusting it with spores. He gives the following experiments to prove this:

1. Husks removed, spores dusted on the bare kernel . .. . . gave	33 ears of which	4 were smutted
2. Husks removed, no spores dusted on the bare kernel . . . . . "	53 " "	0 "
3. Husks removed, spores dusted on the outside . . . . . . "	50 " "	0 "
4. Husks not removed, spores not dusted on the outside .. . . "	62 " "	0 "

[1] Fourth Ann. Rep. N. Y. Ag. Exp. Sta. 1884, p. 129.
[2] Jensen. Nye Undersög. og Forsög., S. 9; Prop. and Prev. of Smut in Oats and Barley, p. 5.
[3] Jensen, Prop. and Prev. of Smut in Oats and Barley, p. 8.

The spores can, however, be carried to the grain without removing the husk if the seed is immersed in water in which spores are suspended. Jensen gave the following trial of this:

Oats dipped in spore-charged water produced... 29 per cent. smutted ears.
Oats dusted with dry spores produced . . . . 0 smutted ears.

In an experiment of ours in 1889 (plot 34; seep. 256), the untreated seed was wetted, then rolled in smut. This seemed to increase the amount of smut appreciably. The plot had, out of 3,000 heads counted, 432 heads or 14.4 per cent. smutted, while the nearest untreated plot had only 8.06 per cent. smutted.

Jensen, in Gardeners' Chronicle for April 5,1888, suggests that the infection of the plant is brought about by spores inside the husks, which lodged there when the crop was in blossom. In an experiment of ours in June, 1888, a square rod of oats just in blossom was dusted with smut spores in considerable quantity on the 20th, 22d, 25th and 27th of the month. When ripe, it was harvested and kept separate. In the spring of 1889 it was planted, together with other plots, with seed from other parts of the same field. One of the artificially infected plots (23) was 6.8 per cent. smutted, and the other was 5.36 per cent., while the untreated plot had 6.4 per cent. of smut, midway between the two artificially smutted ones. Hoffman[1] also states that attempted infection at the time of flowering was without result. It is probable that he used barley in this test, but he does not state. However, the fact that immersing the seed five minutes in hot water effectually prevents smut, (which treatment of course has no effect on the power of the spores in soil or manure to infect the plant,) proves that the infection is brought about by spores adhering to the seed. It is probable that under very favorable circumstances spores carried to the field in manure might infect the plants grown there, but in view of the results from Jensen's, and from our own experiments, the chances are probably very small.

METHODS OF TREATMENT.[2]

HISTORICAL.

I. Superstitious practices used by the Ancients.

Pliny in his Nat. Hist., book XVIII, chapter 45, says:[3] "As for mildew, that greatest curse of all to corn, if branches of laurel are fixed in the ground it will pass away from the field into the leaves of the laurel." Pliny probably uses the word mildew *(robigo)* to include the rusts and smuts of grains, and perhaps also other diseases.

[1] Hoffman, Ueber den Flugbrand, S, 202 and 203.
[2] In the following account, the methods of treatment against all common smuts are given, since they have almost all been used against the oat smut. The earlier writers usually paid most attention to the stinking smut of wheat (Tillelia).
[3] Nat. Hist. of Pliny, translated by Bostock and Riley, London, MDCCCLVI, Vol. IV, p, 58.

II. *Methods of planting, cultivation, etc.*

(a) Change of seed, etc.

Of this, Tull, writing about 1730, says:[1] " . . . there are but two remedies proposed, and these are brining, and change of seed." Again:[2] "But of the two remedies against smuttiness a proper change of seed some think most certain." The change of seed seems always to have been a favorite remedy, and even as late as 1878 it was recommended in Austria by v. Ahasbahs.[3] Of course a change of seed is a very good preventive of smuts, provided of course that the seed comes from a locality free from smut. The measure is however only temporary, since the seed gradually becomes infested with smut from surrounding fields, or especially with stinking smut of what from the soil. It is also from an injudicious change of seed that the smut is often introduced into new localities or produced in greater abundance in the old.

(b) Avoidance of certain manures.

(1) Because of their direct effect on the host plant.

Fischer v. Waldheim says:[4] "In fine, therefore, it appears to me that we have every reason to affirm that in all probability it is the excessive supply of carbon in the supporting plant that more than anything else promotes the development and the epidemic diffusion of parasitic fungi. We are, therefore, compelled to admit that unfortunately . . . by cultivation . . . we frequently produce . . . conditions favorable to a luxuriant parasitic growth." He says: "We invariably found the specimens containing *Ustilago carbo* (black rust) in greatest abundance on the oats and barley plants that were best developed." Jensen also mentions[5] that the amount of smut in oats may be increased by in any way increasing the fertility of the land. We have not in our experiments noticed any such increase in the amount of smut in the manured plots, and in the counts made in the fields about Manhattan the highest per cent. of smut would often be shown where the plants were on high land, small and crowded.

(2) Because of carrying the spores of the smut or aiding their development.

Brefeld[6] has vigorously upheld the claim that oat smut as well as other smuts may be carried in the manure and enabled to multiply enormously in it by the formation of multitudes of yeast-like sporidia. He has obtained from his experiments (see p. 234) results seeming to support this view. He strongly recommends that the use of fresh manure on grain fields

[1] Jethro Tull. The Horse-Hoeing Husbandry, London, 1829, p. 222.
[2] Tull Horse-Hoeing Husbandry, p. 224.
[3] V. Ahasbahs. Beobactungen über den Weizenbrand und den Samen Wechsel, in Oesterrisches landw. Wochenbl.. 1879. S. 145. Rev. Just. Bot. Jahresbr.. 7 Jahrg. 1879. I. S. 545 (by Sorauer).
[4] F. v. Waldheim. Remarks on the Causes of the Occurrence of Parasitic Plants upon Cultivated Cereals, in Trans. N. Y. St.. Ag. Soc. for —, p.161.
[5] Jensen. Propagation and Prevention of Smut in Oats and Barley, p. 4.
[6] Brefeld. Hetenpilze and New Unters, 11.

be avoided. Jensen, however, strongly combats this view, and claims: "The spores of smut in farmyard manure, when applied to the field, will not to any appreciable extent infect oats and barley." In our attempts to infect oats, a considerable quantity of oat smut was applied with manure to the soil in July, 1888; oats were planted in the spring of 1889, but no considerable effect of the smut and manure could be observed. In fact, the per cent. of smut on such plots was actually less than on untreated plots. (See p. 256.)

(*c*) Hastening the growth of the seed.

From the fact that infection of the host plant takes place only when the plants are very small, it has long been held that anything which increases the vigor of the seed, or in any way secures a more rapid germination, aids in preventing the smut.

Brefeld, in his infection experiments, found that while the infection was very successful when carried out at 10°C. (50°F.), it was of scarcely any effect when the temperature was over 15°C. (59°F.) (See p. 234.) Now oats are usually planted when the ground is still cold, and we might reasonably expect that if planted later, when the ground was warm, a very rapid growth would result, and, conformably to Brefeld's experiments, infection fail. In 1889 this was indeed the case. In many oat-fields about Manhattan, seed falling to the ground at harvest-time (July) caused a volunteer crop to spring up. *In every case this second crop was absolutely free from smut.* Even when the first crop had been very badly smutted, and the volunteer crop very abundant, yet the result was the same— no smutted heads. The only exception was, that rarely new stalks arose from smutted hills, and these were uniformly smutted. The plants so raised are, however, very much attacked by rusts *(Uredo of Puccinia coronata* and of *Puccinia graminus).* It might be, however, that sufficient oats for seed might be raised from a late planting. Owing to the ease with which any oats may be disinfected by Jensen's hot-water treatment, it is probable that such late seeding would not be profitable.

Tull claimed[1] that with wheat a "crop planted very early is not so apt to be smutty."

III. *Treatment of seed before planting.*

A. MECHANICALLY.

Tessier says[2] wheat "passed a great number of times through a wire sieve produces fewer corrupted ears than if sown without any treatment." Sinclair says:[3] "It is said that passing seed wheat loosely through mill-stones, so as not to injure the grain, has been found to prevent smut." A vigorous fanning of the seed has also been recommended to prevent the smut.

[1] Tull. Horse-Hoeing Husbandry, p. 226.
[2] Tessier. Result of Experiments made at Rambouillet under the King's eye relative to the distemper of wheat called the smut. In Young's Annales of Agricultural, Vol. VI, 1786, p. 206.
[3] Sinclair. Code of Agriculture. Fifth Edition. London, 1832, App., p. 59, foot-note.

Though such treatment might in part prevent the smut of wheat, it would be wholly ineffectual when applied to oats, whose grain is protected by a husk, which also incloses the spores that bring about the infection of the young seedlings.

B. CHEMICALLY.

(a) Washing the seed with solutions of various substances.

(1) Brining.

Soaking in brine is undoubtedly the oldest seed treatment against smut. Tull says:[1] " Brining of wheat, to cure or prevent smuttiness (as I have been credibly informed) was accidentally discovered about seventy years ago [about 1660[2]], in the following manner, viz.: A ship-load of wheat was sunk at Bristol in autumn, and afterwards at ebbs all taken up after it had been soaked in sea-water; but it being unfit for making of bread, a farmer sowed some of it in a field, and when it was found to grow very well the whole cargo was bought at a low price by many farmers and all of it sown in different places. At the following harvest all the wheat in England happened to be smutty except the produce of this brined seed, and that was all clean from smuttiness. This accident has been sufficient to justify the practice of brining ever since, in all the adjacent parts, and in most places in England."

(2) Brining and liming.

This practice, a modification of simple brining, was undoubtedly the most common of all known in the eighteenth century, and was everywhere practiced. It is not very much discussed in the books and periodicals of the time, but this is without doubt because of it being the universal practice of farmers. Only new or strange remedies were mentioned. There are many forms of the treatment, but in all the grain was either simply wetted in a heap or immersed completely in the brine for some time, after which the grain is limed in order to dry it.

This treatment, like simple brining, largely prevents the smut, but does not completely prevent it, unless so strong as to injure the seed considerably.

(3) Liming.

Simple liming was much used before the discovery of the value of copper compounds, and was strongly recommended by Tessier[3]. The usual form was to make a solution of the fresh lime, and put the grain in this solution.

(4) Other solutions.

Young[4] experimented against wheat smut in 1786 to 1788, and used, besides brining, and brining and liming, simple liming, soaking in lye, in arsenic, in arsenic and salt, arsenic and lye, &c., in various ways. These do

[1] Tull. Horse-Hoeing Husbandry, chap. XII, pp. 222 and 223.
[2] Sinclair. Code of Agriculture. 5th ed. App., p. 58 (foot note*).
[3] Tessier. Traité sur la Maladie des Graines; Result of Exp. made at Rambouillet. In Young's Ann. of Ag., Vol. VI, 1786, pp. 205-211.
[4] Young's Annales of Agric., Vol. VIII, 1787, pp. 409–413, and Annales of Agric,, Vol. X, 1788, pp. 131 and 132.

not, however, seem to have been in very general use, except perhaps lye or arsenic combined with lime. Soaking in urine, either fresh, or stale, and with or without the addition of other substances, was also used. Tessier[1] used in his experiments sulphate of copper, clear juice of lemon, ether, spirits of mint, alcohol, hartshorn, &c.

(5) Copper compounds.

According to Prevost,[2] Tessier in 1789 sowed some wheat treated with a solution of sulphate of copper, and the crop produced no smut. The experiment did not prove anything, since the untreated wheat produced only $^1/_{1800}$ of smutted heads. In 1807 Bénédict Prevost published a very important paper giving an account of the successful use of copper treating stinking smut of wheat. He accidentally discovered the value of copper in trying to germinate some smut spores. Some of the spores, placed in water which had been distilled in a copper vessel, failed to germinate, while the same spores placed in water which had not touched the copper, germinated as usual.[3] He then experimented with copper compounds to prevent the smut in the wheat. He used solutions of copper sulphate, copper acetate, verdigris obtained by the action of vinegar on copper, and of copper oxide. He recommends the use of a solution of 9 decagrammes of copper sulphate in 14 litres of water for every hectolitre of wheat, (about a 6-per-cent. solution.) He claims this to be a remedy superior to anything else, and to be, if properly applied, an infallible antidote. It very soon became quite widely known and practiced. Sinclair says:[4] "It may be added, that Prevost's discovery was in a great measure accidental, and that the utility of preparations from copper has long been known in Flanders." He also states[5] that Prevost uses one ounce of blue vitriol to every bushel of grain, dissolved in a wine galloon of water. The grain is stirred well with the solution, skimmed, and left stand an hour, after which it is drained; then washed in rain or pure water to prevent injury to the grain, and then dried either with or without lime. In 1858 Kühn[6] recommended a dilute solution of copper sulphate as a remedy against smuts. He used one pound of copper sulphate for every five Berlin bushels of wheat. The copper sulphate was dissolved in hot water, and then mixed with sufficient cold water to cover the grain 4 inches deep. It was left in this solution 12–14 hours, then dried. The treatment was much used in this form, and indeed is yet. The later authors use a ½-per-cent. solution by weight.

(6) Copper sulphate, with subsequent liming.

In 1873 Dreisch[7] published an account of an exhaustive series of experi-

[1] Tessier, art. Carie, p. 721. Quoted from Prevost, Mém., p. 65, § 163.
[2] Prevost. Mémoire sur la immédiate de la carie on charbon des blés et de plusieurs autres maladies des plants at sur les préservatifs de la carie. Paris, 1807, p. 65, § 163.
[3] Prevost. Mém., p. 55, § 130.
[4] Sinclair. Code of Agric., 5th cd., App., p. 62.
[5] Sinclair. l. c., App., p. 59.
[6] Kühn. Die Krankheiten der Kulturgewächse, ihre Ursachen und ihre Verhütung. Berlin, 1859, $.85-89.
[7] Dreisch, Unters. über die Einwirkung verdünntert. Kupferlös. den Kelmprocess des Weizen. Dresden, 1873.

ments upon the influence of dilute copper solutions on the germinative power of wheat. He found that even a dilute solution injured the germinative power of the wheat to an appreciable extent, and that if the wheat was soaked for a few minutes in lime water after being soaked in copper sulphate this injury was largely prevented. This practically perfected the blue-vitriol treatment, and as thus modified has been very much used. Perhaps the best form is to soak the grain 12 hours in a one-half-per-cent. solution of copper sulphate, after which it is immersed five minutes in milk of lime made by slacking lime in ten times its weight of water. This treatment is very effective against the stinking smut of wheat and covered barley smut, but it does not entirely prevent oat smut, and has little effect upon the naked barley smut.[1] According to Plowright; this and other treatments have little effect on the loose smut of wheat.

(b) Exposing the seed to the action of gases or vapors.

(1) Dissolved.

In 1879 Zoebl[3] published an account of the use of sulphurous oxide (SO_2) as a remedy for smut. He burned sulphur in a barrel half-full of water, which absorbed the SO_2 produced. Into this he put the grain and completely closed the barrel. Then the barrel was rolled, to thoroughly wet the grain, after which it stood for 3–6 hours. The grain was then dried for sowing.

(2) In gaseous form.

Tessier used ether to prevent wheat smut. It may be that some of the means used for killing grain beetles may also prove effectual against the smut. In this event the gaseous treatment might be of considerable importance. The following are worthy of trial, and most of them are now being tested: Carbon bisulphide (CS_2), chloroform ($CHCL_3$), ether $(C_2H_5)_2,O$, sulphurous acid (SO_2), and vapors of gasoline, kerosene, ammonia, and alcohol.

(c) Sowing solids with the seed.

This is practically done when the wheat is treated with a solution of any non-volatile substance, as copper sulphate, lime, &c. The solutions upon drying leave a quantity of the substance adhering to the seed. Brefeld supposes[4] that copper sulphate so adhering is of great use in treating grains to prevent smut. The substance would kill all sporules in the soil which might otherwise be able to infect the young plant. Even a very small amount of copper sulphate dissolved in the water of the soil about the seed would be able to poison the delicate sporules or their germ tubes, which, unlike the spores, are not protected by a thick wall. This fact may explain why Jensen found[5] in one of his experiments that a ¼-per-cent. copper sulphate solution reduced the per cent. of smutted heads from 36 to ½, but

[1] According to the experiments of Jensen. (See Prop. and Frey. of Smut.)
[2] Plowright. Br. Ured. and Ust., p. 102.
[3] Zoebl. Die schwefelige Saure als Mittel gegen den Steinbrand des Weizens, in Oesterr. landw. Woehenbl., 1879, Nr. 13, S. 145. Reviewed in Just, Bot. Jahresbr. 7 Jahrg. 1879, I. S. 545; Sorauer, Pfl. Krkh. 2 Aufl. II. S. 207.
[4] Brefeld. Neue Unters. II, Nachr. aus d. K1. d. Landw. zu Berl,, Nr. 222., S. 1602.
[5] Jensen. Prop. and Prev. of Smut, p.13.

only reduced the vitality of the smut spores from 20 per cent. to 5 per cent. Thaxter has recently[1] recommended sowing chemical substances, such as sulphur, or sulphide of sodium, with the seed as a remedy against onion smut *(Urocystis cepulæ* Frost). This will undoubtedly prove to be a valuable remedy against smuts (such as of onions) which remain in the soil and infect the young plants when they germinate. Brefeld supporse this to be the case with oat smut, and it certainly is to some extent the case with stinking smut of wheat.

C. PHYSICALLY.

(a) Washing in water.

Tessier says[2]: "It is the same with washing in water or with salt. These, it is true, diminish the activity of the contagious principle, but are incapable of destroying it completely."

(b) Exposure to sunshine.

Emile Laurent in 1889[3] stated that in some regions of Hainault, and particularly in the canton of Flobeck, a burning sun at the time of sowing seed diminished the chances of smut infection for grains, and particularly for wheat. He investigated the subject because of the common belief to this effect. He exposed spores of "*Ustilago Carbo*" from wheat *(Ustilago Tritici)* to the full sunlight in a glass vessel open above. Other spores were exposed to the light of the sun passed through a layer of solution of sulphate of quinine three centimeters thick. The temperature of the surrounding air did not rise above 40° C. (104° F.). After eight hours the spores exposed to the sun had lost the power of germination even in nutrient solution (unfermented beer). The spores shaded entirely from the sun germinated with great regularity. The spores sheltered from the chemical rays of the sun by the solution of sulphate of quinine did not lose their power of germinating after 16 hours of exposure to a very hot sun. The spores on the exterior of a head of smut are thus killed, while those in the interior of the head remain capable of germinating.

We have noticed in our germination of spores that sometimes the cultures grew better than other; and once in particular spores clinging to the paper in which specimens were inclosed refused to germinate, while spores obtained from the interior of smutted spikelets germinated vigorously. These facts would seem to support the statements of Laurent, since the spores clinging to the paper were undoubtedly mostly from the exterior portions of the smutted heads, and had consequently been exposed to the bright summer sun a considerable time before they were collected. This curious fact may have an effect as yet little appreciated in preventing the smut; for whenever the grain is exposed to the sun to dry, no matter what the treatment was, this disturbing influence would be felt.

[1] Thaxter, Rept. of Mycologist, in Ann. Rep. Conn, Ag. Exp. Sta. for 1889, pp. 146-158.
[2] Tessier. Result of Experiments made at Rambouillet. In Young's Ann, Agr. VI, 1787, p. 207
[3] Laurent. Influence de la luminiere sur les spores du charbon des cereales. In Bull, Soc, Bot. de Belgique, Tome 28, anné 1889, (2e) part, p. 262,

Prevost says, however[1], that alternate wetting and drying of the spores of the stinking smut of wheat, either in shadow or in sunshine, does not destroy their power of germination. He also exposed spores in liquids (water and copper sulphate) to the sun when it was so hot as to cause the temperature to rise to 56° (C.) and they did not lose their power of germinating. The subject is an interesting one, and will be further investigated.

(c) Exposure to heat.

(1) Dry heat.

x Flaming.

Wolff[2] says that the Fellahs and Moors, in order to prevent the smut, "Homari," of the sorghum and sugar cane, threw the seed through a high flame of a straw fire, thus by the sudden heat killing the spores adhering to the seed.

Haberlandt[3] describes a method of preventing the stinking smut of wheat by momentarily exposing the seed to a flame. Sorauer[4] criticises this practice, since the spores within the smutted grains are not killed.

xx Heated dry air.

Sinclair says:[5] "Kiln-drying the seed, . . . though a hazardous, is, when properly executed, a successful mode of preventing smut."

Schindler[6] found that dry heat below 80° C. did not affect the smut spores. According to Pierre,[7] this temperature injures the wheat so much that only 64 per cent. germinated. Jensen exposed oats to dry heat at 125° and at 129° F. for seven hours. This exposure had no effect upon the amount of smut.

(2) Damp heated air.

Schindler[8] found that moistened grains of stinking smut were killed by prolonged heating at 50° C. (122° F.) Jensen in 1888[9] reported the trial of moist heat. Oats exposed for 5 hours at 127° F., caused the destruction of all smut, but also injured the seed somewhat.

(3) Hot solutions.

Tessier[10] says: "I have tried liming from 20° R. (77° F.) of heat up to 80° R. (212° F.), and I have assured myself that the diminution in the amount of smut was not by reason of the degree of heat of the liming, and that it

[1] Prevost Mem sur la cause de la carie, p. 53, § 124.

[2] Wolf, Krankh, d. Landw Nutzpflanzen. Berlin, 1887, S. 58.

[3] Haberlandt. Einfluss des Kupfervitriols auf den Keimfahigkeit des Weizeus, in Muller's landw. Centralb., 1874, Bd. XXII S.381; Reviewed in just, Bot. Jahresbr., 2 Jahrg. 1874, S. 382; Sorauer in auf landw, Centralb., XXII Bd., S. 595.

[4] Sorauer Fremde und eigene neuere Bobactungen auf dem Gebiete der Pflanzenkrankheiten in Muller's landw., Centralbl., XXII, Jahrg. October, 1874, S. 596.

Sinclair. Code of Agric., 5 ed. app., p. 58.

Schindler. Ueb, d. Einfl, verscheid. Temp. auf d. Keimfahigk. der Steinbrandsporen inForsch. auf d. Gebiete der Ag. phys. 1880, Bd. III, Heft. III, S. 288-293. Reviewed in Bot. Centralbl., 1880, S. 929. Plowrught, Br. Ured. & Ust., p. 104; Sorauer, Pflanzenkr. 2 Aufl. 11, S. 206.

J. Isidore-Pierre, Ueb. d. Einfluss d. Warme u. d. Beizens mit Kalk u. Kupfervit. auf d. Keimfahigk. d. Weizens, in Ann. Agronomiques, II, 1876; Bied. Centralbl., 1876, X, S.362-364. Rev. just, Bot, Jahresbr. Jahrg. 1876 S. 880; Sorauer, Pflanzenkr. 2 Aufl. II, S. 206.

Schindler. Enifl. verschied. Temp., I.c.

Jensen. Prop. and Prev. of Smut, pp. 12 and 15.

Tessier. Quoted from Prevost Mem., pp. 32, § 121.

is of no consequence whether the lime be at 20° R. (77° F.), or at 60° R. (167° F.) Prevost thinks that the smut was not heated so high.[1] Sinclair[2] says, under the head *Boiling Water and Lime:* "This mixture, when properly applied, is found to be effectual. Sometimes chalk-lime, recently burnt, is put into a copper of boiling water, and as soon as the lime is dissolved, the mixture, at this degree of heat, is poured upon the wheat, previously spread upon a stone floor, and the wheat and the mixture are immediately well turned together with shovels.[3§] Sometimes the wheat, put into a common wicker basket, is dipped two or three times into a mixture of hot water and quick-lime,[3¶] and sometimes boiling water and quick-lime have been successfully used after the seed has been well washed and. skimmed." [3 ¶]

(4) *Hot water.*

Prevost[4] says he several times sowed wheat that was infected, and which was well wetted with boiling water. It did not germinate so well as wheat sown the same time without having been treated, but it always produced less smut. The next notice of a hot-water treatment was in 1887 by J. L. Jensen,[5] who, in a Danish publication, reported wonderful success with hot water as a preventive against oat and barley smut as well as against the stinking smut of wheat *(Tilletia),* and the stem smut of rye *(Uroc. occulata).* In the same year, Prilleaux, as stated by F. D. Chester[6] "recommends placing the seed in a basket lined with coarse cloth, and then dipping the same in water, heated to a temperature of 110° F., for five minutes; after which the seed is immediately dipped into cold water. The author claims that the germinating quality of the seed is not injured; on the contrary, he claims that the seed will germinate sooner." In the *Gardeners Chronicle* of May 5, 1888, Jensen states that, "the spores of Ustilago segetum of oats and barley are killed by the action of water at a temperature of 56° C, (133° F.) in the course of two or three minutes." In 1888 he published in Danish a very full account[7] of further experiments, all showing the great value of his hot-water method. In the same year he published a very full account in English in the Journal of the Royal Agricultural Society of England for 1888, Vol. XXIV, S. S. Part, pp. 1-19, entitled "The Propagation and Prevention of Smut in Oats and Barley." On p. 12 he gives the following table, showing a comparison of several methods of treatment:

[1] Prevost. Mém,, p. 32, §121.
[2] Sinclair. Code of Agriculture, Fifth edition. App., p. 57.
[3] Sinclair. Code of Agriculture. Fifth edition. App., p. 57. §Middlesex Report, p. 207. ||Dorset Report, p. 212, ¶ Buckinghamshire Report, p. 179,
[4] Prevost. Mém., p. 32, § 21.
[5] J. L, Jensen, Nye Undersögelser og Forsög over Korrrsorternes Brand (Förste Meddelelse). Særtryk af Markfrokontorets Aarsberetning for 1887, Kjöpenhavn.
[6] In Bull. III, Del. Ag. Exp. Sta,, Dec. 1888 last page, from Bull. Soc. Nat. Agric.,1887, XLVIII, P.549.
[7] J. L. Jensen, Om Kornsorternes Brand. (Anden Meddelelse.) Kjöpenhavn, 1888, p. 72.

RESULTS OF DISINFECTION EXPERIMENTS WITH OATS.

No.	MODE OF DISINFECTION.	Smutted ears in the crop	Germinative power of spores in seed	Estimation of quality of crop at the beginning of July; scale, 1—5.
		Per ct.	Per ct.	
1	*Undressed*	36	20	5 Very good.
2	½ Per cent. sulphate of copper	½	5	4 Good.
3	1 P. c. sulphate of copper	0	0	1 Very bad.
4	{1 P. c. sulphate of copper with 4 p. c. quicklime}	½	?	4½ Good; almost good as No. 1.
5	⅔ P. c. English sulphuric acid	13	1 or 2	4 Good.
6	1 P. c. English sulphuric acid	2	?	3 Moderate.
7	1¼ P. c. English sulphuric acid	¼	?	3 Moderate.
8	1½ P. c. English sulphuric acid	0	0	2 Bad.
9	4 P. c. quicklime and 2 p. c. salt	9	4	4 Good.
10	Dry heat, 122° F., for 7 hours	36	20	4½ Good; almost good as No. 1.
11	Dry heat, 129° F., for 7 hours	34	?	4½ Good; almost good as No. 1.
12	Moist heat, 127° F., for 5 hours	0	0	3 Moderate.
13	Warm water, 127° F., for 5 min's	½	½	5 Very good.
14	Warm water, 133° F., for 5 min's	0	0	5 Very good.

In July, 1889, he published a pamphlet *Le. Charbon des Céréles, in* French, giving concise directions for applying his method. Early in 1890[1] he published in German another account of his method. We have already given an account of it in Bulletin No. 8, Experiment Station, Kansas State Agricultural College, October, 1889: "Preliminary Report on Smut in Oats," pp. 94 and 95. Substantially the same is here reproduced:

TREATMENT RECOMMENDED.

The Jensen Hot - Water Treatment.

The hot-water treatment consists in immersing the seed, which is supposed to be infected with smut, for a few minutes in scalding water. The temperature must be such as to kill the smut spores, and the immersion must not be prolonged so that the heat would injure the germ or embryo concealed within the seed-coats. If the water is at a temperature of 132° F., the spores will be killed, and yet the immersion, if not continued beyond fifteen minutes at least, will not in the least injure the seed. The smut spores will possibly be killed by five minutes immersion. An eight- to

[1]Jensen, Ueber die Verhüting des Kornbrandes, Kjöpenhavn.

twelve-minute immersion however is recommended.* The temperature must be allowed to vary but little from 132°; in no case rising higher than 135°, nor falling below 130°. To preserve these conditions when treating large quantities of seed, the following suggestions are offered:

Provide two large vessels, as two kettles over a fire, or boilers on a cook stove; the first containing warm water (say 110°-120°), the second containing scalding water (132°).

The first is for the purpose of warming the seed preparatory to dipping it into the second. Unless this precaution is taken, it will be difficult or impossible to keep the water in the second vessel at a proper temperature. The seed to be treated must be placed, a half-bushel or more at a time, in a vessel that will allow free entrance and exit of water on all sides. For this purpose a bushel basket made of heavy wire could be used, over which stretch wire netting, say twelve meshes to the inch; or an iron frame could be made at a trifling cost, over which the wire netting could be stretched. This would allow the water to pass freely, and yet prevent the passage of the seed. A lid or cover should also be provided, otherwise the portion of seed that tends to float will escape from the wire basket. Now dip the basket of seed in the first vessel; after a moment lift it, and when the water has for the most part escaped (requiring an exceedingly short time) plunge it into the water again, repeating the operation several times. The object of the lifting and plunging, to which might be added also a rotary motion, is to bring every grain in contact with the hot water. Less than a minute is required for this preparatory treatment, after which plunge the basket of seed into the second vessel. If the thermometer indicates that the temperature of the water is falling, pour in hot water until it is elevated to 132°. If it should rise higher than 132°, add small quantities of cold water. This will doubtless be the most effectual method of keeping the proper temperature, and requires only the addition of two small vessels—one for cold and the other for boiling water. The basket of seed should, very shortly after its immersion, be lifted, and then plunged and agitated in the manner described above, and the operation should be repeated several times. In this way only will every grain of the seed be brought and kept in contact with water that is at the temperature necessary for killing the smut spores. When the basket is lifted finally from the scalding water, it must be plunged into cold water, or cold water must be thrown over it, in order to cool it quickly. The seed should then be spread out to dry, but the drying need not be thorough unless the seed is to be stored some time before planting.

EXPERIMENTS WITH TREATED SEED AND TREATED SOIL.

Through the kindness of Mr. J. F. Swingle, we were enabled to plant prepared seed on the edge of an oat-field planted with the same variety un-

*Experiments are under way to determine the minimum time of immersion and the most favorable temperature of the water.

treated. A strip about forty rods long, and one rod wide, was planted with common winter oats— one-third treated with iron sulphate,* one-third with hot water,† and one-third untreated. The seed was sown broadcast, and harrowed in. The land was a rich creek-bottom. The oats were sown on March 16. came up equally well, and on July 2 were harvested. Little difference could be seen between the plots until they headed out. The following diagram shows the relative positions of the plots:

Count 11. (8.44 per cent. smutted.)	Count 10. (5.54 per cent. smutted.)	Count 9. (4.9 per cent. smutted.)
III. (8.11 per cent. smutted.) Seed untreated.	II. (0 per cent. smutted.) Heated Water 15 minutes, at 132° F.	I. (4.67 per cent. smutted.) Iron sulphate; 18 hours in a $1^{1}/4$ lbs. to 1 gal. sol.

Just before cutting, the per cent. of smut was obtained by count, both in the plots and in the adjacent portion of the field. The results of the count are given above, in the diagram of the experiment. Not a single smutted head could be found in Plot H, treated according to Jensen's hot-water method; but the iron sulphate had little or no effect.

When the oats were harvested, the self-binder was run through the middle of Plots I, II, and III, and as the machine was entirely inside of the plots, a cut of the full width (4 ft. 8 in.) was insured. A strip exactly 100 feet long was cut from each plot, and care was taken to secure all of the grain. On July 18 it was threshed, with the result shown in the following table:

TABLE SHOWING THE YIELD IN POUNDS OF GRAIN AND STRAW IN PLOTS I-III.

Plot I	29½	18½
Plot II	44¾	21 ¾
Plot III	28¾	18¼

With the yield of grain and straw in III as 100, the comparison is as follows:

TABLE SHOWING COMPARATIVE YIELD OF PLOTS I-III, WITH III AS 100.

	Straw.	Grain.
Plot III	100	100
Plot II	$155^{3}/5$	$119^{1}/5$
Plot I	$102^{5}/8$	$101^{3}/8$

*Soaked 18 hours in a solution of 11/4 pounds to 6 gallons of water.
† Treated as described above, p.

It will be seen that Plot II yielded 55 3/5 per cent. more straw, and 19 1/5 per cent. more grain, than No. III; while No. I was almost exactly the same as No. III, the difference being about equal to the difference in the per cent. of smut. It is impossible to account for the great superiority of Plot II over the others, unless, besides killing the smut, the Jensen treatment also caused the seed to germinate better.

It is an interesting, and, perhaps, very important fact, that Jensen[1] has found a similar increase in the yield over and above the amount of smut destroyed both in barley and oats. The following shows the comparative yield in two experiments conducted with barley in 1888; the figures indicate kilos per hectare[2]:

	I.	*II.*	*Average.*
Treated with warm water	2,307	4,107	3,207
Untreated	1,978	4,022	3,000

The loss from smut was 4 per cent., but the yield was increased nearly 7 per cent. Similar experiments with oats gave[2]:

	I.	*II.*	*Average.*
Jensen treatment	1,265	3,178	2,222
Untreated	1,210	3,038	2,124

The loss from smut was only about ¼ per cent., but the yield was increased nearly 5 per cent.

Another experiment was performed on upland soil, as follows: On March 21, 1889, twelve plots, each eighteen feet square, were planted. The accompanying diagram shows the arrangement of the plots.

[1] Jensen. Udbytteformerelsen ved Varmvands Methoden, Kjöp., 1890; Jensen, Ueber die Verhüting des Kornbrandes, Kjöp., 890, p. 3.
[2] Jensen. Ueber die Verhüting des Kornbrandes, Kjöp., 1890, p. 3.

1. Seed untreated, and soil untreated. *(11.1 per cent. Smut.)*	7. Seed as 1, and soil manured and smutted. *(9.1 per cent. Smut.)*
2. Seed treated with $CuSo_4$, (4 oz. to 1 gal.); soil untreated. *(2 per cent. Smut.)*	8. Seed as 2; soil manured and smutted. *(1.73 per cent. Smut.)*
3. Seed treated with hot water (132°), soil untreated. *(0 per cent. Smut.)*	9. Seed as 3; soil manured and smutted. *(0 per cent, Smut.)*
4. Seed untreated, soil untreated. *(11 per cent. Smut.)*	10. Seed as 4; soil smutted, not manured. *(8.63 per cent. Smut.)*
5. Seed treated with $CuSo_4$, (4 oz. to 1 gal.); soil untreated. *(1 per cent. Smut)*	11. Seed as 5; soil smutted, not manured. *(0 per cent. Smut.)*
6. Seed treated with hot water (132°), soil untreated. *(0 per cent. Smut.)*	12. Seed as 6; soil smutted, not manured. *(0 per cent. Smut.)*

On August 7, 1888, the land occupied by Plots 7, 8 and 9, was manured with stable manure, and all the plots from 7 to 12 inclusive were inoculated with smut. The smut had been collected in July, 1888, while the oats were yet standing. A smutted head was put on at least every square foot of ground. Then all the plots from 7 to 12 inclusive were at once plowed. Just before seeding, in March, 1889, all the plots from 1 to 12 inclusive were again plowed.* The prepared seed was sown with a drill. Red winter oats from the Farm Department were used. The seed used in Plots 2, 8, 5 and 11 was prepared by soaking 18 hours in a solution of copper sulphate of the strength of 4 oz. to 1 gal. of water. The seed used in Plots 3, 9, 6 and 12 was treated by the Jensen hot-water method before described. The other plots were untreated. The oats in the plots planted with seed treated with copper sulphate did not come up well, and the plants that appeared were not very health. On July 9 and 10, 1889, three thousand (3,000) heads were counted in each plot, with the result which follows:

PLOT l.—Of 3,000 heads 333 were smutted, or 11.1 per cent. The stand was good.

PLOT 2.—Of 3,000 heads 60 were smutted, or 2 per cent. All these, however, were along the edge adjoining Plot 1, and were probably from a few smutted grains left in the drill after planting Plots 1 and 7. The stand was very poor.

PLOT 3.—Of 3,000 heads not one was smutted. The stand was very good, and the plants looked vigorous.

PLOT 4.—Of 3,000 heads 330 were smutted, or 11 per cent, Almost exactly the per cent. found in the similar plot 1.

PLOT 5.—Of 3,000 heads 3 were smutted, or .1 per cent. The stand, &c., was as in Plot 2.

PLOT 6.—Of 3,000 heads not one was smutted. Stand, &c., as in Plot 3.

PLOT 7.—Of 3,000 heads 273 were smutted, or 9.1 per cent. Though grown on smutted and manured soil, the per cent. of smut was less than in Plot 1 adjoining. The stand was good; the growth was very rank.

PLOT 8.—Of 3,000 heads 52 were smutted, or 1.73 per cent. These smutted heads adjoined Plot 7, and are to be explained as in case of Plot 2. Stand was poor, but growth was rank.

PLOT 9.—Of 3,000 heads none were smutted, showing that not a single kernel was infected from the soil. The growth was rank, and the stand good.

PLOT 10.—Of 3,000 heads 259 were smutted, or 8.63 per cent.; less than the adjacent Plot 4 on unsmutted soil. The growth, &c., was as in Plot 4.

PLOT 11.—Of 3,000 heads none smutted. Stand was, as in Plot 5, very poor.

PLOT 12.—Of 3,000 heads none were smutted.

* By inadvertency, the land occupied by all the plots was plowed a second time the last week in October, 1888.

This experiment seemed to show:

1. Treatment of the seed with hot water by the Jensen method completely prevented the smut in every case, and improved rather than diminished the germinating power of the seed and the vigor of the plants.

2. Treatment with a solution of copper sulphate, 4 ounces to 1 gallon for 18 hours, prevented the smut, but greatly injured the seed.

3. Soil treated with manure and smut the previous August, and also soil simply smutted at the same time, actually gave a less per cent. of smut than untreated soil. This result is unexplainable, unless it can be referred to the immediate plowing which the other plots did not receive.

Another series of plots adjoining Nos. 1–12 were planted on March 23, 1889. The accompanying diagram shows the arrangement of the plots. Plot 13 was just below 12 and 6.

The variety used was Red Winter, except where otherwise mentioned. The seed of alternate plots was untreated. A garden hand-drill was used in planting, but the stand was uneven, necessitating a thinning-out of some of the dense bunches. In some of the plots the stand was very poor, owing to the injurious effects of the treatment on the seed. On May 28 the weeds were hoed out of all the plots that needed weeding. The rows were rather wide apart, and could be easily hoed without disturbing the grain. All of the plots were about 22 feet long, and most of them were about 6 feet wide, and had 6 rows. Nos. 29, 30 and 32, 33 had only 3 rows, and were of half the width, and No. 34 had 10 rows, and was correspondingly wider. The soil in all cases was without treatment of any kind, except that occupied by No. 13, which had been artificially smutted at the same time and in the same manner as that occupied by plots 10–12. The land was plowed August 8, 1888, October, 1888, and March, 1889. The diagrams on the following pages show the position and shape of the plots.

13. Untreated; soil smutted (the only one). *(9.26 per cent. Smutted.)*
14. Seed treated with hot water as in Plot 11. *(0 per cent. Smutted.)*
15. Copper sulphate (4 oz. to 1 gal.), 18 hours. *(0 per cent. Smutted.)*
16. Untreated. *(8.4 per cent. Smutted.)*
17. Lime and soap (excess of lime) 18 hours. *(0.73 per cent Smutted.)*
18. Untreated. *(11.33 per cent. Smutted.)*
19. Lime and soap (less soap) 18 hours. *(2.16 per cent. Smutted.)*
20. Untreated. *(10.23 per cent. Smutted.)*

21. Five per cent. lye, 18 hours. *(.0006 per cent. Smutted.)*
22. Untreated. *(9.83 per cent. Smutted.)*
23. Same as 25, but untreated. Winter Oats. *(6.8 per cent. Smutted.)*
24. Untreated. Red Winter. *(9.46 per cent. Smutted.)*
25. Artificially smutted when in bloom. Winter Oats. *(6.43 per cent. Smutted.)*
26. Untreated. Red Winter. *(9.13 per cent. Smutted.)*
27. Same as 23, like 25, but untreated. Winter Oats. *(5.43 per cent. Smutted.)*
28. Untreated. Red Winter. *(10.76 per cent. Smutted.*

29. Three per cent. sulphuric acid. BLACK OATS. *(1.70 per cent. Smutted.)*
30. Ten per cent. sulphuric acid. BLACK OATS. *(7.61 per cent. Smutted.*
31. Untreated. RED WINTER. *(9.24 per. cent. Smutted.)*
32. Untreated. BADGER QUEEN. *(9.07 per cent. Smutted.)*
33. Untreated. BLACK OATS. *(18.64 per cent. Smutted.)*
34. Smutted by moistening the seed and rolling in smut just before planting. RED WINTER. *(14.4 per cent. Smutted.)*

PLOT 13.—Seed untreated—soil smutted, same as in Plot 10 above. Of 3,000 heads counted 278 were smutted, or 9.2 per cent. of the whole.

PLOT 14.—Planted with seed treated with hot water, as for Plots 3, 6, 9 and 12 above. Soil (as for all the following) untreated. Of 3,000 heads counted none were smutted.

PLOT 15.—Seed treated with copper sulphate (40z. to 1 gal.) for 18 hours, as in Plots 25, 3 and 11 above. Of 1908 heads none were smutted. The plants were evidently much injured by the treatment.

PLOT 16.—Untreated. Of 3,000 heads 252 were smutted, or 8.4 per cent.

PLOT 17.—Seed treated by being immersed in a solution of lime and castile soap (with excess of undissolved lime) for 18 hours. Of 3,000 heads 22, or .73 per cent., were smutted. The stand was quite good.

PLOT 18.—Untreated. Of 3,000 heads counted 340 were smutted, or 11.3 per cent. of all.

PLOT 19.—Planted with seed treated the same as in Plot 17, except that the quantity of solid lime was less, and that of undissolved soap was greater. Of 3,000 heads 65 were smutted, or 2.16 per cent.

PLOT 20.—Untreated. Of 3,000 heads 307 were smutted, being 10.2 per cent. of the whole.

PLOT 21.—Seed soaked 18 hours in a 5-per-cent. solution of concentrated lye. All of the panicles produced were counted, namely 2,918, and of these but two were smutted (.0007 per cent.). The seed injured by the treatment. The two smutted were without doubt from an untreated seed, since they grew just where the drill started after planting untreated seed.

PLOT 22.—Untreated. Of 3,000 heads, 295 were smutted, or 9.8 per cent.

PLOT 23.—The seed, winter oats, but not the same as the preceding, was obtained from the field where count 5 (giving 12.6 per cent. smutted heads) was made. When the plots were in bloom, in 1888, fresh smut was dusted over them repeatedly with a view of infecting the seed more thoroughly; but of 3,000 heads counted in this plot, only 204, or 6.8 per cent., were smutted. (See Plot 27.)

PLOT 24.—Red Winter; untreated. Of 3,000 heads counted, 284, or 9.4 per cent., were smutted.

PLOT 25.—Seed from same field as that used in Plots 23 and 27, but *not* artificially smutted. Of 3,000 heads counted, 193, or 6.4 per cent., were smutted.

PLOT 26.—Red Winter; untreated. Of 3,000 heads counted, 274 were smutted, being 9.13 per cent. of all.

PLOT 27.—Seed the same as in Plot 23. Of 3,000 heads, 163, or 5.43 per cent., were smutted.

As will be seen on comparison with Plots 23 and 25, the per cent. of smutted heads in the plots planted with artificially smutted heads was in No. 23 larger and in 27 smaller than in No. 25 planted with untreated seed from the same field. In this case the attempted artificial inoculation was entirely without effect.

PLOT 28.—Red Winter; untreated. Of 3,000 heads 323, or 10.76 per cent., were smutted.

PLOT 29.—(3 rows.) Planted with black oats which had been soaked 18 hours in a 3-per-cent. solution of sulphuric acid. Of the 1,409 heads produced, 24, or only 1.7 per cent., were smutted. The plants were somewhat injured by the treatment.

PLOT 30.—(3 rows.) Seed same as in Plot 29, but was treated with 10-per-cent. solution of sulphuric acid. The seed was much injured by this treatment, and only 761 heads were produced. Of these none were smutted.

PLOT 31.—Red Winter; untreated. Of 3,000 heads 272, or 9.24 per cent., were smutted.

PLOT 32.—(3 rows.) Planted with Badger Queen; untreated. Of 1,377 heads produced, 125, or 9.07 per cent., were smutted.

PLOT 33.—(3 rows.) Planted with black oats, as Plots 29 and 30, but seed untreated. Of 2521 heads 470, or 18.64 per cent., were smutted.

PLOT 34.—(10 rows.) Planted with untreated Red Winter, artificially smutted just before planting by moistening the seeds and dusting them with smut. Of 3,000 heads counted 432 were smutted, or 14.4 per cent. To be of value this experiment should have been tried with seed treated with hot water, so that any smut obtained would be from that applied to the seeds when planted. As it was, there seemed to be an increase in the per cent. over the other plots of untreated Red Winter.

The experiments seemed to show, so far as the results of a single year can be relied upon:

1. Artificially dusting smut on the plants when they were in blossom had no appreciable effect. (See Plots 23, 25, and 27.)

2. Artificially dusting the untreated seed with smut seemed to increase the per cent. of smut slightly. (See Plot 34.)

3. Treatment with lime and castile soap solution (with excess of lime) prevented smut almost entirely. It injured the seed but slightly. (See Plot 17.)

4. Treatment with lime and castile soap solution (with excess of soap) reduced the smut much, though not so much as the treatment with excess of lime, and like that injured the seed but little. (See Plot 19.)

5. Treatment with 5-per-cent. lye solution prevented all smut, but injured seed considerably.

6. Treatment with 3-per-cent. sulphuric acid solution prevented much of the smut, but considerably injured the seed; while treatment with a 10-per-cent. solution greatly injured the seed and completely prevented the smut.

8. The per cent. of smut varied somewhat in different plots from the same seed, and much more in different varieties.

This is clearly shown in the tables on the following pages, which give the detailed counts of all the plots from 1 to 34.

PER CENT. OF SMUT IN DIFFERENT PLOTS.

PLOT 1.		PLOT 2.		PLOT 3.		PLOT 4.		PLOT 5.		PLOT 6.		PLOT 7.	
Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....
100	9	100	0	100	0	100	14	100	0	100	0	100	12
100	8	100	0	100	0	100	20	100	0	100	0	100	10
100	8	100	0	100	0	100	14	100	0	100	0	100	10
100	8	100	0	100	0	100	14	100	0	100	0	100	8
100	14	100	0	100	0	100	19	100	0	100	0	100	4
100	15	100	0	100	0	100	11	100	0	100	0	100	9
100	6	100	0	100	0	100	5	100	3	100	0	100	4
100	20	100	0	100	0	100	4	100	0	100	0	100	9
100	18	100	0	100	0	100	4	100	0	100	0	100	10
100	20	100	0	100	0	100	16	100	0	100	0	100	8
100	10	100	1	100	0	100	12	100	0	100	0	100	12
100	9	100	1	100	0	100	6	100	0	100	0	100	9
100	11	100	0	100	0	100	11	100	0	100	0	100	16
100	13	100	7	100	0	100	6	100	0	100	0	100	14
100	9	100	12	100	0	100	10	100	0	100	0	100	9
100	12	100	0	100	0	100	8	100	0	100	0	100	4
100	12	100	0	100	0	100	5	100	0	100	0	100	12
100	11	100	9	100	0	100	13	100	0	100	0	100	3
100	6	100	6	100	0	100	7	100	0	100	0	100	15
100	14	100	0	100	0	100	10	100	0	100	0	100	8
100	7	100	0	100	0	100	9	100	0	100	0	100	10
100	8	100	7	100	0	100	7	100	0	100	0	100	10
100	7	100	11	100	0	100	10	100	0	100	0	100	7
100	11	100	8	100	0	100	10	100	0	100	0	100	15
100	11	100	0	100	0	100	19	100	0	100	0	100	11
100	9	100	0	100	0	100	20	100	0	100	0	100	0
100	15	100	0	100	0	100	11	100	0	100	0	100	13
100	16	100	0	100	0	100	14	100	0	100	0	100	8
100	6	100	0	100	0	100	10	100	0	100	0	100	7
100	10	100	0	100	0	100	11	100	0	100	0	100	6
3000	11.1	3000	0.02	3000	0	3000	11	3000	0.001	3000	0	3000	9.1

PLOT 8.		PLOT 9.		PLOT 10.		PLOT 11.		PLOT 12.		PLOT 13.		PLOT 14.	
Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....
100	9	100	0	100	5	100	0	100	0	100	9	100	0
100	3	100	0	100	5	100	0	100	0	100	5	100	0
100	10	100	0	100	5	100	0	100	0	100	11	100	0
100	0	100	0	100	14	100	0	100	0	100	12	100	0
100	0	100	0	100	6	100	0	100	0	100	7	100	0
100	6	100	0	100	15	100	0	100	0	100	10	100	0
100	0	100	0	100	4	100	0	100	0	100	11	100	0
100	1	100	0	100	7	100	0	100	0	100	4	100	0
100	2	100	0	100	9	100	0	100	0	100	10	100	0
100	3	100	0	100	15	100	0	100	0	100	2	100	0
100	5	100	0	100	12	100	0	100	0	100	4	100	0
100	0	100	0	100	13	100	0	100	0	100	3	100	0
100	12	100	0	100	9	100	0	100	0	100	5	100	0
100	1	100	0	100	8	100	0	100	0	100	13	100	0
100	0	100	0	100	5	100	0	100	0	100	12	100	0
100	0	100	0	100	4	100	0	100	0	100	13	100	0
100	0	100	0	100	19	100	0	100	0	100	15	100	0
100	0	100	0	100	9	100	0	100	0	100	13	100	0
100	0	100	0	100	10	100	0	100	0	100	11	100	0
100	0	100	0	100	11	100	0	100	0	100	17	100	0
100	0	100	0	100	7	100	0	100	0	100	9	100	0
100	0	100	0	100	10	100	0	100	0	100	13	100	0
100	0	100	0	100	18	100	0	100	0	100	6	100	0
100	0	100	0	100	10	100	0	100	0	100	7	100	0
100	0	100	0	100	9	100	0	100	0	100	8	100	0
100	0	100	0	100	6	100	0	100	0	100	7	100	0
100	0	100	0	100	7	100	0	100	0	100	10	100	0
100	0	100	0	100	1	100	0	100	0	100	6	100	0
100	0	100	0	100	3	100	0	100	0	100	10	100	0
100	0	100	0	100	3	100	0	100	0	100	10	100	0
3000	1.73	3000	0	3000	8.63	3000	0	3000	0	3000	9.26	3000	0

PER CENT. OF SMUT IN DIFFERENT PLOTS—CONTINUED.

PLOT 15.		PLOT 16.		PLOT 17.		PLOT 18.		PLOT 19.		PLOT 20.		PLOT 21.	
Heads counted..	Smutted heads . ..	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....
100	0	100	13	100	1	100	1	100	1	100	5	100	0
100	0	100	2	100	1	100	12	100	2	100	8	100	0
100	0	100	2	100	0	100	21	100	2	100	6	100	0
100	0	100	12	100	1	100	15	100	3	100	8	100	0
100	0	100	6	100	1	100	16	100	4	100	11	100	0
100	0	100	13	100	1	100	6	100	2	100	6	100	0
100	0	100	11	100	0	100	9	100	2	100	16	100	0
100	0	100	22	100	0	100	11	100	2	100	13	100	0
100	0	100	8	100	0	100	17	100	1	100	8	100	0
100	0	100	9	100	3	100	8	100	1	100	15	100	0
100	0	100	4	100	0	100	12	100	2	100	13	100	0
100	0	100	8	100	0	100	13	100	1	100	11	100	0
100	0	100	7	100	2	100	11	100	9	100	7	100	0
100	0	100	20	100	1	100	21	100	1	100	9	100	0
100	0	100	5	100	0	100	9	100	5	100	5	100	0
100	0	100	5	100	4	100	11	100	1	100	15	100	0
100	0	100	5	100	0	100	14	100	2	100	11	100	0
100	0	100	7	100	0	100	17	100	1	100	13	100	0
100	0	100	3	100	0	100	15	100	2	100	9	100	0
8	0	100	13	100	0	100	5	100	2	100	10	100	0
		100	7	100	0	100	5	100	3	100	14	100	0
		100	9	100	0	100	15	100	1	100	9	100	0
		100	7	100	0	100	10	100	0	100	10	100	0
		100	11	100	1	100	18	100	2	100	17	100	0
		100	7	100	1	100	16	100	4	100	10	100	0
		100	6	100	1	100	3	100	2	100	5	100	0
		100	14	100	2	100	12	100	0	100	14	100	0
		100	3	100	0	100	5	100	3	100	17	100	0
		100	7	100	2	100	7	100	2	100	4	100	2
		100	6	100	0	100	5	100	2	100	8	18	0
1908	0	3000	8 4	3000	0.73	3000	11.33	3000	2.16	3000	10.23	2918	0.0006

PLOT 22.		PLOT 23.		PLOT 24.		PLOT 25.		PLOT 26.		PLOT 27.		PLOT 28.	
Heads counted..	Smutted heads	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....
100	15	100	2	100	10	100	5	100	11	100	10	100	6
100	15	100	9	100	6	100	10	100	5	100	3	100	13
100	5	100	6	100	8	100	3	100	9	100	6	100	20
100	6	100	6	100	11	100	8	100	8	100	3	100	12
100	8	100	14	100	10	100	3	100	11	100	4	100	4
100	18	100	8	100	14	100	3	100	10	100	8	100	7
100	9	100	10	100	7	100	10	100	7	100	3	100	12
100	10	100	13	100	.5	100	6	100	7	100	3	100	10
100	9	100	2	100	11	100	5	100	8	100	1	100	7
100	8	100	6	100	1	100	5	100	12	100	6	100	10
100	6	100	7	100	11	100	8	100	10	100	3	100	10
100	6	100	2	100	6	100	12	100	10	100	4	100	12
100	11	100	6	100	16	100	4	100	11	100	2	100	14
100	9	100	7	100	21	100	10	100	14	100	3	100	8
100	9	100	3	100	14	100	8	100	6	100	7	100	11
100	9	100	1	100	7	100	8	100	7	100	8	100	9
100	12	100	10	100	14	100	9	100	14	100	8	100	8
100	10	100	9	100	6	100	1	100	12	100	8	100	13
100	12	100	8	100	16	100	3	100	2	100	9	100	16
100	9	100	6	100	11	100	5	100	8	100	10	100	14
100	11	100	6	100	10	100	12	100	13	100	2	100	15
100	6	100	11	100	10	100	7	100	9	100	5	100	12
100	11	100	3	100	8	100	6	100	15	100	6	100	5
100	4	100	11	100	3	100	9	100	5	100	1	100	11
100	9	100	11	100	7	100	5	100	6	100	1	100	11
100	7	100	7	100	4	100	1	100	8	100	12	100	9
100	15	100	6	100	9	100	5	100	13	100	4	100	4
100	14	100	2	100	10	100	10	100	6	100	7	100	13
100	11	100	7	100	9	100	4	100	9	100	2	100	17
100	11	100	5	100	9	100	8	100	8	100	14	100	10
3000	9.83	3000	6.8	3000	9.46	3000	6.43	3000	9.13	3000	5.43	3000	10.76

PER CENT. OF SMUT IN DIFFERENT PLOTS—CONCLUDED.

PLOT 29.		PLOT 30.		PLOT 31.		PLOT 32.		PLOT 33.		PLOT 34.	
Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....	Heads counted..	Smutted heads.....
100	3	100	0	100	5	100	9	100	17	100	14
100	2	100	0	100	9	100	6	100	27	100	12
100	7	100	0	100	12	100	6	100	4	100	14
100	6	100	0	100	11	100	7	100	18	100	12
100	0	100	0	100	5	100	7	100	29	100	15
100	1	100	0	100	8	100	12	100	23	100	7
100	0	100	0	100	10	100	6	100	17	100	11
100	0	61	0	100	7	100	5	100	25	100	16
100	0			100	3	100	15	100	22	100	18
100	0			100	5	100	10	100	33	100	13
100	2			100	13	100	10	100	16	100	12
100	0			100	9	100	16	100	19	100	26
100	3			100	8	100	11	100	20	100	16
9	0			100	8	77	5	100	22	100	20
				100	7			100	16	100	12
				100	9			100	8	100	26
				100	9			100	24	100	17
				100	10			100	7	100	25
				100	10			100	25	100	17
				100	11			100	25	100	14
				100	11			100	13	100	12
				100	8			100	18	100	9
				100	11			100	19	100	13
				100	6			100	14	100	13
				100	5			100	7	100	17
				100	15			21	2	100	10
				100	8					100	8
				100	10					100	19
				100	20					100	4
				100	9					100	10
1309	1.70	761	0	3000	9.06	1377	9.07	2521	18.64	3000	14.4

A NEW FORM OF OAT SMUT.

(*Ustilago Avenæ* var. LEVIS.)

While investigating the oat smut, a curious form was noticed in a specimen from Shelburne, N. H., collected in August, 1882. (Ellis, N. A. F., No. 1091.) The spores were entirely smooth aud quite granular, supposed to be due to imperfect ripening of the spores. No further attention was given to it until specimens from Americus, Kansas, (collected by C. W. Coman, June 23, 1889,) which germinated with unusual vigor, were found to have these same smooth spores. The Manhattan specimens were then carefully examined, and among many hundred smutted heads four or five of this form were found. They showed the same vigorous germination as the Americus specimens. The only reference to different forms of oat smut found is by Jensen, who says[1]: “I would also add that some smutted ears of oats differ very considerably in their appearance from others, but I have not had the opportunity of investigating this question minutely.” Nothing is stated regarding the nature of the different forms, and it may perhaps be that Jensen had in view smut attacked by bacteria.

[1]Jensen. Prop. and Prev. of Sm., J. R. A. S. XXIV, SS. II, p. 11.

The following is the name used:

USTILAGO AVENæ (Persoon) Jensen, variety LEVIS Kellerman and Swingle, nov. var.

Injuries to Host Plant.

This form, from what has already been said, would seem to be rather rare. It is, however, hard to separate from the normal form. The outside membrane, covering the smutted spikeIets, seems somewhat more firm, and more persistent, and often the smutted spikelets have a quite marked grayish color, arising probably from the dark spores being seen through the light membrane.

Characters of the Smut.

The spores in mass are a very dark brownish, lacking any shade of olivaceous. They seem in the specimens somewhat darker than *Ustilago Avenæ,* but not so dark as *Ustilago Hordei.* They are of about the same size as in the typical form of oat smut, being 6-12x5½–8μ, mostly 6–9x6–7μ. In shape, also, they are nearly normal, being mostly oval, sometimes elliptical, or sub-globose, and sometimes angular, or irregular. The great peculiarity of the variety is, however, that the *epispore is smooth,* or at any rate not spiny, or punctate. Sometimes thicker portions appear, but they are slight, and not like the spines of the typical form. As usual, one side of the spore is lighter colored. The contents of the spore are quite often granular or guttate.

Germination in Water.

This has not been well investigated, but seems very much as in the usual form, except perhaps the promycelia are somewhat shorter.

Germination in Nutrient Solution. [1]

The germination seems uniformly to proceed with greater vigor than in the normal form. One striking feature which called our attention to the first culture made was the growth in the air. Already by 24 hours the surface of the liquid seemed mouldy, and later the whole surface became snowy white. This growth in the air was composed of long, slender branches or germ threads proceeding from the promycelium. Examination showed that the germination of this form varied from that of the species principally in the following points: (1) More of the spores germinated—often nearly all. (2) The promycelia remain attached; they never are detached in such large numbers, and those that do fall off do so mostly in old cultures. (3) The promycelia are shorter—17-45x2½-4μ, mostly 24–36x2½-3½μ, and also less angled at the knee-joints. (4) Conidia rather fewer. (5) Germ threads very abundant, and *often very narrow,* (1–¾μ.) These very narrow germ threads had apparently a very watery and vacuolate protoplasm, yet they grew to enormous length; larger germ tubes, as they progressed often became narrower.

[1] Modified Cohn solution. (See page 231.)

The exact importance of this variety is as yet little known. It is important that investigators be certain which they are observing or experimenting with. It maybe a distinct species, but some specimens seemed intermediate between the typical form and the variety.

THE LOOSE SMUT OF WHEAT, Ustilago Tritici (Persoon) Jensen.

HISTORICAL.

Until within a few years, the loose smut of wheat has been supposed to be the same as that of oats, or, at most, simply a variety of that species. In fact, all the loose smuts have long been known under the name *Ustilago segetum*. It was first included under the name *Ustilago*, by Tragus,[1] in 1552; Lobel soon after used the same name, and figured it[2]; and in 1570 again mentioned[3] it under the name Ustilago. In 1595, C. Bauhin described it under the name, *Ustilago secalina*. These authors, however did not recognize it as a fungus. This was first done by Linnæus and Bulliard, and the first distinctive name was applied to it by Persoon,[5] who called it *Uredo Tritici*, and considered it as a variety *b* of *Uredo segetum* (Bull.) Pers. DeCandolle[6] also named it as a variety of *Uredo carbo*. Philippar[7] called it *Uredo Carbo- Tritici*. Wallroth[8] named it *Erysibe vera b Tritici*. Tulasne[9] called it Ustilago Carbo *a vulgaris* a *Triticea*. None of these writers, however, noticed any difference in it from the loose smut growing on oats and barley, except that it grew on wheat. Jensen[10] in 1888 reported that wheat smut would infect only wheat plants, and gave the following results of his experiment with the spores of these smuts when applied to the bare kernels:

Spores from smutted wheat on wheat kernels gave 1 per cent. smutted heads; spores from smutted oats on wheat kernels gave no smutted heads; spores from smutted barley (covered smut) on wheat kernels gave no smutted heads. He also adds: "With regard to the variety of smut which occurs on wheat, it should be remarked that only one diseased plant was produced in the infection experiment quoted above. Now the germinative power of wheat-smut spores is much more feeble than of other varieties. I found that of last year's wheat-smut spores only one or two in a thousand germinated when examined this year, although they had been kept in a dry place all the winter. Further, wheat-smut spores produced this year (1888) germinated even more feebly, while with barley-smut and oat-smut spores the germinative faculty was more than a hundred times as great. This ac-

[1]Tragus, De stirpinm. Nomencl. prop. lib. III, p. 666, with figure, sec. F. v. Waldheim; lib. III, cap 34, sec. L. R, et Ch. Tulasne.
[2]Lobelius. Obs. plant, p.22, with figure, sec. L. R, et Ch. Tulasne and F. v. Waldheim.
[3]Lobelius et Pens stirpium adversarial nova. Londini, 1570, p. 11, sec. L. R. et Ch. Tulasne and F. v. Waldheim.
[4]C. Bauhin. Phytopinax. Basileæ, 1596, p. 52, sec. L. R. et Ch. Tulasne and F. v. Waldheim.
[5]Persoon. Synop. meth. fung. pars prima, p. 224.
[6]DeCandolle. Flora Francaise, VI, p. 76.
[7]Philippar. Traité sur la carie, etc., p. 92, pl. 4, ch. et R.
[8]Wallroth. F1. crypt. germ., p. 217, No. 1672.
[9]Tulasne. Sur les Ustilag. comp. aux les Ured., 1847, p. 80.
[10]J. L. Jensen. The Prop. and Prev. of Smut in oats and Barley, J. R. A. S., Vol. XXIV, S. S. Part II, p. 9.

cords with the well-known fact that wheat is less liable to be smutted than other kinds of corn. All this tends to show the distinctness of wheat smut from all the other varieties."

Plowright[1] notices the peculiar color of the spores, saying: "*U. segetum*, when it occurs in wheat has a distinctively golden luster, but when on *Avena elatior* it is sooty black. Physiological research will possibly show that these two forms are specifically distinct."

Brefeld considers wheat smut received from Dr. Kühn, from Halle, Germany, the same as the naked smut of barley.[2]

Fischer von Waldheim[3] notices the greater length of the promycelia of wheat smut, and says their disorganization followed earlier than in the forms on oats, barley, and Arrhenatherum avenaceum.

The following shows, as far as known, the synonymy of the species:

USTILAGO TRITICI (Persoon) Jensen.

1552 *Ustilago* Tragus, De stirp. Nomencl. pr. lib. III, p. 666. Lobelius, Obs. plant., p. 22; Stirp. adv. nov., p. 11. p.p.
1596 *Ustilago secalina* Bauhin, Phytopinax, p. 52.
1797 *Uredo segetum* Persoon, Disp, meth. fung., p. 56. p.p.
1801 *Uredo (Ustilago) segetum b Uredo Tritici* Persoon, Syn. meth. fung., p. 224.
1809 *Cœoma segetum* Link, Obs. I, p.4; Sp. pl. Willd. VI, II, p.1, No. 1. p.p.
1815 *Uredo carbo b Tritici* De Candolle, F1. fr. VI, p. 76.
1833 *Erysibe vera b Tritici* Wallroth, F1. crypt. germ. pars post., p. 217, No. 1672.
1837 *Uredo Carbo-Tritici* Philippar, Traité, p. 92, pl. IV.
1847 *Ustilago Carbo a vulgaris* a *Triticea* R. et Ch. Tulasne, Mém. sur les Ustilag. comp. aux les Ured. in Ann. sci. nat., 3 série, t. 7, p. 80.
1888 *Ustilago Hordei* Brefeld, Neue Unters. II in Nachr. aus d. Klub der Landw. zu Berl., Nr. 221, 28 Juni, 1888, S. 1593 (*Ustilago Hordei* Brefeld, l. c., Nr. 220, 8 Juni, 1888, S. 1581, foot-note). p.p.
1888 *Ustilago segetum* var. *Tritici* Jensen, Om Kornsorternes Brand. (Anden Meddelelse), S. 61.
1888 *Ustilago segetum* var. *Tritici* Jensen, Prop. and Prev. of Smut, in J. R. A. S. XXIV, s. s. Part II, p. 11.
1890 *Ustilago Tritici* Jensen, in letter dated Jan. 24, 1890.

INJURIES TO HOST PLANT.

The loose smut of wheat resembles oat smut and naked barley smut in converting the head attacked into a powdery mass of spores, which are then liberated with the greatest ease. There is almost always a considerable

[1]C. B. Plowright. British Ured. and Ust. 1889. p. 70.
[2]Brefeld, New. Unters, II, S. 1593. "Auch in diesen fand sich derselbe Pilz wie in der Gerste, die Sporen machten keine Conidien."
[3]F. v. Waldheim. Contr. to Biol. in Tr. N. Y. Ag. Soc. 1870. p.335.

amount of shreds and plates of tissue running through the spore mass. These remnants of the tissue of the flowering parts are more numerous and larger than in *Ustilago nuda* (covered barley smut). Very often these shreds preserve more or less of their natural color at the tip, and in bearded wheat sometimes the awns remain though somewhat stunted. This remaining tissue is plainly shown in Plate II, fig. 2. In more of the specimens examined was there any sign of an external membrane or covering as in the two barley smuts. In this respect, the smutted heads resemble those of oats. Almost always the whole head is smutted; but in Plate II, fig. 1 is represented a head (from Minnesota) which was smutted only at the base. The spores are completely free, and this species is perhaps the dustiest of all the loose smuts. A few spores remain clinging to or entangled among the fibers for a considerable time. The infected heads attain their normal height.

According to Bessey's observations,[1] unlike the oat smut, a stool or hill all grown from one seed may often produce both smutted and sound heads. The following table is prepared from his report; the observations were made in different years:

No. of stalks in hill.	No. smutted.	No. sound.
2	2	..
2	2	..
2	2	..
2	2	..
4	2	2
7	5	2
1	1	..
2	2	..
2	1	1
3	3	..
3	2	1
3	2	1
4	4	..
4	4	..
4	4	..
5	5	..
5	5	..
6	3	3
16	4	12
77	55	22

The amount of damage from this parasite is usually very small, and it is hence often overlooked. Mr. Erwin F. Smith, however, reports it from Michigan, and says: "Does more or less injury every year. I saw one field of five acres much injured (50 per cent.) in 1870."[2] It seems scarcely possible that the loose smut would ever be so abundant, and it may be that he had instead the stinking smut, which is sometimes even more destructive than that.

[1]Bulletin of the Iowa Ag. Coll Dept. Bot., 1884. Cedar Rapids, Iowa, pp. 123 and 124.
[2]Erwin F. Smith, in Rept. Dept. Agr. for 1886, (Myc. sect.,) p. 133.

GEOGRAPHICAL DISTRIBUTION.

The wheat smut occurs sparingly in wheat all over the world, in all probability, and hence no attempt is made to give its detailed distribution. Its small damage is probably the cause of its not being more generally recognized. It is said to attack summer wheats the most, winter wheats less, and least of all hard wheat and spelt.

CHARACTERS OF THE SMUT.

The loose wheat smut has free spores which have a dark or dusky brown color, with a distinct olivaceous tinge almost exactly like *Ustilago nuda.* This peculiar tinge of color in the spore, when seen in mass, serves to distinguish them from the black spores of *Ustilago Hordei.* The color of the spores varies only slightly in specimens from very different localities.

In shape the spores are rather regular, being less variable than in *Ustilago Avenæ.* They are, as in *Ustilago Avenæ* and *Ustilago nuda,* mostly oval, varying rather often to subglobose and less often to angular or elliptical. (See Plate VI.) Abnormal forms are very rare, though quite often the spores are slightly angular.

In size the spores are rather variable, more so than in *Ustilago nuda,* and less so than in *Ustilago Avenæ.* They are 5-8x4½-7μ, mostly 5½-7½x5-6μ. The variations in size are shown in the many figures on Plate VI. The wall is composed of two layers, the *endospore* within and the *epispore* without. The line of separation between the two without the use of reagents is hard to see; it is, however, shown in Plate VI, figs. 4, 26, and 35. In figs. 1, 13–17, 28, 29 and 33 the division between the two layers of the wall cannot be seen.

Character of the Spore Wall.

One side of the spore is always darker colored, and in most cases the difference between the two sides is considerable. This coloration is seen in all the figures of spores on Plate VI. In optical section, the combined epispore and endospore could in some cases be traced only on the dark side of the spore (Plate VI, figs. 6 and 29). In others, as in figs. 1, 13, 17, 28, and 37, the wall could be traced entirely around; it was, however, plainest, and sometimes apparently thickest, on the dark side, where the endospore and epispore could be distinguished in optical section. In such cases, the line of separation between the two layers is usually clearest on the light side, as figs. 26 and 35. Although the wall was, as has been just noted, in some cases difficult or impossible to see, by the use of reagents it was plainly shown to exist. The promycelium, as in all the other species, arises from this lighter-colored side of the spore. The epispore of this species is always clothed with spines, which are somewhat variable in size and distribution over the surface. They may in some cases be plainly seen on the edge of the spore, as is shown in Plate VI, figs. 14, 25, 26, 32, and others. In other instances they cannot be seen on the edge—only on the face of the spore which happens to be uppermost. There is, as in *Ustilago Avenæ and Ustilago* *nuda,* a space immediately surrounding the place where the promycelium will appear (of course on the light side), a small area where spines are wanting. The spore is only rarely split when it germinates, and the promycelium is at first usually constricted where it passes through the wall, though in older cultures it often expands. Spores in nutrient solution quite often swell up and crack, as is shown in fig. 19.

Action of Reagents.

In chloriodide of zinc a portion of the spore colored at once, the entire contents being stained reddish and the wall remaining unchanged, as in fig. 1. Others collapsed, but did not stain, as shown in figs. 2 and 3. At first this was supposed to furnish an indication of the per cent. of spores capable of germinating, since older specimens which would not germinate would not stain readily, while in fresh specimens many of the spores quickly became stained. To a certain extent this test may be a good one, but it was found that if the spores are left long enough in the chloriodide of zinc all would eventualy become stained. In chromic acid the spores were rapidly dissolved, and in a few minutes only the dark side of the spore remained, and this was gradually corroded.

GERMINATION IN WATER.

This species germinates somewhat slower than *Ustilago Avenæ* and *Ustilago Hordei.* By 15 hours some of the spores had sent out a promycelium to a considerable length (18–33μ) while other spores had just germinated. All these promycelia were continuous, and some of them considerably curved, even if short. From this point the growth was rapid; by 24 hours the promycelia had in many cases obtained their full size, 18–45x3–4½μ, and were nearly all 2-3 septate, and some even (faintly) 6–7 septate. These promycelia were, like those of *U. nuda,* always attached; sometimes vacant at base, and rarely in others places. Knee-joint fusions were quite often seen. There were some branches, especially from the base, which were usually short and rather thick. With this the growth of the promycelia practically ceased. The further changes were a slight growth of the branches, especially those from the base of the promycelium. The segments often became empty above and below, leaving one to several filled segments in the middle like the one shown in Plate VI, fig. 11. Then the segment in many cases swelled slightly (becoming 4-5½μ diam.) and became rounded and somewhat slightly enlarged at the septa. The knee-joint fusions also swelled somewhat, and were often bent at a considerable angle. With this, practically all growth ceased. A few fusions were seen of the slender tube branches, either with the segments of the same promycelium or of another. At no stage were any sporidia formed or free segments produced. It was noticed that in pure water the per cent. of germination was small; but in one case a small quantity of mucilage from the label was dissolved in the water and many more germinations were observed. The character of the growth was, however, practically the same as in pure water, except perhaps slightly more vigorous.

The noticeable facts regarding the germination of *Ustilago Tritici in* water are:

1. The general weakness and small amount of the growth as compared with the cultures in nutrient solution.
2. *All* the promycelia remain attached.
3. *No sporidia are formed nor segments freed.*
4. Total *absence of long growths from knee-joint fusions* (in fact in some instances a portion of the promycelium including a knee-joint fusion was vacant, the protoplasm having receded to the cell above and below); in this respect differing very markedly from *Ustilago nuda* (q. v.).

GERMINATION IN NUTRIENT SOLUTION.[1]

In the course of about 15 hours germination begins, and then progresses rapidly. At first the growth is as already described in water, but always more vigorous. Very soon in most cases branches arose from the segments near the septa, and rapidly grew forth. They remained thick, and soon became branched themselves. These branches are peculiar in being in most cases curved (in floating spores outward and downward). By 30 hours these branches are exceedingly numerous, and form a tangled mass difficult to trace. There are on the promycelia (which are by this time more elongated and 5–8 septate) a few knee-joints, and from these grow out long germ threads, 100–250μ long, empty at base (as are sometimes the knee-joints), and filled at tip. These are slender, being 2–2½μ in diam. in filled portion, and 1½–2μ in diam. in vacant basal portion. The filled tips are 80–110μ long. This is a peculiar and noticeable phenomenon of the growth, since the ordinary branches are yet crowded with contents and are commonly septate and repeatedly branched, while the germ thread grows from the same promycelium, and has a long vacant base. Not all the promycelia by 30 hours are so much branched, and some are as simple as those shown in Plate VI, fig. 14, which is from the same culture as figs. 17 and 35, but some are as much branched as the ones shown in Plate VI, figs. 17 and 35. Fig. 17 is a good figure, as it shows also somewhat of the curved growth so common. However, the branches themselves are often strongly curved. As growth progresses a difference is to be noticed between spores floating free from and those lying close to others. In two or three days, when free, the promycelium is still free to grow, and accordingly continues to produce blunt, short septate branches till the whole makes a very complicated mass often 150μ or more in diam., all crowded full of contents and much more intricate than shown in fig. 17. On the contrary, when united in a mass, the promycelia become empty or nearly so, as do also the branches at their bases. The branches now grow out into coarse germ threads 100 to perhaps 300μ or more long, with tips 75-110x2–3μ, and base 2½μ in diam.

[1] Modified Cohn solution.

These grow rapidly, and to a great length. They are just like the same threads already found growing from the knee-joint fuisions when the culture was 20 hours old, except they are coarser. As the culture becomes exhausted these germ tubes swell up somewhat, becoming 4–5μ diam. and shorter (25–50μ long). They may remain so or become septate, as is especially the case when by a contraction of the protoplasm the tip is almost empty. No sporidia are produced nor free segments, but by consulting fig. 17 it will be seen that by mechanical injury segments might easily be loosened.

The description above is of the germination obtained in very great vigor from specimens collected by J. M. Holzinger at Winona, Minnesota, July 15, 1889. The only other specimen of wheat smut on hand that could be induced to germinate was that issued in A Century of Illustrative Fungi, 1889, by Underwood and Cook, "No. 56, on wheat, Syracuse, N. Y., June, 1889." The germination was much less vigorous than from the Minnesota specimens, and was moreover somewhat different. The promycelia branched much less, and sent out after several days the slender branches shown in figs. 13 and 34. In a few cultures segments or sporidia were seen, and are figured in Plate VI, figs. 10, 12, 18, and 36; also a free promycelium(?), as shown in fig. 16. It may be that these conidia and segments were from such promycelia breaking to pieces, as the similarity of figs. 12 to 16 would seem to show, but more probably it was an impurity of some kind in the culture experiment, as many cultures made after the plate was sent to the engraver failed to show such growths.

Brefeld[1] considers wheat smut the same as naked barley smut, and says it produces no sporidia. It seems certain, however, that the forms investigated by us are distinct from *Ustilago nuda*, since in nearly every particular of growth they are different.

PREVENTION.

On this point little is recorded. Plowright says[2]: "There is a certain point in connection with the reproduction of smut *(U. segetum)* wherein it differs essentially from bunt *(T. Tritici);* it is this — that however carefully wheat may be dressed with cupric sulphate, arsenic, brine, lime, etc., while such dressing almost absolutely protects the crops from bunt, yet it has no appreciable effect on the smut. This fact is obvious to any one residing in an agricultural district. The wheats are dressed for bunt on every well-managed farm, but they are as much affected with smut as the barley and oat crops, which latter, never being affected with bunt, are never subjected to protective dressing."

It is, however, very probable that the form of treatment recommended for oats may be applied with similar results to wheat. It has been proved that such treatment will completely prevent the stinking smut *(Tilletia).*

[1] Brefeld. Neue Unters, II, Nachr. aus d. Kl. d. Landw. zu Berl., Nr. 221, S. 1593.
[2] C. B. Plowright. British Urediueæ and Ustilagiueæ, p. 102.

THE COVERED BARLEY SMUT, Ustilago Hordei (Persoon) Kellerman and Swingle.

HISTORICAL.

The first writer to separate the smut of barley from that of oats was Lobelius, who, in 1591,[1] referred the forms on barley to *Ustilago Polystichi* and *U. Hordei distychi.* There is no means of knowing whether he included one or both of the barley smuts under these names. Bauhin, in 1596,[2] also separated barley from oat smut, calling the former *Ustilago hordeacea;* nothing further is known of this. Other writers included this with the other loose smuts till Tessier,[3] according to Persoon,[4] notices this smut; but Persoon, in 1801,[4] was the first to give a recognizable description of it. He has it *Uredo (Ustilago) segetum a Uredo Hordei,* "pseudoperidio subelliptico, rugulosa, pulvere latente"; or, spore cases sub-elliptical, slightly wrinkled, powder *hiding.* This reference to the powder as latente (hiding) would seem to make it certain that he had the covered barley smut. After Persoon many writers copied his varietal names, without adding anything. Tulasne in 1847[5] called the smut of barley *Ustilago Carbo a vulgaris* c *Hordeacea.* Jensen in 1888[6] was the first writer to clearly separate this form from the other on barley, under the name *Ustilago segetum* var. *tecta,* and also *Ustilago segetum* var. *hordei tecta.* In Le charbon des céréales, published in 1889, he calls it *Ustilago hordei* var. *tecta* (Jensen). In a recent letter he recognizes it as a species, calling it *Ustilago tecta hordei* Jensen. The law of priority, however, compels the use of the earliest name, so the principal synonomy will be as given below. It is, however, nearly all doubtful, since almost all the writers confused *Ust. Hordei* with *Ust. nuda.*

USTILAGO HORDEI (Persoon) Kellerman & Swingle.

1552 *Ustilago* Tragus, De stirp. Noreen. pr., lib. III, p. 666.
1591 *Ustilago Polystichi* Lobelius, Icon., p. 36. p. p. ?
1591 Ustilago *Hordei distychi* Lobelius, Icon., p. 29, with figure. p. p. ?
1596 *Ustilago hordeacea* C. Bauhin Phytop. lib. I, Sec. IV, p. 52. p. p. ?
1767 *Chaos Ustilago* Linné, Syst. nat., Ed. XIII, II, p. 1472 p. p.
1791 (?) *Reticularia Ustilago* Linné, Syst. nat., Ed. XIII, II, p. 1472. p. p.
1791 *Reticularia segetum* Bulliard, Hist. des champ., I, p. 90, tab. 472, lit. E. G. H. I. K. L. M. p. p.
1801 *Uredo (Ustilago) segetum a Uredo Hordei* Persoon, Syn. meth. fung., p. 224.
1809 *Cæoma segetum* Link, Obs., I, p. 4; Sp. pl. Willd., VI, II, p. 1, No. 1. p. p.
1813 *Ustilago segetum* [Bulliard] Dittmar, in Sturm Deutschl. Fl., Bd. III, Heft 3, S. 67, T. 33, and of various authors. p. p.

[1]Lobelius. Icones stirpium, p. 36.
[2]Baubin. Phytopinax, p. 52.
[3]Tessier. Traité sur les mal., p. 306, f. 2–4, and p. 336.
[4]Persoon. Synopsis method. fungorum, p. 224.
[5]L. R. et Ch. Tulasne. Mém. 1847, p. 80.
[6]Jensen. Om. Kornsorternes Brand., S.56, *et seq.;* Prop, and Prev. of Smut, p. 10.

1815 *Uredo carbo a Hordei* DeCandolle, Fl. fr., VI, p. 76. p. p. ?
1833 *Erysibe vera a Hordei* Wallroth, Fl. crypt. Germ. pars. post., p.217, No. 1672. p. p.?
1837 *Uredo Carbo-Hordei* Philippar Traité, p. 92, pl. 3. p. p. ?
1847 *Ustilago Carbo a vulgaris c Hordeacea* L. R. et Ch. Tulasne Mém. s. 1. Ust. comp. aux Ured. in Ann. sci. nat. 3 Série t. 7, p. 80, p. p. *Ustilago Carbo* of authors in part.
1856 (?) *Ustilago segetum b Hordei* Rabenhorst, Klotzchii herb. viv. myc., Ed. nova, Cent. 3, No. 397. p. p.?
1888 *Ustilago segetum* var. *Hordii* f. *tecta.* Jensen, Om Kornsortenes Brand. S. 61.
1888 *Ustilago segetum* var. *tecta* Jensen, Prop. and Prev. of Sm. in J. R. A. S. XXIV s. s. p. 10; Plowright Br. Ured. and Ust. p. 274.
1888 *Ustilago Hordei* (Rabenhorst) Lagerheim, Revision der im Exsiccat "Kryptogamen Badens von Jack, Leiner und Stizenberger" enthaltenen Chytridiaceen, Peronosporeen, Ustilagineen und Uredineen, S. 2, Nr. 41. p. p.?
1888 *Ustilago segetum* var. *hordei tecta* Jensen, Prop. and Prev. of Sm. 1. c. p. 11.
1889 *Ustilago hordei* v. *tecta* Jensen, Le charbon des céréa1es, p. 4.
1890 *Ustilago tecta hordei* Jensen, in letter dated January 24, 1890.

NATURE OF INJURIES TO HOST PLANT.

The covered barley smut differs from all the other loose smuts in that the attacked panicle is not at once converted into a powdery mass by the escape of the smut, but the smut remains more or less completely inclosed by a membrane. This membrane consists of more or less of the outer-surface tissue of the attacked glumes, palets, etc., of the diseased flower. It is not, as in case of the stinking smut of wheat, simply the enter coat of the transformed seed, but a membrane composed of the outer layer of the many firmly united floral parts. It is usually confined to the bases of these parts, and consequently the awns are sometimes as long as in normal spikelets. Sometimes, however, they are much stunted, and often some of the smaller floral parts are smutted to the extreme tip. The membrane surrounding this smut is not nearly as fragile as in case of the open barley smut or the loose smut of wheat and oats. It keeps the smut intact for some time, and finally allows it to escape through rents and fissure; in the membrane. (See Plate II, figs. 3–6.) Figure 6 shows a specimen in which the tips of the floral parts were apparently sound, though somewhat distorted. They were however smutted at the base. The inside of the diseased spikelets is by no means a simple powdery mass of spores. In every specimen examined (from eight widely-separated localities) the interior of these diseased spikelets was occupied more or less by thin plates and shreds of unsmutted tissue. These plates and shreds are variously connected, and in some cases are so firm that a section can be easily cut through the whole spikelet without previous preparation of any kind. The spores themselves do not readily fall to powder, and seem more or less firmly glued together. This more or less rigid strengthening of the smutted spikelet and firm mass of spores prevent very effectually their rapid escape.

GEOGRAPHICAL DISTRIBUTION.

Persoon in naming *Uredo Hordei* says nothing of its distribution or hosts.

Jensen reports it as being less abundant in Denmark than the naked barley smut.[1]

Plowright says[2]*:* "*Tecta* [Ustilago Hordei] has been found in the island of Iona, but it doubtless occurs all over Britain."

Beyond this we know of no record of its existence.

Our European specimens are as follows:

(1) On *Hordeum vulgare,* Franconia, Bayreuth. Ex herb de Thümen, June, 1874. A few specimens mixed with more abundant *Ust. nuda.*

(2) On *Hordeum vulgare,* Halm, Sweden. Eriksson, Fungi parasitici Scandinavici, No. 2, August 2, 1881.

(3) On barley, Denmark. J. L. Jensen, 1889.

The following are from the United States and Canada:

(4) On *Hordeum vulgare,* Shelburne, New Hampshire. Dr. W. G. Farlow, in Ellis's North American Fungi, No. 1091, August, 1882.

(5) On cultivated barley, Dearborn county (near Sparta), Indiana. H. S. Bolley, June 19,1888.

(6) On barley, Eaton county, Michigan. W. J. Beal, June 6, 1889. A few specimens, with several of *Ustilago* nuda.

(7) On *Hordeum vulgare* (?), Manhattan, Kansas, June 27,1889. Kellerman & Swingle, No, 1933.

(8) On *Hordeum,* Sevey, St. Lawrence county, New York, July, 1889. Chas. Peck.

(9) On *Hordeum,* Ottawa, Canada, July 10, 1889. Jas. Fletcher.

(10) On *Hordeum,* Orono, Maine, 1889. Prof. F. L. Harvey.

In two instances (Nos. 1 and 6) it occurred as an admixture with *Ustilago* nuda. The smutted heads were, however, easily distinguished, and were all either one or the other,

Since so little was known in this country regarding the distribution of the barley smuts, requests for specimens and notes were sent to many mycologists of the United States and Canada. Most of these sent specimens and reported that they had seen only one form, and none had noticed both forms. In many States no specimen could be obtained, there being, as in Kansas, very little barley raised.

Prof. E. S. Goff, of Wisconsin, reports[3] that barley smut is sometimes very destructive — "sometimes the damage amounts to nearly one-fourth of the whole crop." Prof. W. J. Beal says[3]: "The smut was very bad in this State

[1] Jensen. Prop, and Prev. of Smut in Oats and Barley, l. c., p. 10, and letter of Jan. 24,1890.
[2] Plowright. Br. Ured. and Ustil., p. 274.
[3] In letter, 1890.

[Michigan] last year on wheat, barley, and oats, and especially on the last." Only two smutted heads of barley were found in the small plat on the College farm at Manhattan, Kansas, this year, and both were U. *Hordei.*

CHARACTERS OF THE SMUT.

This smut is readily characterized by the dark color of its spores when compared with the open smut of barley, or the loose smut of wheat and oats. The spores in mass seem *perfectly black;* rarely in some specimens, the color is a very dark brown. It never has *any* shade of olivaceous, and seems more like *U. Avenæ* than *U. nuda* or *U. Tritici* in color. It is, however always darker than oat smut.

In shape also the spores of this species are well marked. They are almost exactly spherical, and only rarely approach the oval form so common in the other three species. The spores are, however, often very slightly angular; rarely they have a small outgrowth (Plate VII, fig. 20); and still more rarely the spores are double (Plate VII, fig. 35). The usual forms may be easily seen by inspecting Plate VII. In size the spores vary less; they are 5–8x5-7μ (mostly 6–8x6–7,μ), being appreciably larger than those of *Ustilago nuda.*

Character of the Spore Wall.

The wall is as in other species composed of two layers, the epispore and endospore. They are, however, not well defined, and often the line between them cannot be seen at all. The compared thickness of the two layers is from 1μ to 2μ, or rarely somewhat more.

As in the other species, one side of the spore is darker, and often has a thicker epispore (Plate VII, figs. 47 and 48, also figs. 40, 41). The coloration is peculiar in that it is often very dark over the greater portion of the spore, and quite light in one area. In many instances there are two such light areas; in this case one is always larger and lighter than the other. The spore appears to have dark sides, and a dark band across the middle. This is faintly shown in Plate VII, figs. 19, 25, and 40. More than the usual number of spores in this species germinated twice, and in such cases the second germ tube came out of the smaller light area. (See Plate VII, fig. 25.)

Epispore Perfectly Smooth.

The epispore of this species is different from those of the other three species in being *always perfectly smooth.* This character alone is sufficient to distinguish at a glance the two barley smuts, since *Ustilago nuda* has a spiny epispore.

The spores do not seem to separate into a powder as readily as do those of the other loose smuts under consideration, and in some cases constitute a somewhat firm mass inside the diseased spikelet. This again hinders the escape of the spores.

With reagents the spores behave much as those of *Ustilago nuda, Tritiei*, and *Avenæ*. Chromic acid soon dissolves them, beginning at the lightest side. Nitric acid causes them to swell and become lighter colored. (See Plate VII, fig. 41.) In chloriodide of zinc the endochrome is readily colored and the wall somewhat decolorized. (See Plate VII, fig. 40.)

GERMINATION IN WATER.

After remaining a few hours in water the spores sent out one, or rarely two, blunt hyaline tubes from the lightest-colored portion. When two tubes were sent out they usually arose from opposite light areas of the spore. At first this tube was narrow (usually about 2–3μ) and short; it, however, rapidly elongated, and became thicker either close to the spore or gradually — in the latter case the promycelium was club-shaped. The ends often became pointed where they produced sporules. By 24 hours, if the spores were of last year's growth (the investigation was made during February and March, 1890,) nearly every spore had germinated, and the promycelia had attained a length of 15-40μF—or even as much as 50μ. when exceptionally slender or when the promycelium had itself sent out a tube, as will be described later. The most usual length was 18–26μ; in width they ranged from $2\frac{1}{2}$-4μ. During these 24 hours the promycelium had become septate, either once or twice in most cases. Many sporidia had been formed, both from the sides of the promycelium, usually just below a septum, and also in many cases from the tip. These sporidia were rather abundant, but fell off almost as soon as formed, so that very few were seen in situ, although in rare instances they remained attached while they themselves budded, producing secondary sporidia of about the same size. The sporidia were narrow, cylindrical to sub-oval in shape, usually about $5\frac{1}{2}$–7x2–3μ, very rarely as much as 12μ long, being more regular in size and shape and smaller (especially narrower) than the sporidia produced in nutrient solution. The detached sporidia often budded, producing a secondary sporidium of about equal size. In a few cases sporidia sent out short germ tubes, and in a very few instances conidia lying not far apart were united by fusion of the germ tubes. The promycelia in very many cases became detached from the spore during the first 24 hours. They seemed to break off just at the spore, and often had a short hyaline cell attached at this end, since even in attached promycelia the protoplasm often recedes, leaving a vacant space at the base. The detached promycelia were somewhat variable. In the Canada specimens they were blunt and soon fell to pieces, vacant cells rarely being attached to filled ones. In the course of two to three days they became considerably swollen (as much as 5–$6\frac{1}{2}\mu$), and at the septa, (where the original attached promycelia were slightly constricted), now became deeply constricted, the two adjacent cells often being swollen and rounded at the ends, causing them to be of a dumb-bell shape from the gradual narrowing towards the middle. Knee-joints were common. In Denmark specimens the detached promycelia differed from these principally in not falling to pieces so readily, the promycelia usually remaining entire, hyaline cells and all; in being narrower, and in showing more buckle-joint and other fusions. The

Manhattan specimens were intermediate between those from Canada and Denmark, as were those from Maine. The detached promycelia were in all cases so abundant as to perceptibly whiten the drop of water at the bottom of the concavity in the slides used. The attached promycelia exhibited the same swelling at the joints, and greater or less degree of coherence of the segments the same as the more numerous detached promycelia. Curious fusions and abnormal growths were, however, more common. Quite often a slender tube arose from the spore just at the base of the promycelium. This tube was always more slender than the main promycelia, and was almost always continuous. It very often united with some of the upper segments of the promycelia in fusion, and in Plate VII, fig. 43, has fused with two of the cells. The intermediate joints were sometimes connected by knee-joint fusions, making a double fusion, as is described by Brefeld.[1] In fact these slender tubes were very much like those described by him as found in *Ustilago Avenæ*. They were sometimes fused with other promycelia, as is seen in the fine specimen represented in Plate VII, fig. 45, and sometimes grew straight out, not fusing at all.

In general, fusions were rather abundant, and knee-joint fusions between adjacent cells were extremely so. A curious case of attempted fusion was seen in a number of instances where two adjacent cells grew out almost as for knee-joints, but, instead of fusing, both grew to considerable length, remaining appressed to each other the whole distance. In these cases the end of the double tube was often curved, or even uncinate. In some cases the attached promycelia, or some of the cells of detached ones, send out a tube of smaller diameter ($^3/_4$-2μ). These tubes were usually short, and often curving somewhat in their course. They were sometimes pointed, and rarely bore on the end a sporidium. In some cases many of the sporidia were produced on the ends of slender tubes, which were, however, short. A curious form was one sometimes seen, in which the promycelium is very short (4 to 6μ) though of the usual diameter, and bears a thread-like, acute spicule, which, as far as seen, was sterile. Similar ones were seen in *Ustilago Avenæ* which had germinated in place in old heads.

After being three or four days in water, at a temperature of 23° or 27° C., all growth ceased, and the culture remained dormant until the water evaporated, or it was invaded with bacteria which gradually increased until they destroyed it.

GERMINATION IN NUTRIENT SOLUTION.

The first stages of germination in the nutrient solution (modified Cohn sol.*) are very similar to that in water. Promycelia are sent out from the pale side of the spore, or, rarely, from two pale areas, and are at first short

[1] Brefeld. Bot. Unters. üb. Hefenpilze. V. Hefte, S. 56.

* This is Cohn's solution (with the addition of sugar):

Water (distilled)	41 7 grammes.	Potassium phosphate	.125 grammes.
Sugar (granulated)	7.5 grammes.	Magnesium sulphate	.125 grammes.
Ammonium Tartarate	.25 grammes.	Calcium phosphate	.125 grammes.

The solution has a sediment, which, however, settles, leaving it clear. It was sterilized by discontinuous heating in steam sterilizer.

and simple. Soon they become septate, the division wall nearest the tip appearing first, and finally one or two nearer the base. About this time sporidia begin to be produced from the end of the promycelia, and also from their sides at the septa. (See Plate VII, fig. 42.) These sporidia are much like those produced in water-cultures, but are slightly wider and larger, and much more abundant. By 24 hours nearly every spore has germinated, and the promycelia are about as long as they ever become when grown in water. They differ from those grown in water-cultures in being thicker and more vigorous. Knee-joint fusions are common in some cultures by this time, but no other kind are seen. Many of the promycelia have become detached, and sink, while on the surface some few grow into the air and produce sporidia there (from the end, at least). The size and shape of the promycelia vary according to the locality from which the specimens were obtained. Those from Canada produced short (23–26x3–3 $^{1}/_{2}\mu$) promycelia, which were nearly straight. The Maine specimens produced longer (25–37x3-5μ), more vigorous promycelia, which were often bent, or angled, especially at the base, The Denmark specimens were similar to those from Maine, while the Manhattan, Kas., and New York specimens were intermediate between the Canada and Maine specimens. These differences were, however, only as to details, and in general all were much alike.

Thus far, the cultures in nutrient solution were much like those in water, the difference being that the promycelia were more vigorous, wider, and the sporules more abundant and budding more profusely.

Instead of now growing less and less, and finally ceasing growth and becoming dormant, as the water-cultures do after two to four days, the growth in nutrient solution increases in vigor till the nourishment begins to fail. By 48-72 hours the promycelia and sporidia in all cultures had changed very much. The liquid on the slides was now white with the growth of promycelia and sporidia. Examination shows that the promycelia had branched and become many-septate, or in many cases had fallen to pieces more or less from every septum, and end cells arise, which, according to circumstances, may fall off, and would then be sporidia, or remain fast and grow or bud, and be called branches. (See Plate VII, fig. 48.) The promycelia of spores from different localities now differ still more. Those from Maine were remarkably long (as much as 200-350μ), and the spores floating on the surface of the drop were united firmly by the long, entangled growth. Branches were numerous, and sporules present in myriads. When the promycelia were separate from those of other spores, they were much-branched in all directions, and many-septate in all parts. When growing in dense mats, the course of the promycelia could not be clearly seen; but those near the edge grew out from the mass, and from some of them arose germ threads, 2–2 $^{1}/_{2}\mu$. in diameter and as much as 200-300μ long, which were vacant and many-septate for a considerable distance at the base, but were filled and less septate above. These threads were similar to those found in *Ustilago Avenæ*, but were wider and shorter. Rarely, sporules arose from the septa of these germ threads. The very numerous detached sporidia reproduced very freely by budding, and were mostly of an oval, or even sub-globose shape, like those shown in Plate VII, figs. 2, 7, 15, 28, etc. All of the segments were still active in most cases, and although those at the base of the promycelium were large, scarcely any were abruptly swollen.

The New York specimens differed much from those from Maine in having very much less branched and less vigorous promycelia. The promycelia were about 25–125x2–7μ, and were, when detached, very much broken up into the separate segments. Those attached broke up less, but still were at best but loosely connected. The segments of both attached and detached promycelia were in part swollen, and in part narrow and unhealthy. Both free segments and sporidia were abundant, and both budded freely.

The Manhattan (Kansas) specimens were still shorter, the promycelia being mostly 25–50x4–7μ, rarely 100μ, long. They were much disintegrated, but some were entire and much-branched. In a few of these, slender germ threads, like those in the Maine specimens, were seen, but much shorter and apparently unhealthy, since there was a small vacant space on either side of each septum, while the protoplasm was present in every cell. The swollen cells were numerous, and, conversely, the slender, dying ones still more abundant. The detached sporidia and segments budded, but the sporules were in these specimens slender, and not short and oval.

The Canada specimens were much like those from Manhattan, but produced sporules only scantily.

In general this species is characterized by producing, when the nutrient fluid approaches exhaustion, certain *swollen segments* or groups of segments *which alone live.* These can be seen in Plate VII, figs. 17, 22, 23, 29, 31, 48, &c. They are not so large in any other loose smut of cereals, and are really resting cell. As the cultures become older these swollen cells are more abundant, and they increase in size till all growth ceases. Sometimes they are single, as Plate VII, fig. 22; sometimes consist of almost the entire promycelium, Plate VII, fig. 46. More often, however, they are certain cells in the promycelium to which the other dead empty segments remain attached, as in Plate VII, figs. 29 and 31. The sporules also by growing and rounding obtain much this form, but are often smaller. If now from an exhausted culture containing such resting cells a new culture be started, these cells bud or sprout at once. Usually they produce sporidia by budding, and often these sporidia while attached produce secondary sporidia by budding themselves. Such may be seen in Plate VII, figs. 17, 31, and 53. Others send out germ tubes which usually are short. These are shown in Plate VII, figs. 24, 31, and 58.

The sporidia of this species grown in nutrient solution vary very much in shape and size. They are usually oval, occasionally sub-globose, and vary to narrow cylindrical. In size they are about 5–11½x3–4½μ, mostly 6–8½x 3-4μ. They may be seen in Plate VII, figs. 1–15, and others.

Fusions, aside from knee- join fusions between adjacent cells, are uncommon—much rarer than in water cultures. The knee-joint fusions are numerous, and appear within the first 24 hours. They open up when the cells become swollen, as in Plate VII, fig. 46, and very often send out branches, Plate VII, figs. 16 and 48. No such variation, consisting of parallel tubes, as was found in water culture was seen. Other fusions are represented in Plate VII, figs. 50 and 52. Sporidia rarely fused.

After remaining in nutrient solution some time the spores often opened widely where the promycelium was attached and the portion within the cell apparently grew out. An example of this is seen in Plate VII, fig. 30. In such cases the cell-wall appeared to be dissolved, being very thin on the edges.

In germinations either in water or in nutrient solution, the exact course of the promycelium through the wall was hard to trace; it was, however, apparently at first always a small round hole, as is seen in fig. 16, from the inside of the spore, and in figs. 47 and 48 in optical section. From these it would seem that there is a definite pore in the light portion of the space rather than a rent, or perhaps the growing promycelia dissolves the cell-wall away. This last is rendered probable by the further solution of the wall, as is shown in Plate VII, fig. 30.

MANNER OF INFECTION OF HOST PLANT.

On this point very little is known. Jensen[1] says spores of covered smut "adhering externally to the barley kernels will propagate the smut. In this respect it is different from all the other loose smuts, and resembles the stinking smut of wheat." It is, however, according to Jensen, much less infectious. It spreads only slowly to an adjacent field, because the spores, being inclosed more or less, are not blown about by the wind.

METHODS OF PREVENTION.

According to Jensen, the loose smut is readily killed, either by treating the seed with copper sulphate or in hot water. The more common *Ustilago nuda* (naked barley smut) is, however, less easily prevented, and the methods of treating will be given under the description of that species. Of course the longer soaking required to prevent that species also prevents this completely.

It is, however, necessary to notice that this species is capable of infecting grains of barley to which it adheres, and hence the treated barley must be carefully protected from all contact with the smut.

THE NAKED BARLEY SMUT. — Ustilago nuda (Jensen) Kellerman & Swingle.

Until very recently the naked barley smut has been confused with the covered barley smut, or at any rate not carefully separated from it. Its early history is therefore the same as already given for *Ustilago Hordei*.

[1] J. L. Jensen, letter of Jan. 24, 1890.

(See p. 268.) It cannot, however, be the *Uredo Hordei* of Persoon, and from the figure is probably not *Ustilago Carbo a vulgaris c Hordeacea* of Tulasne.[1] Jensen in 1888[2] clearly separated this species from the covered barley smut. He recognized then only a varietal difference. He then uses the names *Ustilago segetum* var. *nuda,* and also *Ustilago segetum* var. *hordei nuda.* In Plowright's "British Ured. and Ust." the name is given as var. *nuda.* Recently, in a letter, he considers it as a species—*Ustilago nuda hordei.* He separated it from the covered smut by its light, olivaceous color, smaller spores, and loose character of smutted head. From other smuts it is distinguished in being unable to infect other plants than barley.

Brefeld, in a lecture delivered Jan. 28,1888,[3] describes the germination of barley smut, and evidently had this species, since he found slender threads but no sporidia.

He calls it *Utilago Hordei* Bref. He states that it retains its germinative power only a single year, while that of oats retains it more than six years. He also states that the dissimilar germination of loose smut, sometimes with and again without sporidia, has long been known.

He experimented by artificially infecting oats and barley with sporidia of oat smut obtained by growing the spores in nutrient solution. In these nine experiments, made in various manners, in every case the barley plants remained *entirely sound,* while the oat plants were in some cases as much as 40–46 per cent. smutted. These experiments showed conclusively that the oat smut was incapable of infecting the barley. According to J. P. Petersen,[4] Rostrup, in commenting on a paper by Jensen, communicated that in his germinating experiments there was a very material difference between the two kinds of barley smut: the covered barley smut develops sporidia, whereas the naked barley smut, in contradistinction from all other known forms of smut, does not form sporida, and therefore grows directly into the germinating plants.

The following synonymy includes nearly all the names applied to barley smut, but since *Ust. nuda* has been constantly confused with *Ust. Hordei* it is somewhat doubtful:

USTILAGO NUDA, (Jensen) Kellerman & Swingle.

1552 *Ustilago* Tragus, De stirp. nomen. pr., lib. III, p. 666, with figure. p. p.
1591 *Ustilago Polystichi* Lobelius, Icones, p. 36. p. p. (?)
1591 *Ustilago Hordei distychi* Lobelius, Icones, p. 36, with figure. p. p. (?)
1596 *Ustilago hordeacea C.* Bauhin, Phytop. lib. I, sec. IV, p. 52. p. p. (?)
1767 *Chaos Ustilago* Linné, Syst. nat., ed. XII, II, p. 1356. p. p.

[1] R. et Ch. Tulasne. Sur les Ured. comp. aux les Ustil., 1847, p. 15.
[2] J. L. Jensen. Om Kornsorternes Brand., S. 56, *et seq.;* Prop. and Prev. of Smut, p. 10.
[3] Brefeld. Neue Unters. II., Nachr. der K1, Nr. 221, S. 1592 und 1598.
[4] J. P. Petersen. Nye Forsög over Brand i Vaarsæden, in Landmand's Blade. Ugeskrift for Agerdyrkning, Kvægavlog Mælkeridrift. Udgivet of J. P. Petersen, 22 Aargang, Nr. 35, Den 31 August, 1889, S. 589, "Docent *Rostrup* meddelte derhos, at han ved Spirings forsög havde godtgjort, at der fandtes den meget væsentlige Forskjel mellem de to Brandarter, at dækket Bygbrand af sin Forkim udvikler Sporidier, hvorimod nogen Bygbrand i Modsætning til alle andre i saa Henseende kjendte Brandarter ikke danner Sporidier, og altsaa umiddelbart spirer ind i Kimplanten."

1791 (?) *Reticularia Ustilago* Linné, Syst. nat., ed. XIII, II, p. 1472. p.p.
1791 *Reticularia segetum* Bulliard, Hist. des champ., I, p. 90, tab. 472, lit. E. G. H. I. K. L. M. p. p. (?)
1809 Cæoma segetum Link, Obs. I, p. 4; Sp. pl, Wind., VI, II, p. 1, No. 1. p. p.
1813 *Ustilago segetum* [Bulliard] Dittmar, in Sturm, Deutschl. F1., Bd. III, Heft 3, S. 67, T. 33, and of various authors. p. p.
1815 *Uredo carbo a Hordei* DeCandolle, Fl. fr., VI, p. 76. pp. (?)
1833 *Erysibe vera a Hordei* Wallroth, F1. crypt. Germ. pars. post., p. 217, No. 1672. pp. (?)
1837 *Uredo Carbo-Hordei* Philippar, Traité, p. 92, pl. 3. p. p. (?)
1847 *Ustilago Carbo a* vulgaris c *Hordeacea* L. R. et Ch. Tulasne, Mém, sur les Ust. comp. aux les Ured. in Ann. sci. nat. 3 Série, t. 7, p. 80. p. p. (?) *Ustilago Carbo* of authors in part.
1856 (?) *Ustilago segetum b Hordei* Rabenhorst, Klotzchii, Herb. viv. myc. ed. nova, Cent. III, No. 397. p. p. (?)
1888 *Ustilago Hordei* Brefeld, Neue Unters üb. d. Brandp. u. Brandkrankh. II, in Nachr. aus d. K1. d. Landw., zu Berl., Nr. 221, 28 Juni, 1888, S. 1593. p. p.
1888 *Ustilago segetum* var. *Hordii* f *nuda* Jensen, Om Kornsorternes Brand., S. 61.
1888 *Ustilago segetum* var. *nuda* Jensen, Prop. and Prev. of Sm., in J. R. A. S. XXIV s. s., P. II, p. 10; Plowright, Br. Ured. and Ust., p. 274.
1888 *Ustilago segetum* var. *hordei* nuda Jensen, Prop. and Prev. of Sm., 1. c., p. 11.
1888 *Ustilago Hordei* (Rabenhorst) Lagerheim, Revision der in Exsiccat “ Kryptogamen Badens von Jack, Leiner und Stizenberger,” enthalten Chytridiaceen, Peronosporeen, Ustilagineen und Uredineen. S. 2, nr. 41. p. p. (?)
1889 *Ustilago hordei* v. *nuda* Jensen, Le charbon des céréales, p. 4.
1890 *Ustilago nuda hordei* Jensen, in letter dated Jan. 24, 1890.

INJURIES TO THE HOST PLANT.

The naked barley smut resembles oat smut and loose smut of wheat in that the attacked panicles are converted into a loose, powdery mass of spores, held together only by a few shreds of tissue, and readily blown about by the wind. It differs very materially from the closed barley smut in this particular. It is, like that species, covered with a membrane, which, however, is much thinner than in *Ustilago Hordei,* and consists apparently of the outer walls of the modified epidermal cells. Usually all, or nearly all of the floral parts are converted into the smut, only rarely being like *Ustilago Hordei* in having the tips of the floral parts sound. The awns are quit often intact, but are almost always stunted. (See Plate II, figs. 7–11. The coalesced floral parts, while yet covered by their membrane, are of a dark, dull-grayish color much darker than *U. Hordei*). The envelope ruptures very easily in any direction, and allows the loose spores to fall out. Through the spore masses run some plates, or ribbons, of host tissue, which usually remain till nearly all the spores have fallen. Some of the papery outer membrane usually remains attached to these fibers until eventually both fibers and membrane are weathered away, and the formerly smutted head has more or less the appearance shown in Plate II, fig. 8. The reason, that not withstanding the presence of fibers and a thin enveloping membrane, this species sheds its spores very readily and seems wholly different from typical *Ustilago Hordei,* **is, we** think, found in the fact that the spores are completely free, and do not adhere to each other or to the shreds of the host tissue. The infected heads, unlike those of *Ust. Hordei,* grow to their normal height, and do not tend to remain inclosed by the uppermost sheath of the barley plant.

AMOUNT OF INJURIES.

Jensen[1] gives the following table showing the amount of smut in fields in various parts of Denmark:

SMUT IN BARLEY FIELDS.

No.	LOCALITY.	Per cent. of naked smut.	Per cent. of covered smut.	Per cent. of both.
1	Field at Fyen	1.1	0.2	1.3
2	" " "	3.6	1.1	4.7
3	" " "	5.3	2.7	8.0
4	" " "	0.9	0.1	1.0
5	" " "	3.1	2.4	5.5
6	" " "	0.2	0.3	0.5
7	" " "	0.4	0.0	0.4
8	Field in Aarhusegnen	0.1	17.6	17.7
9	" " "	0.5	0.0	0.5
10	" " "	1.0	1.0	2.0
11	" " "	1.7	1.7	3.4
12	" " "	2.3	0.0	2.3
13	Field in Kallundborgegn	2.0	2.5	4.5
14	" " "	2.0	0.0	2.0
15	Agricultural College at Copenhagen—continuous barley,	1.0	2.0	3.0
16	" " Fermaks Drift	2.8	1.4	4.2
	Average	1.75	2.06	3.81

[1] Jensen. Om Kornsorternes Brand., S. 60.

Jensen says later[1] : " I found in 1889 there was six times as many ears of *nuda* as of *tecta [Ust. Hordei]."*

GEOGRAPHICAL DISTRIBUTION.

On this point Jensen says little, but from the above table it will be seen that the naked as well as the covered barley smut is found in many parts of Denmark. Brefeld records *Ustilago nuda* from Germany (Minster, i. B.), and also from Japan (Yokohama).[2]

Plowright says: "Of these, *nuda* is by far the most common."[3] He gives *Hordeum vulgaris, H. distichum* and *H. hexastichum* as hosts for *Ustilago segetum*, and from a statement following it must be *Ustilago nuda* that occurs upon them.

The specimens in our herbariums, as well as those sent to us by many correspondents, have been examined carefully.

The following are European:

(1) On *Hordeum vulgare,* Franconia, Bayreuth. Ex. herb. de Thümen, June, 1874. The specimens are mostly this species, but some are *U. Hordei.*

(2) On *Hordeum vulgare,* Bavaria. Thümen, Mycol. Universalis, No. 137, August, 1874. Very much parasitized by insects in the specimens examined.

(3) On *Hordeum vulgare,* Nossen and Konigstein, Saxony. Krieger, Fung. Saxonia, No. 761. Col. 24, July, 1886 and 1887.

(4) On *Hordeum,* Denmark. J. L. Jensen,[4] 1889.

The following are from the United States:

(5) On *Hordeum*, Lancaster, Fairfield Co., Ohio. W. A. Kellerman, No. 291, May 30, 1883.

(6) On *Hordeum vulgare,* Decorah, Iowa. E. W. D. Holway, June 18, 1884.

(7) On *Hordeum vulgare,* La Crosse, Wisconsin. L. H. Pammel, July, 1884.

(8) On *Hordeum*, Syracuse, N. Y. L. M. Underwood, July 7, 1886.

(9) On Hordeum, Eaton Co., Mich. W. J. Beal, June 6, 1889, with a few specimens of *Ustilago Hordei.*

(10) On *Hordeum (?),* Winona, Minnesota. J. M. Holzinger, June 15, 1889.

Only in two cases (Nos. 2 and 9) were there both *Ustilago nuda* and *U. Hordei* in the same collection. In both cases the *Ustilago nuda* was the more abundant.

In the American Agriculturist for October, 1881, (Vol. XL., No. 10, p. 404,) B. D. Halsted[5] figures barley smut from C. M. Youmans, Lyon Co., Minnesota. From the figure and description it is certain that the specimens were *Ustilago nuda*.

1 Jensen in letter, January 24, 1890.
2 Brefeld, Neue Unters, II Nachr., Nr. 221, S. 1592,
3 Plowright, Br. Ured. and Ustilag., p. 274.
4 Jensen, in letter, Jan. 24, 1890.
5 Wheat, Oat, and Barley Smut. l.c., fig. 3.

BOTANICAL AND MICROSCOPIC CHARACTERS OF THE SMUT.

Color, shape, and size.

The spores of this species are perfectly free from each other, and form a dusty mass of a dark, dusky olivaceous color, almost exactly like *Ustilago Tritici*. In one instance, however, (No. 5, p.280, from Ohio,) the spores were very dark, without any shade of olivaceous, very much like *Ustilago Avenæ*. All the other specimens showed a more or less marked olivaceous tint.

In shape, the spores of this species differ very markedly from those of *Ustilago Hordei*, being oval, or less often elliptical or subglobose; see figures on Plate VIII. They correspond in this respect very closely with those of *Ustilago Tritici* and *Ustilago Avenæ*. The spores are regular in shape, and only rarely present abnormal forms, such as are shown in Plate VIII, figs. 18, 21, 24, 27.

In size, the spores are 4½-8x4½-6µ., mostly 5–7x5–6½µ, and probably the least variable of all the four species studied. As will be noticed by a comparison of the figures on Plates VII and VIII, and of the measurements on p. 271, with those here given, the spores of this species are somewhat smaller than those of *Ustilago Hordei,* a fact that has been noted by Jensen.

Character of the spore wall.

As in the other loose smuts, the wall is composed of two layers, the epispore and the endspore. The two are, however, hard to distinguish in this species. They are both shown in figs. 1, 4, 12, 15, 33, 34, Plate VIII; but in many other cases, as in figs. 7, 11, 14, 22, 26, the wall appeared perfectly simple until reagents were used. These two layers together form a wall 1-2µ in thickness. Outside of the wall a thin, delicate, hyaline layer, the cuticle of Fischer von Waldheim, can often be seen, especially on the dark side of the spore. It is always very faint, but is rendered somewhat more distinct by the use of potassium hydrate or nitric acid.

The spores *lighter colored on one side.*

As in the other loose smuts, one side of the spore is plainly lighter colored than the remainder. An area of perhaps one-quarter, or even one-half of the whole surface is much lighter in color, while the opposite portion of the wall is very dark; between these two extremes the wall shades gradually in color. The promycelium always arises from some part of the light-colored area. The wall, as well as its two layers, can be most clearly seen in the part of the wall between the lightest and darkest portions. Often the two layers of the wall can be plainly seen in this part, when they can be distinguished only with much difficulty on the darkest part, and not at all in the light area.

The epispore spiny or warty.

The epispore in this species is covered with minute spines or warts, which show plainly in profile, and can usually be seen in optical sections along the light part of the wall, but not at all along the very darkest portion. In figs. 3, 20, 25, 31, 35, 36, and others, the spines can be seen, both on the face and on the edge of the spore; while in figs. 6, 7, 12, 15, 18, 21, 22, 23, and others, the warts could not be seen along the edge, though in all cases they were visible on the face of the spore. On the light side of the spore there is usually a space free from spines, as is shown in Plate VIII, figs 29, 30. The spines or warts are quite numerous, but are not very thickly or regularly set, the distance between them being ½-2μ; usually about 1-1½μ.

The germ-pore large.

The promycelium is scarcely contracted where it passes through the wall, either in cultures in nutrient solution or in water. In nutrient solution especially, the opening thus made is very wide; see figs. 4, 7, 12, 15, 17. Often the wall in such cases splits down from the opening, and in some cases the wall is then dissolved away, leaving a wide crack which may extend entirely across the spore; see fig. 2. Sometimes the wall is gradually dissolved away by the nutrient medium, all around the opening for the promycelium. When long continued the result is much as has been shown for *Ustilago Hordei* on Plate VII, fig. 30. In spores germinated in water cultures, the openings through which the promycelia pass, though not so wide as in spores grown in nutrient solutions, are wide compared with other species of loose smut. In water cultures the promycelium was often 2–3μ in diameter where it passed through the spore wall, and there was often a rent in the wall extending down from the opening. Curiously on an old spike of barley from which almost all the spores had fallen (shown in Plate II, fig. 8), many of the spores, like those of *Ustilago Avenœ* found under similar conditions, had germinated. The germ-pore in these spores could be seen, as a small, definitely limited, round opening, shown in Plate VIII, figs. 29 and 30 in profile, and in fig. 28 in optical section.

The contents of the spore are usually perfectly homogeneous as far as can be seen.

The action of reagents.

The various reagents affect the spores of this species very much as they do those of *Ustilago Avenœ*. Potassium hydrate in 20 per cent, aqueous solution obscures the markings of the epispore, but causes the endospore to swell greatly. Sulphuric acid, when diluted one-half with water, renders the markings evident, and aids in distinguishing the epispore and endospore. Salicylic acid in concentrated aqueous solution (at 32° *C.)* shows the two layers of the wall, if the spores are examined, as soon as the reagent is applied. Chlor-iodide of zinc stains the contents of the spore strongly, rendering the wall (which is only slightly tinted) very evident. It does not, however, show the two layers of the wall. This can be done by adding chlor-iodide of zinc to spores which have previously been treated with salicylic acid a moment. Nitric acid decolors and swells the spores somewhat, but renders the markings of the wall and the cuticle evident.

GERMINATION IN WATER.

After remaining a number of hours in water (somewhat longer than for *Ustilago Hordei),* the spores sent out a single hyaline germ tube, which at first appeared as a minute elevation, or boss, on the surface of the spore; it at length grew to a straight or curved slender promycelium. By 20 hours, at a temperature of 18–25° C., the promycelia were 20–46μ. long and 2½-4μ wide; continuous, or one to three septate; often with one or two knee-joint fusions, and rarely branched. They appeared much like figs. 2 and 4 in Plate VIII. These promycelia, unlike those of *Ustilago Hordei,* throughout their growth *always* remained attached to the spore. Out of a hundred careful examinations, not a single one was found detached. By 30 hours the promycelia had attained their full length, and did not change further, except in one important respect: from many segments, and very often from buckle-joints, long slender germ threads grew out, which by 48 hours reached a length of 50-150μ. The promycelial segments, and the lower portion of the thread, became entirely empty. Some germ threads, 50μ or more in length, were yet entirely filled, but those 100–150μ. long had a many-septate vacant basal portion. These tubes were 1½-2μ, in diameter, and were somewhat narrower in the vacant basal portion, which had numerous septa 7-15μ apart. The tips yet filled with protoplasm were 30–120x2μ, and but faintly if at all septate, though the protoplasm was often guttate. These threads continued to grow for four or five days, till they sometimes reached the enormous length of 300–400μ (one measured 412μ long). They remain of practically the same character all the while, and never branch. By four days none of the threads were filled to the base, and all of the promycelia thus grown out were entirely emptied. In fact, the basal portion of these germ threads was so hyaline that it was in many cases a severe task to follow the long barren length to the promycelium to which they were attached. A hasty glance seemed to show hyaline, promycelia and disconnected slender tubes filled with protoplasm. However, none were found detached.

Unfortunately, none of these were figured in time to be included in the plate, so nothing of the kind is seen on Plate VIII. The appearance was very similar to the tube shown in fig. 28, Plate V, (Ustligo *Avence)* except that it arose from a segment, or knee-joint fusion, and not from a sporidium.

It is to be especially noted, that in all the changes passed through, these threads remained without further growth of any kind until the water evaporated, or the culture was destroyed by bacteria and moulds. *No sporidia whatever were produced at any stage of growth or decay. There was not the slightest tendency observable to break into segments, or in any way throw off fragments.*

Rarely the original promycelia became as many as 6-septate after the growth of the germ threads began.

Not all the promycelia sent out these germ threads, though the great majority did. Those that did not were usually simple, but, rarely, had short, blunt branches. They showed no change while the other promycelia were sending out germ threads.

Fusions, aside from buckle-joint fusions, were rare. These were common enough, and there were often two on a single spore. A single case was seen where the base was united to the top by a tube, much as in Plate VIII, fig. 5, only more slender in all parts.

Quite often the promycelia were somewhat branched, and from these branches, or buckle-joints on them, germ threads arose.

The promycelia of 20 hours' growth had a diameter of 2½-3μ at the junction with the spore, and in consequence the spore was often sprit a short distance down the side.

IN NUTRIENT SOLUTION.[1]

At first the cultures much resemble those already described for water. The promycelia are of about the same size and shape, though perhaps less often and less plainly sepatate. Very often, in fact, they were continuous like those shown in Plate VIII, figs. 1, 3, and 4. This was the appearance at the end of 24 hours; however, some became slightly swollen and septate like fig. 6. The growth of the promycelia did not cease so soon as in water cultures, but lateral branches arose in many cases. In order cultures these branches were usually short and thick, as shown in figs. 8 and 16. Rarely germ threads grew out to a length of 100μ or even more. These lengthened branches, though like those produced in water cultures in sometimes having a vacant base, differed in being thicker, septate, and usually somewhat irregular in diameter. These irregularities were usually slight, but sometimes quite marked. They may exist in any part of the promycelial growth. This irregular diameter may or may not be connected with septa. A good example of a somewhat advanced branched and irregularly swollen promycelium is shown in fig. 14.

After 48 hours little change occurred, except that the *free ends of branches and promycelia became swollen*. By four days this was quite marked, as may be seen by examining Plate VIII, figs. 9 and 15. Not all of the branches were thus swollen up, though many were. Rarely the whole promycelium was more or less swollen, as is shown in fig. 12. During the growth many of the promycelia became emptied for one or more segments at the base, as in figs. 5, 8, 9, 14, and 16. More rarely the tip was empty, as in fig. 17. In almost every instance the promycelia remained firmly attached to the spore throughout their whole growth. A detached promycelium is figured in 8; another, probably dead, is shown in fig. 13. *At no stage of the growth were any sporidia formed, and no detached segments of promycelium were seen.*

Fusion knee-joints were very common, and often originated strong-growing germ threads. In a very few cases fusions like those shown in fig. 5 were seen. Two tubes arose from the spore, or a branch grew out at the surface of the spore and the two united at the tip. The regularly swollen

[1] Modified Cohn solution was used exclusively.

tips were very noticeable; in many cases they were as large as the spores, or even larger.

MANNER OF ENTERING THE HOST PLANT.

On this point very little is yet known. Jensen say's spores of *Ustilago* adhering externally to the barley grains will not propagate the smut —"I have proved this by experiments."

In general its behavior with preventatives is more resistant than is *Ustilago avenæ* and ustilago Tritici. It acts very differently from *Ustilago Hordei,* which, according to Jensen, infects the grain to whose external surface it adheres.

According to the same author it spreads from field to field readily, while the opposite is the case with *Ustilago Hordei.*

Jensen, finding that solutions which kill the spores adhering to the outside of the grain do not prevent the smut, says:[2] "Hence we must conclude that the infective medium is internal, not external, to the covering of the seed corn." This view, however, requires confirmation.

METHODS OF PREVENTION.

All authors previous to 1887, when Jensen published his first paper, recommended the same treatment for barley smut as for oat smut. They did not, of course, notice any difference regarding the two species growing on barley, as these were not recognized as distinct till 1888.

Jensen reported that soaking in sulphuric acid or sulphate of copper had little effect on barley smut, though it largely prevented that of oats. Treatment five minutes in water at 133° F. did not sensibly diminish the number of smutted heads.[3] He cites[4] the following experiments made in Denmark under his direction:

AT RODSTENSEJE.

Undressed barley	Amongst	2,000	heads	49	were smutted.
Treated with 1 per cent. sulphate of copper	"	2,000	"	38	" "
" " 1 " " " " limed 12 hours after	"	2,000	"	50	" "
" " 2.7 " sulphuric acid	"	2,000	"	43	" "
" " 2.7 " " " quicklimed 12 hours after	"	2,000	"	41	" "

AT GERSDORFSLUFD.

Undressed barley	Amongst	2,000	heads	40	were smutted.
Treated with 1¼ per cent. sulphate of copper	"	2,000	"	58	" "
" " 5 " " " "	"	2,000	"	23	" "

In the first series, the seed was completely immersed in the solution for twelve hours. The sulphuric acid of this strength killed a great deal of the seed, but was of little value in preventing the smut; and the same is true of the 5-per-cent. solution of sulphate of copper, which, although it killed much of the seed, did not completely prevent the smut. Lime and salt were without effect.

Heating the seed barley five minutes in water at 127° F., after it had

1 J. L. Jensen, in letter, Jan. 28, 1890.
2 J. L. Jensen. Smut (Ustilago segetum) in Oats and Barley, in Gardeners' Chronicle, May 5, 1888, p. 555.
3 J. L. Jensen. Smut in Oats and Barley, in Gard, Chron., 1. c., p. 555.
4 J. L. Jensen. Nye Undersögelser og Forsög over Kornsorternes Brand, S. 15; Prop. and Prev. of Smut in Oats and Barley, p. 15.

previously been soaked eight hours in cold water, prevented the smut completely, as his results quoted below show. The experiment was conducted at his suggestion by Mr. C. F. Jensen, at Rodstenseje, Denmark, in 1888:

"2,000 unprotected barley plants had 45 smutted.
2,000 treated with warm water as above, none smutted."

In his fifth paper he reports an experiment as follows.[1] Three equal packages of the same barley seed were planted, but they were treated differently:

Barley not prepared	113	smutted heads.
Barley treated by Kuhn's method[2] 14 hours	104	" "
Barley treated with hotwater[3]	0	" "

In another test there reported, he prolonged the treatment according to Kühn to 24 hours. Again three equal parcels of seed were used:

Barley treated by Kühn's method 12 hours	302	smutted heads.
Barley " " " 24 "	240	" "
Barley " with hot water	0	" "

All of these experiments show clearly the inefficacy of the copper-sulphate and lime (Kühn) treatment, and the superiority of the Jensen treatment.

In his letter of January 24, 1890, he reports the following experiment:

(Same quantity sown of the three samples.)	*First farm.*	*Second farm.*
Barley, unprepared	628 smutted heads,	459 smutted heads.
Barley, bluestoned	542 " "	388 " "
Barley, dipped in warm water	0 " "	0 " "

All of these experiments were really concerned with *Ustilago nuda*, or naked barley smut, alone, since Jensen says (in letter) that dry dipping in hot water and treatment with copper sulphate *will completely prevent covered smut*, though not *Ustilago nuda*. The covered smut would, therefore, have been destroyed in all of the above experiments, except in untreated seed.

Owing to the extreme scarcity of barley about Manhattan, Kansas, we did not conduct any experiments to prevent this smut; nor do we know of any being attempted in the United States.

From the numerous experiments of Jensen, repeated every year since 1887, it would seem that he has the most complete and most satisfactory method for destroying the smut.

He finds that if the barley is soaked eight hours, and then put in water at a temperature of 126-128° F. for five minutes, all smut is prevented; a higher temperature proved injurious.

We therefore strongly recommend his latest form of the treatment, which is as follows: Soak the barley seed *four hours* in cold water, and then let it stand *four hours longer* in a wet sack. Finally dip and drain as *directed in the treatment for oat smut* for five minutes in water of a temperature of *126–128° F.*, after which dry and plant as in case of oats.

[1] J. L. Jensen. Le charbon des céréales. Copenhagen, July, 1889.
[2] Soaked 14 hours in a ½-per-cent. solution of copper sulphate, after which it was soaked in milk of lime.
[3] Soaked 4 hours in cold water, then left stand 4 hours in a moist sack, after which it was immersed 5 minutes in water at 127° F.

The temperature must not he above 128°, since the soaked seed would then be injured, and not below 126°, for then not all the smut would be killed. Both vessels should contain water of this temperature. Instead of soaking four hours and letting the seed stand four hours longer in a wet sack, it may be simply soaked eight hours, drained, and then treated with hot water.

The covered barley smut *will be also completely prevented by these means.* But since this (covered) smut is capable of infecting grains to which it adheres externally, care must be taken to prevent any smut from reaching the treated grain. The sacks to receive it should therefore be also disinfected with hot water.

NATURAL ENEMIES OF THE SMUT.

Although the fact is not commonly known even to specialists, the smut of oats (and smut of other plants) has several important enemies. Owing to the ease with which the disease can be prevented in other ways, the work of these natural enemies in checking the increase of oat smut is not of very great consequence. They may, however, prove to be of great advantage in combatting other smuts or similar fungi whose ravages are less easy to prevent. At least five different enemies of the oat smut have been found at Manhattan—three of them fungi, and two of them insects.

(a) THE WHITE MOULD (*Fusarium Ustilaginis* Kell. & Sw.[1]).

This causes the smut to become a compact mass covered with a white or slightly pinkish coating, often being converted into a compact mass firmly bound together by the root-like threads of the fungus. The disease is a common one. The spores or *conidia* are borne on the ends of upright, much branched, colorless threads (Plate IX, figs. 1 and 2). The conidia are spindle-shaped, usually slightly curved, and vary greatly in size (20–66x 3–6 1/2μ.). The conidia are commonly divided into cells by 2 to 9 transverse septa (Plate IX, figs. 3–13).

(b) THE BLACK MOULD (*Macrosporium utile* Kell. & Sw.[2]).

This parasite, less common than the white mould, is somewhat related to it. It causes the smutted spikelets to become a greenish brown or dark

---

[1] *Fusarium Ustilaginis* Kellerman & Swingle, n. sp. Effuse, forming a white or slightly pinkish coating over the smutted spikelets or sometimes extending all over the head and even to the dead tissues of the host. Hyphæ usually crowded—below simple and stout, above usually much branched, sometimes in an opuntoid manner, ultimate branches often clavate. Conidia abundant; very variable, at first oval, finally lanceolate or linear fusoid, usually crowded more or less; rather acute at both ends, 1-9 mostly 3-5 septate; 20-66x3–6 1/2μ, mostly 30-48x3-5 1/2μ. On *Ustilago Avenæ*, Manhattan, Kansas. This species seems very much like *F. Schiedermayeri* Thümen, F. Austr., n. 78, Sacc. Syll. IV, p. 712, No. 3376, and may be that, but that species is said to have hyaline or very lightly dusky, thick, somewhat branched hyphæ. The hyphae of this species are never even slightly dusky, and are very considerably branched. The conidia of that species are 44-48x5μ. Like *Fusarium Ustilaginis* it occurs in company with *Ustilago (U. Luzulæ* or *Luzula pilosa)*, but upon the ovaries shrunken by the parasite.

[2] *Macrosporium utile* Kellerman & Swingle. Effused, forming a dark-brownish, olivaceous, velvety coating over the surface of the smutted spikelets. Hyphae dark, erect, septate, slightly or not at all constricted at septa, simple or rarely branched, showing toward the tips the marks of attachment of the conidia, 50–125x4 1/2-6μ. Conidia very dark, elongate cylindrical, elliptical obovate or oblong, usually somewhat narrowed into a short pedicel; 3-8 septate transversely, usually constricted at septa; longitudinal septa few, often irregular, 29-67x8-12μ, mostly 30-40x9-llμ. Mycelium dusky, or rarely becoming pallid; in some cases provided with very small flattened expansions which probably are attached to the spores of the smut. Found on oat smut at Manhattan, Kansas. Spores apparently of this species have been seen on *Ustilago nuda* from Denmark, and on *Ustilago Avenæ* from Canada.

olivaceous color, instead of the normal dark dusky brown of the smut. The fungus consists of dark-colored threads penetrating the smut and giving rise to simple dark upright threads (Plate IX, figs. 16 and 17), which bear the very large (30–67x7–16μ) dark-colored conidia (Plate IX, figs. 18 and 19). These conidia are divided into many cells by partitions running in both vertical and horizontal directions. Spores apparently of this species have been seen on barley from Denmark.

(c) BLIGHT, A BACTERIAL DISEASE (*Bacterium* ? sp.)

The smutted spikelets attacked by the blight become very compact, and are of an entirely black color. The parasite is invisible except when the blackened smut is examined with the microscope. Many of the smut spores are then seen to be imperfect, and surrounded by myriads of colorless oval bacteria. The cells of this parasite are very minute (1–1 $^1/_2$x$^1/_2\mu$), oblong or rod-shaped; stain well with methyl violet. It somewhat resembles the *Bacillus sorghi,* illustrated in the First Annual Report, but unlike that, does not show so far as observed any spore formation. It is possible that the bacteria attack the gelatinous threads, thereby injuring or destroying the contained smut-spores. This imperfectly known parasite is probably a species of *Bacterium*.

(d) SMUT-EATING BEETLES.

(1) *Phalacrus* sp. (P. *politus* or P. *penicillatus).* This beetle belonging to a small family *(Phalacridæ)* is a minute, oval, shining black insect about $^1/_{12}$ of an inch long. It moves rather slowly, but is not particularly sluggish, though it falls to the ground when disturbed. (Outline figures are shown—Plate IX, fig. 21, as seen from above, and fig. 22 from the side.) It feeds on the smut, and probably there lays its eggs, which hatch into minute white larvæ. These larvæ grow rapidly and eat smut voraciously. They become longer than the beetles when full grown, and are straight, slightly hairy, and have a small, brownish head. The pupæ are short, and somewhat resemble the mature insect in shape.

Of the closely allied, if not identical, species *Phalacrus penicillatus,* Say, writing in 1824, says:[1] "In many parts of the United States this species is found in seed vessels of such plants of wheat as are destroyed by the parasitic vegetable called smut."

It is very common in all kinds of smut about Manhattan.

(2) *Brachytarsus variegatus* Say. This beetle belongs to the *Anthribidæ,* is larger than the *Phalacrus* just mentioned, and is of a silvery grayish or canescent color, variegated with brownish and bright silvery spots. It is about $^1/_8$ inch long, and is very sluggish in its movements, falling to the ground at once when disturbed (Plate IX, fig. 20). It also feeds on the smut. Its larvae are abundant in oat smut, especially where the smutted head does not entirely emerge from the sheath inclosing it. These larvæ

[1] Journ. Acad. Nat. Sci. of Philadelphia, IV, p. 91; Insects of North America, II, p. 231,

resemble minute white grubs, are about $^1/_8$ inch long, strongly curved, and have rather large brown heads. They are slow in motion compared to the larvæ of Phalacrus. The *pupæ* are common, and somewhat resemble the beetle in shape. Of this species Say, in 1826, remarks[1]: "The species is not uncommon, and I have found it on the 'smut' of wheat. Mr. Lea took eighty individuals from six heads of wheat." In all its stages this beetle strongly resembles the *Anthribus cornutus,* illustrated in Bulletin No. 3 of this station, pp. 34, 35, figs. 4, 5; also in the First Annual Report, p. 217, fig. 4, and p. 218, fig. 5. As seen from the quotations above, these beetles have long been known to feed on smut. We can find, however, no record of the fact that the larvæ of *Phalacrus* as well as of *Brachytarsus* are found in and feed on smut.

THE STINKING SMUT OF WHEAT.

This disease affects wheat only,* and is by no means so conspicuous (Plate III, figs. 1 and 2) as the loose, or black smut (Plate II, figs. 1 and 2), while the grain is standing. In fact, it would be overlooked unless careful search were made, as the infected heads are but little if at all different from healthy ones, and the grain (which is the only part smutted) is covered in the usual manner by the chaff; nor does the grain usually break open so as to expose the dark mass within.

But after threshing, the smutted grains are readily detected by their dark color and swollen appearance (Plate IV, figs. 5 and 6). When crushed between the fingers they emit a very strong and disagreeable odor, for which reason the disease is properly designated *stinking smut.* There are two forms, distinguishable only by the character of the spores; the one with smooth spores (which seems to be the commoner) is called in botanical language *Tilletia foetens* (B. & C.) Trel.; and the other, having spores ornamented with a net-work of ridges, is called *Tilletia Tritici* (Bjerk.) Wint. The general parasitic nature of these is the same as that of the black smut described in the preceding pages. Both species occur in Kansas.

Samples of wheat affected with the stinking smut have been received this season from Pawnee, Pratt and Rooks counties. Inquiry has revealed the fact that the disease has been prevalent in considerable portions of western Kansas. No report has reached us of the stinking smut in the eastern part of the State.

It is well known that wheat containing much smut is wholly unfit for making flour, and it is of course unsalable. Some information, therefore, in regard to this preventable pest will be here briefly given—to be supplemented next season with a full report detailing experiments already undertaken, to determine the comparative value of numerous fungicides.

The very minute reproductive bodies (spores) of which the dark mass of

[1]Journ. Acad. Nat. Sci. of Philadelphia, V, p. 251; Insects of North America, II, p. 315.
*The varieties of soft wheat are especially liable to attack; the hard wheat is said to be free from the disease.

smut is composed, adhere to the surface of the grains of the seed wheat. These, after the wheat is sown, germinate, and their slender germinal threads penetrate the young wheat in the same way as does the smut of oats before described. These slender threads, or tubes, constitute the vegetative portion of the parasite. They ramify through the tissue of the growing wheat plant, appropriating the nourishment which the latter elaborated for its own use. They enter the young grain as soon as it is formed, and in it produce the spores.

The dark color and swollen appearance of the smutted grains are shown in Plate III, figs. 5 and 6. Some of the grains become nearly globular. The deep furrow in the normal grain (Plate III, fig. 3) becomes almost entirely obliterated (fig. 5 and 6). This is shown clearly in cross-sections (fig. 4) showing the normal grain, and figs. 7 and 8 showing smutted grains. Within the testa, or hull of the diseased grain, none of the original tissue or contents remain; the space is solidly packed with the brown powder, composed of the spores as above mentioned. The penetrating and disagreeable odor is a distinguishing and unmistakable character.

If seed wheat absolutely free from the spores be used, or if the affected seed be thoroughly treated with hot water, as recommended for oats, there is no reason whatever to apprehend danger from this pest.

IMPORTANT NOTICE. — *Owing to delayed publication we are enabled to make the following important statements regarding the prevention of oat smut:*

(1) *The immersion of the seed in the scalding water should be prolonged to 15 minutes (instead of 8 to 12 minutes as above recommended).*

(2) *The volume of scalding water should be very much greater (at least 6 or 8 times) than that of the seed treated at one time.*

(3) *The basket or sack containing the seed which is being treated should be only partially filled.*

EXPERIMENTS IN CROSSING VARIETIES OF CORN.

Numerous crosses were made during the past season, between varieties of dent, flint and soft corn, as indicated in the tabulation below. Sweet corn, which very readily crosses with other varieties, and pop corn, which is of less agricultural interest, were not included in the experiments.

The plan of planting and mode of manipulation were the same as detailed in the previous report,* and will not be here repeated.

SUMMARY OF RESULTS.

By consulting the tabulation, it will be seen that fifty-six different varieties were used—45 dent, 9 flint, and 2 soft corn. Crossing was attempted in 188 cases; of these, 175, or 93 per cent., were successful. (In the previous year, 1888, when the season was unfavorable for corn, 59 per cent. only

* First Annual Report Kansas Experiment Station, pp. 316, 317.

of the attempted crossings were successful.) Six of the ears obtained were too immature, or otherwise too defective, for satisfactory comparison, and are omitted from the summary by groups which here follows:

DENT CROSSED WITH DENT.

Number of crosses	132
No evidence of cross manifest	79 (or 60 %)
Doubtful evidence of cross.	21 (or 16 %)
Evidence in character of grains.	18 (or 14 %)
Evidence in color only	14 (or 10 %)
Total evidence of cross	32 (or 24 %)

DENT CROSSED WITH FLINT.

Number of crosses	3
No evidence of cross manifest	1
Doubtful evidence of cross	1
Evidence of cross in color only	1

DENT CROSSED WITH SOFT.

Number of crosses	4
No evidence of cross	1
Doubtful evidence of cross	3

FLINT CROSSED WITH FLINT.

Number of crosses	9
No evidence of cross	6
Doubtful evidence	1
Evidence in character of grains.	1
Evidence in color only	1

FLINT CROSSED WITH DENT.

Number of crosses	18
No evidence of cross	14
Doubtful evidence.	1
Evidence in character of grains.	1
Evidence in color only	2

SOFT CROSSED WITH DENT.

Number of crosses	3
No evidence of cross.	3

TOTAL.

Number of crosses attempted	188
Number of crosses successful	175 (or 93 %)
Ears too defective for comparison.	6
No evidence of cross manifest	104 (or 62 %)
Doubtful evidence of cross	27 (or 16 %)
Evidence of cross manifest	38 (or 22 %)
—Evidence in color only	29 (or 17 %)

COMPARED WITH RESULTS OF OTHER EXPERIMENTERS.

Our results show in common with those of others that the (so-called) varieties of maize cross more or less freely, and the effects may or may not be visible the current year. The opinions of, and the results obtained by, others are shown below in the "Biliography." Here, however, might be mentioned more fully the work of Dr. E. Lewis Sturtevant, as reported in the N. Y. Exp. Sta. Report for 1884, pp. 148–154. Instead of artificially fertilizing the pistils of any variety with pollen from another, he planted the numerous sorts of corn together, so that the pollen being distributed by natural agencies might have a fair opportunity to fertilize the several varieties indiscriminately. He judged of the fact of crossing solely by the visible effects, and his propositions are based on experiments and observations extending over several years. The first, namely, that maize does not in general show the effects of current cross-fertilization, the exception being sweet corn, may be said to be confirmed in part by our results. Yet, in case of the experiments in 1888, 7½ per cent. of the crossed ears of the dent, flint and soft varieties exhibit unmistakable evidence of the crossing, and 19 per cent. showed the effects doubtfully. In case of the crosses made in 1889, 24 per cent. of the ears showed evidence of the cross, and 12½ per cent. were doubtful.

Our experiments during the past two years do not show, as Dr. Sturtevant's do, that the agricultural species* have a strong tendency to resist cross-fertilization with each other. By consulting our tabulations and summaries it will be seen that dent, flint, soft, sweet and pop corn cross as freely with each other as with the different varieties in their own class. The confirmation of this statement depends in part on the effects seen in the second generation (which see in the article that follows, namely, "Crossed Corn the Second Year").

According to Dr. Sturtevant, "where cross-fertilization has taken place in maize the tendency is to produce both parental types, and not toward intermediates." We find that the cross the first or current year is sometimes intermediate in character of grains. The second year's product may show exact intermediates (see Nos. 4 and 26 in the following article), and in no case are the ears exactly like either parent.

In cross-fertilization variation in color is commoner than variation in other characters. About one-half of the crossed ears which exhibit the effect of the crossing the first year show it in color only.

IMPROVING VARIETIES.

While one object in carrying on the work this season was the same as heretofore, namely, to study the practicability of crossing varieties and record the effects, an attempt was also made to improve certain leading ones.

The following crosses (suggested by H. M. Cottrell, Assistant in the Farm Department) were made with a view of improving the nine varieties named:

(1) *Clarage Yellow* crossed with Pride of the North, Learning, Early Yellow, Hathaway, and King of the Earliest.

(2) *Conscience* (large ears, deep kernels, ripens too late, kernels not solid enough,) crossed with Mosby's Prolific, Pride of the South, and Maryland White Dent.

*The agricultural species are given by Dr. Sturtevant as follows: *Zea saccharata,* sweet corns; *Zea indurata,* flint corns, *Zea indentata,* dent corns; *Zea amylacea,* soft corns; *Zea everta,* pop corns.

(3) *Farmer's Favorite* crossed with Mammoth Cuban, Big Buckeye, Shannon's Big Tennessee Yellow, and Glick's Yellow.

(4) *Golden Beauty* crossed with Big Buckeye, Murdock's, Leaming, Woodworth's Yellow, Farmer's Favorite, Glick's Yellow, and Mammoth Cuban.

(5) *Hickory King* (highest per cent. of corn to the cob, but the ear is too small) crossed with Conscience, Johnston's Mammoth Early White, Normandy Giant, St. Charles, and Shannon's Big Tennessee White.

(6) *Learning* (one of the best second-early varieties, and a heavy yielder) crossed with Clarage Yellow, Big Buckeye, Early Yellow Hathaway, King of the Earliest, Pride of the North, Riley's Favorite, Woodworth's Yellow, Chester County Mammoth, Farmers' Favorite, and Golden Beauty.

(7) *Mason's Flour Corn* (has habits of growth of a typical fodder corn, except that it matures too early, and does not grow high enough) crossed with Conscience, Blount's Prolific Ensilage, and Southern Horse Tooth.

(8) *Mosby's Prolific* (has remarkable tillering habits) crossed with Bullock's White Prolific, Brazilian Flour, Conscience, Red Cob Ensilage, Mason's Flour Corn, and Shannon's Big Tennessee White.

(9) *St. Charles* (medium stalk and ear, with a tendency to sucker considerably) crossed *(to make an ensilage variety)* with Bullock's White Prolific, Red-Cob Ensilage, Southern Horse-Tooth, and *(to make a field variety)* with Mammoth White Dent, and Normandy Giant.

The above crosses and the descriptions of the resulting ears will be found in the tabulation below and the "Notes on Ears Obtained" which follow. Those that are in any respect promising will be planted the coming season and carefully observed.

LIST OF VARIETIES.

The following varieties were used in making the crosses; the seed was obtained from the Farm Department:

Angel of Midnight; yellow flint.
Beard's Pearl White; white dent.
Big Buckeye; yellow dent.
Blount's Prolific Ensilage; white dent.
Brazilian Flour; white soft.
Bullock's White Prolific; smooth white dent.
Champion White Pearl; white dent.
Chester County Mammoth; light yellow dent.
Clarage Yellow; yellow dent.
Compton's Early; yellow flint.
Conscience; white dent, grains long.
Cook's; white dent.
Cranberry White; white dent, pinkish-tinged.
Early California; yellow dent.
Early Red Blazed; yellow flint.
EarIy White Dawn; white dent.
Early White Dent; white dent.
Early Yellow Hathaway; yellow dent.
Ellm's Early Yellow; yellow flint.

Farmers' Favorite; large yellow dent.
Glick's Yellow; large yellow dent.
Golden Beauty; large yellow dent.
Hickory King; white dent.
Improved Shoe Peg; white dent.
Johnston's Mammoth Early White; white dent.
King of the Earliest; yellow dent.
King Philip; red-brown flint.
Learning; yellow dent.
Longfellow; yellow flint.
Mammoth Cuban; yellow dent.
Mammoth White Dent; white dent.
Maryland White Dent; white dent.
Mason's Flour; soft corn.
Mosby's Prolific; white dent.
Murdock's; yellow dent.
Normandy Giant; white dent.
Parish White; white dent.
Parker & Wood's Perfect Ensilage; white dent.
Prairie King; yellow dent.
Pride of the North; small yellow dent.
Pride of the South; white dent.
Red-Cob Ensilage; white dent.
Red Dent.
Riley's Favorite; yellow dent.
Self-Husking; reddish or brownish yellow flint.
Shannon's Big Tennessee White; white dent.
Shannon's Big Tennessee Yellow; yellowish dent.
Sheep's Tooth; white dent.
Southern Horse Tooth; white dent.
St. Charles; white dent.
Thoroughbred White Flint; large white flint.
Waushakum; yellow flint.
White Dent.
White Flat Ensilage; smooth white dent.
Woodworth's Yellow; yellow dent.
Yellow Mammoth; yellow dent.

EXPLANATION OF THE TABLE.

The following table gives the details of all the experiments. In the first column is given the serial number (continued from the previous year); in the second, the name of the variety; in the third, the date of inclosing the tear with the cloth sack ; in the fourth, the date of applying the pollen (in all cases the number of the month, instead of the name, is given); in the fifth, the variety (followed by its serial number) which furnished the pollen; in the sixth, the result of the attempted crossing (in case an ear was obtained, it is given a number [continued from the previous year], which refers to the description below under the heading, “Notes on Ears Obtained”); in the seventh, the date of inclosure of the tassel in order to secure pollen; and finally, in the eighth, the variety (with its serial number) fertilized by this pollen.

TABLE OF EXPERIMENTS IN CROSSING VARIETIES OF CORN.

No.	Name of variety.	Date of inclosure of ear.	Date of fertilization.	Source of pollen.	Result.	Date of inclosure of tassel.	Variety fertilized.
97	White Flat Ensilage	......	......	......	......	7-27	Golden Beauty (191). Clarage Yellow (340).
98	Early White Dent	7-21	7-28	Maryland White Dent (290)	Ear 44	......	———
99	Early White Dent	7-20	7-26	Murdock's (210)	Ear 45	......	———
100	Normandy Giant	......	......	......	......	7-17	Hickory King (180).
101	Normandy Giant	......	......	......	......	7-20	Champion White Pearl (108).
102	Normandy Giant	......	......	......	......	7-22	St. Charles (232).
103	Normandy Giant	......	......	......	......	7-26	Chester County Mammoth (48). Southern Horsetooth (228). Pride of the North (114). Longfellow (124). Murdock's (211).
104	Normandy Giant	7-21	7-27	St. Charles (230)	Ear 46	7-21	St. Charles (237).
105	Normandy Giant	......	......	......	......	7-27	St. Charles (238).
106	Normandy Giant	......	......	......	......	7-27	Golden Beauty (200). St. Charles (243).
106a	Normandy Giant	......	......	......	......	7-20	Glick's Yellow (348).
107	Champion White Pearl	......	......	......	......	7-7	Glick's Yellow (348).
108	Champion White Pearl	7-10	7-21	Normandy Giant (101)	Ear 47	......	———
108a	Champion White Pearl	......	......	......	......	7-12	Early Yellow Hathaway (255). Pride of the North (111).
109	Champion White Pearl	7-10	7-14	Waushakum (219a)	Ear 48	......	———
110	Champion White Pearl	7-10	7 18	Chester County Mammoth (213),	Ear 49	......	———
110a	Pride of the North	......	......	......	......	7-19	Johnston's Early White (226). Longfellow (116).

TABLE OF EXPERIMENTS IN CROSSING VARIETIES OF CORN—CONTINUED.

No.	Name of variety.	Date of inclosure of ear.	Date of fertilization.	Source of pollen.	Result.	Date of inclosure of tassel.	Variety fertilized.
111	Pride of the North	7–12	7–15	Champion White Pearl (108*a*)	Ear 50	......	————
112	Pride of the North	......	......	......	......	7 13	Leaming (153). Early Yellow Hathaway (254).
113	Pride of the North	7–15	7–18	Bullock's White Prolific (246)	Ear 51	7–15	Longfellow (121).
114	Pride of the North	7–21	7–27	Normandy Giant (103)	Ear 52	......	————
115	Pride of the North	......	......	......	......	7–29	Clarage Yellow (338). Farmers' Favorite (163).
116	Longfellow	7–5	7–14	Pride of the North (110*a*)	Ear 53	......	————
117	Longfellow	7–7	7–11	Self-Husking (128)	Ear 54	......	————
118	Longfellow	7–7	7–11	Early Yellow Hathaway (254)	Ear 55	......	————
119	Longfellow	......	......	......	......	......	Self-Husking (125).
120	Longfellow	......	......	......	......	5–12	Thoroughbred White Flint (309).
121	Longfellow	7–10	7–17	Pride of the North (113)	Ear 56	......	————
122	Longfellow	......	......	......	......	7–12	Early Yellow Hathaway (258).
124	Longfellow	7–21	7–27	Normandy Giant (103)	Ear 57	......	————
125	Self-Husking	7–5	7–10	Longfellow (119)	Ear 58	......	————
126	Self-Husking	7–7	7–10	Compton's Early (129)	Ear 59	......	————
127	Self-Husking	7–5	7–10	Early Yellow Hathaway (253)	Ear 60	......	————
128	Self-Husking	7–10	7–18	Woodworth's Yellow (274)	Ear 61	7–10	Ellm's Early Yellow (143). Longfellow (117). Angel of Midnight (218).
129	Compton's Early	7–5	7–10	King Philip (135)	Ear 62	7–7	Self-Husking (126).

130	Compton's Early	7–5	7–15	Early Yellow Hathaway (260)	Ear 63	......	————
131	Compton's Early	......	......	......	......	7–11	Early Yellow Hathaway (253).
132	Improved Shoe Peg	7–15	7–26	Murdock's (210)	Ear 64	......	————
133	Improved Shoe Peg	7–17	7–27	St. Charles (234)	Ear 65	......	————
134	King Philip	7–5	7–15	Leaming (146)	Ear 66	......	————
135	King Philip	......	......	......	......	7–7	Compton's Early (129). Early Red Blazed (249).
136	King Philip	7–13	7–17	Murdock's (208)	Ear 67	......	————
137	King Philip	7–18	7–25	Prairie King (352)	No ear	......	————
138	King Philip	7–5	7–11	Early Yellow Hathaway (254)	Ear 68	......	————
139	King Philip	7–14	7–22	Riley's Favorite	Ear 69	......	————
140	King Philip	7–14	7–19	Chester County Mammoth (215a)	No ear	......	————
141	King Philip	7–17	7–21	Woodworth's Yellow (275)	Ear 70	......	————
142	King Philip	7–18	7–21	King of the Earliest (315)	Ear 71	......	————
143	Ellm's Early Yellow	7–5	7–11	Self-Husking (128)	Ear 72	......	————
144	Ellm's Early Yellow	7–7	7–14	Early Yellow Hathaway (259)	Ear 73	......	————
146	Leaming	7–14	7–16	Farmers' Favorite (168)	Ear 74	7–12	King Philip (134).
147	Leaming	7–16	7–24	Prairie King (351)	No ear	......	————
148	Leaming	7–14	7–19	King of the Earliest (313)	No ear	......	————
149	Leaming	7–17	7–22	Riley's Favorite (317)	Ear 75	7–19	Golden Beauty (193).
150	Leaming	7–18	7–24	Big Buckeye (270)	Ear 76	......	————
151	Leaming	7–19	7–22	Clarage Yellow (337)	Ear 77	......	————
152	Leaming	7–11	7–16	Early Yellow Hathaway (256)	Ear 78	......	————

TABLE OF EXPERIMENTS IN CROSSING VARIETIES OF CORN — CONTINUED.

No.	Name of variety.	Date of inclosure of ear.	Date of fertilization.	Source of pollen.	Result.	Date of inclosure of tassel.	Variety fertilized.
153	Leaming	7–13	7–16	Pride of the North (112)	Ear 79	......	————
154	Leaming	7–14	7–18	Chester County Mammoth (213)	Ear 80	......	————
155	Leaming	7–14	7–17	Early Yellow Hathaway (260)	Ear 81	......	————
156	Leaming	7–14	7–18	Woodworth's Yellow (274)	Ear 82	......	————
157	Leaming	7–17	7–19	Golden Beauty (185)	Ear 83	......	————
158	Leaming	......	......	......	......	7–21	Golden Beauty (188).
159	Leaming	7–21	7–29	A Red Dent (281)	Ear 84	......	————
160	Leaming	7–19	7–21	Chester County Mammoth (215*b*)	Ear 85	......	————
161	Leaming	7–21	7–24	King of the Earliest (314)	Ear 86	......	————
162	Leaming	......	......	......	......	7–21	{ Glick's Yellow (347). { Clarage Yellow (339).
163	Farmers' Favorite	7–15	7–30	Pride of the North (115)	Ear 87	......	————
164	Farmers' Favorite	7–18	7–25	Mammoth Cuban (322)	No ear.	......	Golden Beauty (205).
165	Farmers' Favorite	7–16	7–24	Big Buckeye (270)	Ear 88	......	————
166	Farmers' Favorite	7–19	7–30	Shannon's Big Tenn. White (356)	Ear 89	......	————
167	Farmers' Favorite	7–21	7–30	Red Cob Ensilage (363)	Ear 90	......	————
168	Farmers' Favorite	......	......	......	......	7–16	{ Golden Beauty (201). { Leaming (147).
169	Farmers' Favorite	7–17	7–21	Mammoth Cuban (320)	Ear 91	......	————
170	Farmers' Favorite	7–17	8–1	Maryland White Dent (292)	Ear 92	......	————

172	Farmers' Favorite	7–18	7–22	Glick's Yellow (347)	Ear 94	......	————
173	Farmers' Favorite	7–20	8–2	Cranberry White (332)	Ear 95	......	————
174	Farmers' Favorite	7–25	7–29	Shannon's Big Tenn. Yellow (360)	Ear 96	......	————
175	Hickory King	7–17	7–25	Johnston's Mammoth Early White (361)	Ear 97	......	
176	Hickory King	7–20	8–2	A Red Dent (284)	Ear 98	......	————
177	Hickory King	7–21	7–31	Conscience (333)	Ear 99	......	————
178	Hickory King	7–22	7–31	Shannon's Big Tenn. White (356)	Ear 100	......	————
179	Hickory King	7–22	7–30	Shannon's Big Tenn. White (356)	Ear 101	......	————
180	Hickory King	7–16	7–19	Normandy Giant (100)	Ear 102	......	————
181	Hickory King	7–16	7–21	St. Charles (230)	No ear.	......	————
182	Hickory King	......	......	......	......	7–18	St. Charles (231).
183	Hickory King	7–25	7–31	Early California (326)	No ear.	......	————
184	Hickory King	7–25	8–1	Maryland White Dent (292)	Ear 103	......	————
185	Golden Beauty	7–17	7–30	Maryland White Dent (290)	Ear 104	7–17	Leaming (157).
186	Golden Beauty	7–17	7–24	Big Buckeye (270)	Ear 105	......	————
187	Golden Beauty	7–18	7–22	Murdock's (212)	Ear 106	......	————
188	Golden Beauty	7–18	7–22	Leaming (158)	Ear 107	......	————
189	Golden Beauty	7–18	7–22	Woodworth's Yellow (276)	Ear 108	......	————
190	Golden Beauty	7–21	7–24	Big Buckeye (270)	Ear 109	......	————
191	Golden Beauty	7–21	7–30	White Flat Ensilage (97)	Ear 110	......	————
192	Golden Beauty	7–25	7–30	Mosby's Prolific (298)	Ear 111	......	————
193	Golden Beauty	7–14	7–19	Leaming (149)	Ear 112	......	————

TABLE OF EXPERIMENTS IN CROSSING VARIETIES OF CORN—CONTINUED.

No.	Name of variety.	Date of inclosure of ear.	Date of fertilization.	Source of pollen.	Result.	Date of inclosure of tassel.	Variety fertilized.
194	Golden Beauty	7–14	7–21	Murdock's (209*a*)	Ear 113	......	—
195	Golden Beauty	7 14	7–31	Sheep's Tooth (367)	No ear.	7–15	Blount's Prolific Ensilage (262). Bullock's White Prolific (246).
196	Golden Beauty	7–16	7–18	Woodworth's Yellow (274)	Ear 114	......	—
197	Golden Beauty	7–17	7–21	Big Buckeye (269*b*)	Ear 115	......	—
198	Golden Beauty	7–17	7–21	Mammoth Cuban (320)	Ear 116	......	—
199	Golden Beauty	7–17	7–22	Glick's Yellow (347)	Ear 117	......	—
200	Golden Beauty	7–18	7–29	Normandy Giant (106)	No ear.	......	—
201	Golden Beauty	7–18	7–21	Farmers' Favorite (168)	Ear 118	......	—
202	Golden Beauty	7–18	7–29	Shannon's Big Tenn. Yel. (360).	Ear 119	......	—
203	Golden Beauty	7–18	7–29	A Red Dent (282)	Ear 120	......	—
205	Golden Beauty	7–17	7–21	Farmers' Favorite (164)	Ear 121	......	—
206	Golden Beauty	7–19	7–29	A Red Dent (280)	Ear 122	......	—
207	Golden Beauty	7–19	7–29	A Red Dent (282)	Ear 123	......	—
207*a*	Golden Beauty	7–21	7–29	A Red Dent (281)	Ear 124	......	—
208	Murdock's	......	......	......	......	7–13	King Philip (136).
209	Murdock's	7–15	7–26	Chester County Mammoth (215).	No ear.	......	—
209*a*	Murdock's	......	......	......	......	......	Golden Beauty (194).
210	Murdock's	......	......	......	......	7–22	Early White Dent (99). Improved Shoe Peg (132). Breck's Bost. Mkt. Ensil'ge (145).
211	Murdock's	7–21	7–29	A Red Dent (281)	Ear 125	......	—

212	Murdock's	......	......	......	......	7–21	Early White Dawn (354). Golden Beauty (187).
213	Chester County Mammoth	......	......	......	......	7–17	Leaming (154). Champion White Pearl (110).
214	Chester County Mammoth	7–21	7–30	A Red Dent (282)	Ear 126	......	———
215	Chester County Mammoth	......	......	......	......	7–22	Johnston's Early Wh. Dent (224). Murdock's (209).
215*a*	Chester County Mammoth	......	......	......	......	7–16	King Philip (140).
215*b*	Chester County Mammoth	......	......	......	......	7–17	Leaming (160).
216	Chester County Mammoth	7–21	7–27	Normandy Giant (103)	Ear 127	......	———
217	Angel of Midnight	7–5	7–10	Early Red Blazed (250)	Ear 128	......	———
218	Angel of Midnight	7–7	7–10	Self-Husking (128)	Ear 129	......	———
219	Waushakum	7–7	7–10	Early Red Blazed (250)	Ear 130	......	———
219*a*	Waushakum	......	......	......	......	7–12	Champion White Pearl (109).
220	Waushakum	7–18	7–22	Riley's Favorite (317)	Ear 131	......	———
221	Parker & Wood's Perfect Ensilage	7–21	7–28	Sheep's Tooth (367)	Ear 132	......	———
222	Parker & Wood's Perfect Ensilage	7–27	8–1	Maryland White Dent (293)	Ear 133	......	———
223	Brazilian Flour	......	......	......	......	8–16	Mosby's Prolific (305).
224	Johnston's Early White Dent	7–20	7–26	Chester County Mammoth (215).	Ear 134	......	———
225	Johnston's Early White Dent	7–21	7–31	Early California (327)	Ear 135	......	———
226	Johnston's Early White Dent	7–21	7–27	Pride of the North (110*a*)	Ear 136	......	———
227	Southern Horse Tooth	7–21	7–29	A Red Dent (280)	Ear 137	......	———
227*a*	Southern Horse Tooth	......	......	......	......	7–21	St. Charles (240).
228	Southern Horse Tooth	7–21	7–27	Normandy Giant (103)	Ear 138	......	———
229	Southern Horse Tooth	......	......	......	......	8–2	Mason's Flour Corn (268).

TABLE OF EXPERIMENTS IN CROSSING VARIETIES OF CORN—CONTINUED.

No.	Name of variety.	Date of inclos-ure of ear.	Date of fertili-zation.	Source of pollen.	Result.	Date of inclos-ure of tassel.	Variety fertilized.
230	St. Charles	7–17	7–18	Bullock's White Prolific (246)	Ear 139	7–17	Normandy Giant (104). Hickory King (181).
231	St. Charles	7–17	7–21	Hickory King (182)	No ear.	.....	—
232	St. Charles	7–21	7–24	Normandy Giant (102)	Ear 140	.....	
233	St. Charles	7 21	7–25	Mammoth White Dent (297)	Ear 141	.....	
234	St. Charles	.....	.....	.....	.....	7–24	Improved Shoe Peg (133). Yellow Mammoth (244).
235	St. Charles	7–21	7–27	Red Cob Ensilage (364)	Ear 142	.....	—
236	St. Charles	7–21	7–24	Bullock's White Prolific (247)	Ear 143	.....	—
237	St. Charles	7–22	7–27	Normandy Giant (104)	Ear 144	.....	—
238	St. Charles	7–22	7–28	Normandy Giant (105)	Ear 145	.....	—
239	St. Charles	7–22	7–24	Mammoth White Dent (296)	Ear 146	.....	—
240	St. Charles	7–22	7–27	Southern Horse Tooth (227*a*)	Ear 147	.....	—
241	St. Charles	7–24	7–28	Johnston's Mammoth Early White (361*a*)	Ear 148	.....	—
242	St. Charles	7–27	7–30	Red Cob Ensilage	Ear 149	.....	—
243	St. Charles	7–27	7–29	Normandy Giant (106)	Ear 150	.....	—
243*a*	St. Charles	.....	.....	.....	.....	8–16	Mosby's Prolific (301).
244	Yellow Mammoth	7–19	7–31	Maryland White Dent (291)	Ear 151	.....	—
245	Yellow Mammoth	7–21	7–27	Blount's Prolific Ensilage (263)	Ear 152	.....	—
246	Bullock's White Prolific	7–14	7–21	Golden Beauty (195)	Ear 153	7–14	Pride of the North (113). St. Charles (230).

247	Bullock's White Prolific					7-21	St. Charles (236).
248	Bullock's White Prolific					8-16	Mosby's Prolific (306).
249	Early Red Blazed	7-5	7-7	King Philip (135)	Ear 154		
250	Early Red Blazed	7-7	7-17	Early Yellow Hathaway (257)	Ear 155	7-7	{ Waushakum (219). Angel of Midnight (217).
251	Early Red Blazed	7-7	7-10	Early Yellow Hathaway (258)	Ear 156		
252	Early Red Blazed					7-22	Riley's Favorite (317).
253	Early Yellow Hathaway	7-10	7-14	Compton's Early (131)	Ear 157		Self-Husking (127).
254	Early Yellow Hathaway	7-10	7-14	Pride of the North (112)	Ear 158		{ King Philip (138). Longfellow (118).
255	Early Yellow Hathaway	7-11	7-15	Champion White Pearl (408*a*)	Ear 159		
256	Early Yellow Hathaway					7-16	Leaming (152).
257	Early Yellow Hathaway					7-13	Early Red Blazed (250).
258	Early Yellow Hathaway	7-10	7-15	Longfellow (122)	Ear 160		Early Red Blazed (251).
259	Early Yellow Hathaway					7-13	{ Ellm's Early Yellow (144). King of the Earliest (314).
260	Early Yellow Hathaway					7-15	{ Leaming (155). Compton's Early (130).
261	Early Yellow Hathaway					7-30	Clarage Yellow (341).
262	Blount's Prolific Ensilage	7-14	7-21	Golden Beauty (195)	Ear 161		
263	Blount's Prolific Ensilage					7-21	Yellow Mammoth (245).
264	Blount's Prolific Ensilage					8-1	Mason's Flour Corn (266).
265	Mason's Flour Corn	7-25	7-28	Big Buckeye (271)	Ear 162		
266	Mason's Flour Corn	7-28	8-2	Blount's Prolific Ensilage (264)	Ear 163		
267	Mason's Flour Corn	7-28	8-2	Conscience (334)	Ear 164		
268	Mason's Flour Corn	7-31	8-3	Southern Horse-Tooth (229)	Ear 165		

TABLE OF EXPERIMENTS IN CROSSING VARIETIES OF CORN — CONTINUED.

No.	Name of variety.	Date of inclosure of ear.	Date of fertilization.	Source of pollen.	Result.	Date of inclosure of tassel.	Variety fertilized.
269	Mason's Flour Corn....	......	......	......	......	8–6	Mosby's Prolific (298).
269*a*	Mason's Flour Corn....	......	......	......	......	7–27	Riley's Favorite (317).
269*b*	Big Buckeye..........	......	......	......	......	7–18	Golden Beauty (197).
270	Big Buckeye..........	......	......	......	......	7–22	Leaming (150). Golden Beauty (190). Golden Beauty (186). Farmers' Favorite (165).
271	Big Buckeye..........	7–30	8–2	Cranberry White (332)........	Ear 166	7–27	Mason's Flour Corn (265).
272	Cook's................	7–21	7–25	Mammoth White Dent (297)...	Ear 167	......	
273	Cook's................	7–30	8–3	Early California (328)........	Ear 168	......	—
274	Woodworth's Yellow....	......	......	......	......	7–14	Self-husking (128). Leaming (156). Golden Beauty (196).
275	Woodworth's Yellow....	......	......	......	......	7–17	King Philip (141).
276	Woodworth's Yellow....	......	......	......	......	......	Golden Beauty (189).
277	Woodworth's Yellow....	......	......	......	......	7–22	Red Cob.Ensilage (363).
278	Beard's White Pearl....	7–21	7–25	Riley's Favorite (318)........	Ear 169	......	—
279	A Red Dent...........	7–21	7–25	Riley's Favorite (318)........	Ear 170	......	—
280	A Red Dent...........	......	......	......	......	7–25	Golden Beauty (206). Southern Horse Tooth (227). Blount's Prolific (311).
281	A Red Dent...........	......	......	......	......	7–28	Golden Beauty (207). Murdock's (211). Golden Beauty (204). Leaming (159).

282	A Red Dent..........	......	......	....	....	7–28	Golden Beauty (207). Golden Beauty (203). Chester County Mammoth (214). Clarage Yellow (345). Mammoth Cuban (323). Riley's Favorite (319). Clarage Yellow (342).
282a	A Red Dent..........	......	......	....	....	......	Clarage Yellow (344).
283	A Red Dent..........	......	......	....	....	7–31	Early White Dent (355). Farmers' Favorite (171).
284	A Red Dent..........	......	......	....	....	8–1	Hickory King (176).
286	A Red Dent..........	......	......	... .	....	8–9	Shannon's Big Tenn. Yellow (360).
287	A Red Dent..........	......	......	....	....	8–16	Shannon's Big Tenn. White (359).
288	A Red Dent..........	......	......	....	....	8–16	Blount's Prolific (312). Mosby's Prolific (303). Johnston's Mammoth Early White Glick's Yellow (349).
289	Parish White..........	7–31	8–2	A Red Dent (284).......	Ear 172	......	————
290	Maryland White Dent...	......	......	....	....	7–29	Early White Dent (98). Golden Beauty (185). A White Dent (370).
291	Maryland White Dent...	......	......	....	....	7–30	Yellow Mammoth (244).
292	Maryland White Dent...	......	......	....	....	7–31	Farmers' Favorite (170). Hickory King (184).
293	Maryland White Dent...	... ..	......	....	....	8–16	Parker & Wood's Perfect Ensilage (222). Conscience (336).
294	Mammoth White Dent..	7–21	7–25	Riley's Favorite (318).........	Ear 173	......	- + - - -
295	Mammoth White Dent..	......	......	....	....	......	Johnston's Mammoth Early White (371).
296	Mammoth White Dent..	......	......	....	....	7–22	St. Charles (239).
297	Mammoth White Dent..	......	......	....	....	7–24	St. Charles (233). Cook's (272).
298	Mosby's Prolific........	7–30	8–7	Mason's Flour Corn (269).....	Ear 174	7–29	Golden Beauty (192).
299	Mosby's Prolific........	7–30	8–7	Conscience (335).............	Ear 175	......	————

TABLE OF EXPERIMENTS IN CROSSING VARIETIES OF CORN—CONTINUED.

No.	Name of variety.	Date of inclosure of ear.	Date of fertilization.	Source of pollen.	Result.	Date of inclosure of tassel.	Variety fertilized.
300	Mosby's Prolific	8–2	8–7	Shannon's Big Tenn. White (357).	Ear 176	......	
301	Mosby's Prolific	8–3	8–17	St. Charles (243*a*)	Ear 177	......	————
302	Mosby's Prolific	8–16	8–18	Shannon's Big Tenn. White (358).	Ear 178	......	————
303	Mosby's Prolific	8–16	8–18	A Red Dent (288)	Ear 179	......	————
304	Mosby's Prolific	8–6	8–10	Red Cob Ensilage (365)	Ear 180	......	————
305	Mosby's Prolific	8–6	8–17	Brazilian Flour (223)	Ear 181	......	————
306	Mosby's Prolific	8–9	8–17	Bullock's White Prolific (248)	Ear 182	......	————
307	Mosby's Prolific	......	......	......	......	8–16	Conscience (334).
308	Pride of the South	......	......	......	......	8–16	Conscience (335).
309	Thoroughbred White Flint	7–14	7–18	Longfellow (120)	Ear 183	......	————
310	Thoroughbred White Flint	7–18	7–31	Early California (326)	Ear 184	......	————
311	Blount's Prolific Ensilage	7–21	7–27	A Red Dent (280)	Ear 185	......	————
312	Blount's Prolific Ensilage	7–31	8–18	A Red Dent (288)	No ear.	......	————
313	King of the Earliest	......	......	......	......	7–14	Leaming (148).
314	King of the Earliest	7–15	7–17	Early Yellow Hathaway (259)	Ear 186	7–22	Leaming (161).
315	King of the Earliest	......	......	......	......	7–17	King Philip (142).
316	King of the Earliest	......	......	......	......	7–22	Early California (324).
316*a*	King of the Earliest	......	......	......	......	7–27	Clarage Yellow (343).

317	Riley's Favorite	7–21	7–28	Mason's Flour Corn (269*a*)	Ear 187	......	King Philip (139). Leaming (149). Waushakum (220).
318	Riley's Favorite	......	......	....	....	7–22	Beard's Pearl White (278). A Red Dent (279). Mammoth White Dent (294).
319	Riley's Favorite	7–28	7–30	A Red Dent (282)................	Ear 188	......	———
320	Mammoth Cuban	......	......	....	....	7–17	Farmers' Favorite (169). Golden Beauty (198).
322	Mammoth Cuban	......	......	....	....	7–22	Farmers' Favorite (164).
323	Mammoth Cuban	7–28	7–30	A Red Dent (282)................	Ear 190	......	———
324	Early California	7–19	7–25	King of the Earliest (316)........	Ear 191	......	———
324*a*	Early California	......	......	....	....	7–24	Sheep's Tooth (368).
325	Early California	7–28	8–3	Cranberry White (330)...... ...	Ear 192	7–31	Cranberry White (330). Cranberry White (331). Sheep's Tooth (369).
326	Early California	......	......	....	....	7–30	Hickory King (188). Red Cob Ensilage (366). Thoroughbred White Flint (310).
327	Early California	......	......	....	....	7–30	Johnston's Early Wh. Dent (225). Sheep's Tooth (368).
328	Early California	7–30	8–3	Cranberry White (330)...........	Ear 193	7–31	Cook's (273).
329	Cranberry White...........	7–21	7–25	Clarage Yellow (342).............	Ear 194	......	———
330	Cranberry White...........	7–28	8–1	Early California (325)	Ear 195	7–28	Early California (325). Early California (328).
331	Cranberry White...........	7–30	8–2	Early California (325)	Ear 196	......	———
332	Cranberry White..........	......	......	....	....	......	Prairie King (353). Big Buckeye (271). Farmers' Favorite (173).
332*a*	Cranberry White......	......	......	....	....	8–2	Clarage Yellow (346).
333	Conscience	......	......	....	....	7–30	Hickory King (177).
334	Conscience	7–29	8–18	Mosby's Prolific (307)	Ear 197	8–1	Mason's Flour Corn (267).

TABLE OF EXPERIMENTS IN CROSSING VARIETIES OF CORN—*Concluded.*

No.	Name of variety.	Date of inclosure of ear.	Date of fertilization.	Source of pollen.	Result.	Date of inclosure of tassel.	Variety fertilized.
335	Conscience	8-4	8-18	Pride of the South (308)	Ear 198	8-6	Mosby's Prolific (299).
336	Conscience	8-6	8-18	Maryland Wh. Dent (293)	No ear.	......	——
337	Clarage Yellow	......	......	......	......	7-19	Leaming (151).
338	Clarage Yellow	7-25	7-30	Pride of the North (115)	Ear 199	......	——
339	Clarage Yellow	7-24	7-25	Leaming (162)	Ear 200	......	——
340	Clarage Yellow	7-25	7-30	White Flat Ensilage (97)	*Ear 201*	......	——
341	Clarage Yellow	7-25	7-31	Early Yel. Hathaway (261)	Ear 202	......	——
342	Clarage Yellow	......	......	......	......	7-22	Cranberry White (329).
343	Clarage Yellow	7-24	7-28	King of the Earliest (316*a*)	Ear 203	......	——
344	Clarage Yellow	7-25	7-30	A Red Dent (282*a*)	Ear 204	......	——
345	Clarage Yellow	7-25	7-30	A Red Dent (282)	No ear.	......	——
346	Clarage Yellow	7-28	8-3	Cranberry White (332*a*)	Ear 205	......	——
347	Glick's Yellow	7-21	7-25	Leaming (162)	Ear 206	7-19	{ *Golden Beauty (199).* Farmers' Favorite (172).
347*a*	Glick's Yellow	......	......	......	......	7-25	Prairie King (350).
348	Glick's Yellow	7-28	8-2	Normandy Giant (106*a*)	Ear 207	......	——
349	Glick's Yellow	8-2	8-18	A Red Dent (288)	Ear 208	......	——
350	Prairie King	7-21	7-25	Glick's Yellow (347*a*)	*Ear 209*	......	——
351	Prairie King	......	......	......	......	7-22	Leaming (147).
352	Prairie King	......	......	......	......	7-24	King Philip (137).

353	Prairie King	7–28	8–2	Cranberry White (332)	Ear 210	......	————
354	Early White Dawn	7–19	7–22	Murdock's (212)	Ear 211	......	————
355	Early White Dawn	7–28	8–1	A Red Dent (283)	Ear 212	......	————
356	Shannon's Big Tenn. White	......	......	......	......	7–30	Farmers' Favorite (166). Hickory King (179). Hickory King (178).
357	Shannon's Big Tenn. White	......	......	......	......	8–6	Mosby's Prolific (300).
358	Shannon's Big Tenn. White	......	......	......	......	8–9	Mosby's Prolific (302).
359	Shannon's Big Tenn. White	7–31	8–18	A Red Dent (287)	Ear 213	......	————
360	Shannon's Big Tenn. Yellow	7–31	8–10	A Red Dent (286)	Ear 214	7–27	Golden Beauty (262). Farmers' Favorite (174).
361	Johnston's Mammoth Early White	......	......	......	......	7–22	Hickory King (175).
361a	Johnston's Mammoth Early White	......	......	......	......	7–25	St. Charles (241).
362	Johnston's Mammoth Early White	7–30	8–18	A Red Dent (288)	Ear 215	......	————
363	Red-Cob Ensilage	7–21	7–25	Woodworth's Yellow (277)	Ear 216	7–29	Prairie King (351). St. Charles (242).
364	Red-Cob Ensilage	......	......	......	......	......	St. Charles (235).
365	Red-Cob Ensilage	......	......	......	......	8–9	Mosby's Prolific (304).
366	Red-Cob Ensilage	7–28	7–31	Early California (326)	Ear 217	......	————
367	Sheep's Tooth	......	......	......	......	7–25	Parker & Wood's Perf. Ensil. (221).
368	Sheep's Tooth	7–27	7–31	Early California (324a)	Ear 218	......	————
369	Sheep's Tooth	7–30	8–2	Early California (325)	Ear 219	7–30	Golden Beauty (195).
370	A White Dent	7–30	8–4	Maryland Wh. Dent (290)	Ear 220	......	————
371	Johnston's Mammoth Early White	7–25	7–27	Mammoth Wh. Dent (295)	Ear 221	......	————

NOTES ON THE EARS OBTAINED.

EAR 44. *Early White Dent* (98); crossed with *Maryland White Dent* (290). Length 91 inches, diameter 2 1/8 inches, well filled throughout, dull white, 16-rowed, 4 of the rows irregular, otherwise uniform; grains pure white, wedge-shaped, medium-sized, summits deeply dented and very much wrinkled; cob white, 1 7/16 inches in diameter.

Evidence of cross only in the intermediate size of the grains.

EAR 45. *Early White Dent* (98); crossed with *Murdock's* (210; yellow dent). Length 7 7/8 inches, diameter 1 3/4 inches, not well filled, about one-third of the grains wanting, 12-rowed, slightly reddish yellow; grains dimple-dented and minutely tipped on the chit side; cob light red, 1 1/4 inches in diameter.

Evidence of cross in the intermediate color.

EAR 46. *Normandy Giant* (104; white dent); crossed with *St. Charles* (230; white dent). Length 8 ¾ inches, diameter 2 1/8 inches, well filled throughout, white, but many grains a light yellow color, 12-rowed; grains wide and rather thick, deeply indented and much wrinkled at summit; cob 1 ¼ inches in diameter, color red.

No evidence of cross; the yellow a result perhaps of a previous cross.

EAR 47. *Champion White* (108; dent); crossed with *Normandy Giant* (101; white dent). Length 8 inches, diameter 2 inches, well filled except at extreme tip, 18-rowed, rows somewhat irregular; grains wedge-shaped, white, deeply indented and much wrinkled at summit; cob 1 1/8 inches in diameter, color white.

NO evidence of cross.

EAR 48. *champion White* (109; dent); crossed with *Waushakum* (219a; flint). Length 6 inches, diameter 2 1/8 inches, well filled below, uppermost 2 inches destitute of grains, 16-rowed, 3 rows slightly irregular, color light, bright yellow; grains indented, and in shape and size like typical Champion White.

Evidence of cross only in intermediate color.

EAR 49. Champion *White* (110; dent); crossed with *Chester County Mammoth* (213; yellowish white dent). Length 7 5/8 inches, diameter 1 5/8 inches, imperfectly filled, no grains at base nor at tip, rows very irregular and incomplete; grains yellowish with lighter summits, broad and thick, slightly dented; cob white, 1 1/16 inches in diameter.

Evidence of cross in intermediate color of grains; otherwise anomalous.

EAR 50. *Pride of the North* (111; yellow dent); crossed with *Champion White Pearl* (108a; dent). Length 6 1/8 inches, diameter 2 inches, well filled except upper two inches, 14-rowed; grains mostly yellow, some of them very light yellow with almost white summits moderately indented and somewhat wrinkled, rather narrow and long; cob bright red, 1 $^1/_8$ inches diameter.

No evidence of cross except in the lighter color of grains.

EAR 51. *Pride of the North* (113; yellow dent); crossed with *Bullock's White prolific* (246; dent). Length 7 $^5/_{16}$., diameter 1 $^{13}/_{16}$, well filled, 16-rowed; light yellow, about $^1/_5$ of the grains with whitish summits and somewhat lighter below, moderately indented, wrinkled and slightly tipped, smaller than either parental type, but more nearly the shape of Pride of the North; cob deep red, 1 $^3/_{16}$ inches in diameter.

Evidence of cross only in the intermediate color.

EAR 52. *Pride of the North* (114; yellow dent); crossed with *Normandy Giant* (103; white dent). Length 32 inches, diameter 1 $^5/_8$ inches, incompletely filled on one side, about 14-rowed, light yellow in color; grains small dimple-dented and slightly tipped; cob red, 1$^1/_8$ inches in diameter.

No evidence of cross except in lighter color of grains.

EAR 53. *Longfellow* (116; flint); crossed with *Ride of the North* (110a; yellow dent). Length 7 3/4 inches, diameter 14 inches, 8-rowed; grains flint, yellow, and exactly like typical Longfellow; cob white, 1 3/16 inches in diameter.

No evidence whatever of cross.

EAR 54. *Longfellow* (117; yellow flint); crossed with Self-Husking (128; darker flint). Length 6 $^7/_8$ inches, diameter 1 ½ inches; 8-rowed, grains yellow, flint, exactly like the typical Longfellow; cob white, 1 inch in diameter.

No evidence whatever of cross.

EAR 55. *Longfellow* (118; flint); crossed with *Early Yellow Hathaway* (254; dent). Length 7½ inches, diameter 1$^1/_8$ inches; 8-rowed, but only 20 grains, all near the middle of the ear; grains yellow, flint, exactly like the typical Longfellow, except less flattened by pressure of adjacent grains; cob white, $^7/_8$ inch in diameter.

No evidence of cross.

EAR 56. *Longfellow* (121; flint); crossed with *Pride of the North* (113; yellow dent). Length 9½ inches, diameter 1 $^3/_8$ inches; 8-rowed, well, filled, except near the base; grains yellow, flint, exactly resembling the typical Longfellow; cob white, $^{13}/_{16}$ inch in diameter.

No evidence of cross.

EAR 57. *Longfellow* (124; flint); crossed with Normandy Giant (103; white dent). Length 8 $^5/_8$ inches, diameter 1 $^1/_8$ inches; not well filled at extreme base and tip; very light yellow and dirty white; 8-rowed; grains flint, small; cob white, $^{11}/_{16}$ inch in diameter.

No evidence of cross except in lighter color of grains.

EAR 58. *Self-Husking* (125; reddish flint); crossed with *Longfellow* (119; yellow flint). Length $9\frac{3}{4}$ inches, diameter $1\frac{5}{8}$ inches; 12-rowed, not well filled at tip, about ½ the rows regular, the others irregular, or in places wanting, grains light reddish yellow, intermediate between the parental types, size of grains a little larger than the female parent, but much smaller than the male parent; grains flint, or at least, not dented, but sections showed almost invariably that the central, starchy portion extended to the summit — the corneous matter at the latter point being almost entirely wanting; cob deep red, 1 inch in diameter.

Evidence of cross in the intermediate size and color of grains.

EAR 59. *Self-Husking* (126; reddish flint); crossed with *Compton's Early* (129; yellow flint). Length $7\frac{3}{8}$ inches, diameter $1\frac{9}{16}$ inches; 12-rowed, well filled except at extreme tip and base, a few of the rows irregular and partly wanting; grains a pale reddish inclining to yellow; summits all decidedly indented except when the (few) grains were not crowded and. these were imperceptibly or slightly indented. General appearance of grain much like the usual flint corn, yet in section a more decided resemblance to dent corn — the starch extending nearly or quite to the summit, covered by a very thin corneous layer.

No evidence of cross between Self-Husking and Compton's Early; yet it is probable that a cross with a dent took place the previous year.

EAR 60. *Self-Husking* (127; flint); crossed with *Early Yellow Hathaway* (53; dent). Length $5\frac{7}{8}$ inches. diameter $1\frac{7}{16}$ inches, 10-rowed; rows mostly incomplete; grains reddish yellow, flint, resembling the typical Self-Husking; cob 7/8 inches in diameter, white.

No evidence of cross detected.

EAR 61. *Self-Husking* (128; flint); crossed with *Woodworth's Yellow* (274; dent). Length $6\frac{7}{8}$ inches, diameter $1\frac{1}{16}$ inches, 8-rowed, reddish, yellow only two or three rows well filled; grains flint and similar to, but smaller than those of the female parent; cob dirty white, $\frac{3}{4}$ inches in diameter.

No evidence of cross.

EAR 62. *Compton's Early* (129; yellow flint); crossed with (eastern) *King Philip* (135; reddish flint). Length $8\frac{1}{12}$ inches, diameter $1\frac{5}{8}$ inches, 12-rowed, somewhat irregular, and mostly not well filled, especially at base; grains flint, pale yellow, rather larger than those in the parental type; cob white, $1\frac{1}{8}$ inches in diameter.

No evidence of cross.

EAR 63. *Compton's Early* (130; flint); crossed with *Early Yellow Hathaway* (260; dent) Length 9 ½ inches, diameter 1 ½ inches; 12-rowed, rows incomplete and irregular near the base; grains flint, rather pale yellow, somewhat larger than the female parent; cob white, 1 3/16 inches in diameter.

The grains were mostly destroyed after maturity, but before examination, yet no evidence of the cross was detected.

EAR 64. *Improved Shoe Peg* (132; white dent); crossed with *Murdock's* (210; yellow dent). Length 6 5/8 inches, diameter 1 ¾ inches; 14-rowed, most of the rows ceasing two inches from the base; grains slightly indented, not wrinkled; summits pure white; below yellowish white; cob white, 1 1/8 inches in diameter.

The only evidence of crossing is seen in the slightly yellowish body of the grains.

EAR 65. *Improved Shoe Peg* (132; white dent) ; crossed with *St. Charles* (234; white dent). Length 7 ¼ inches, diameter 1 7/8 inches; 16-rowed, rows somewhat irregular and several of them wanting on one side, both toward the base and toward the tip; grains pure white, in color and in shape as in typical Improved Shoe Peg; conspicuously indented and wrinkled at the summit; cob white, 1 1/16 inches in diameter.

No evidence of cross.

EAR 66. *King Philip (134;* flint); crossed with *Leaming* (146; yellow dent). Length 7 ½ inches, diameter 1 ¼ inches; 8-rowed, but the rows mostly only about half filled; grains flint, dark reddish in color; cob white, 7/8 inch in diameter.

A very inferior ear which showed no approach to the Learning.

EAR 67. *King Philip* (136; flint); crossed with *Murdock's* (208; yellow dent). Avery inferior and defective slender ear, 5 ½ inches long with a dozen very small flint grains, dark red with yellowish summit.

No evidence of the cross.

EAR 68. *King Philip* (138; flint); crossed with *Early Yellow Hathaway* (254; yellow dent). Length 6 inches, diameter 1 3/8 inches, 8-rowed, nearly all of the rows incomplete toward the base; grains flint, brownish red, with lighter summites; cob white, 7/8 inch in diameter.

No evidence of cross.

EAR 69. *King Philip* (139; flint); crossed with *Riley's Favorite* (317; yellow dent). Length 5 inches, diameter 1 1/8 inches, 8-rowed, 4 of the rows defective near the base; grains flint, brownish red with lighter summits; cob white, 1 1/16 inch in diameter.

No evidence of cross.

EAR 70. *King Philip* (141; flint); crossed with *Woodworth's Yellow* (275; dent). Length 5 3/4 inches, diameter 1 inch, 8-rowed, 3 of the rows defective near the base; grains flint, brownish red with lighter summits; cob white, 5/16 inch in diameter.

No evidence of cross.

EAR 71. *King Philip* (142; flint); crossed with *King of the Earliest* (315; yellow dent). Length 6 5/8 inches, diameter 1 3/8 inches, not well filled at tip, about 8-rowed, but the rows very irregular; grains flint, light yellowish red, lighter at summit; cob white, 5/8 inch in diameter.

Color lighter than typical King Philip, but no clear evidence of any cross.

EAR 72. *Ellm's Early Yellow* (143; flint); crossed with *Self-Husking* (128; flint). Length 8 inches, diameter 1 5/16 inches, not well filled at tip nor at base; grains pale yellow, flint, like the typical Ellm's Early Yellow; cob white, 7/8 inch in diameter.

No evidence of cross.

EAR 73. *Ellm's Early Yellow* (144; flint); crossed with *Early Yellow Hathaway* (259; dent.) Length 8 ¼ inches, diameter 1 7/16 inches, not well filled at tip, 8-rowed, rows regular; grains light yellow, flint, like the typical Ellm's Early Yellow; cob white, 15/16 inch in diameter.

No evidence of cross.

EAR 74. *Leaming* (146; small yellow dent); crossed with *Farmers' Favorite* (168 large yellow dent.). Length 6 7/8 inches, diameter 2 inches, not well filled at tip, 18-rowed, rows irregular and somewhat curved spirally. bright yellow in color; grains deeply dimple-dented and scarcely wrinkled; in shape and color like the female parent; cob paleish red, 1 1/4 inches in diameter.

No evidence of cross.

EAR 75. *Leaming* (149; yellow dent); crossed with *Riley's Favorite* (317; yellow dent). Length 8 ½ inches, diameter 1 5/8 inches, not well filled at tip, 12-rowed, a few of the rows slightly irregular and here and there defective; grains bright yellow, moderately indented, slightly wrinkled and with projecting tip on the chit side; cob light red, 1 1/16 inches in diameter.

Slightly resembles the Leaming, though few-rowed; no clear evidence of cross.

EAR 76. *Leaming* (150; yellow dent); crossed with Big Buckeye (270; yellow dent). Length 9 inches, diameter 1 ¼ inches, 14-rowed, a few of the rows irregular, very well filled and rounded at base, fairly well filled at tip; grains deeply indented and usually much wrinkled, light yellow, but nearly one-half the grains with white summits; cob light red, 1 inch in diameter.

Color lighter than in typical Leaming, but no evidence of cross.

EAR 77. *Leaming* (151; yellow dent); crossed with *Clarage Yellow* (337; dent). Length 7 ½ inches, diameter 2 1/16 inches, well filled, 14 rowed, 4 rows on one side somewhat irregular; grains large, light golden yellow, deeply crease-dented, much wrinkled, often pinched at summit; cob light red, 1 1/8 inches in diameter.

The grains resemble very strongly the Clarage Yellow, though slightly lighter in color. Very positive evidence of the cross.

EAR 78. *Leaming* (152; yellow dent); crossed with *Early Yellow Hathaway* (256; dent). Length 7 ½ inches, diameter 2 ¼ inches, not well filled at tip and base, 16-rowed, many of the rows irregular; grains bright yellow, moderately indented, not wrinkled at summit, thicker and broader than in typical Leaming, and somewhat resembling the Early Yellow Hathaway; cob light red, 2 inches in diameter.

Slight evidence of cross in shape of grains, which approach the male parent.

EAR 79. *Leaming* (153; yellow dent); crossed with *Pride* of *the North* (112; small yellow dent). Length 7 5/8 inches, diameter 24 inches, well filled, 20-rowed, a few of the rows defective on one side near the base; about one-half of the grains bright yellow with lighter summits, the other half nearly white with almost pure white summits; all moderately indented and usually somewhat wrinkled at summit; cob white, 1 1/8 inches in diameter.

Is not intermediate between the two parents — resembles the Learning except in the nearly white color and white cob. It can hardly be considered a cross between the two named above. It is rather to be persumed that the seed was not pure, *i. e.*, that this is the effect of a cross in the previous generation.

EAR 80. *Leaming* (154; yellow dent); crossed with *Chester County Mammoth* (213; light yellowish dent). Length 7 ¾ inches, diameter 2 1/8 inches, well filled, very rough, 16-rowed, rows regular; grains light golden yellow, deeply indented, very much wrinkled and often pinched at summit; cob bright red, 1 3/16 inches in diameter.

No evidence of cross except in the wrinkled and pointed summits.

EAR 81. *Leaming* (155; yellow dent); crossed with *Early Yellow Hathaway* (260; dent). Length 5 ½ inches, diameter 2 1/8 inches, not well filled at tip, 20-rowed, rows regular; grains deep yellow, rather deeply dimple-dented, not wrinkled at summit; cob light red, 1 1/8 inches in diameter.

No evidence of cross unless it be faintly indicated in the slightly thickened or shorter grains.

EAR 82. *Leaming* (156; yellow dent); crossed with *Woodworth's Yellow* (274; dent). A very defective ear, length 6 ½ inches, with about 50 scattered bright yellow, dimple-dented, rather large grains; cob red, 1 inch in diameter.

No evidence of cross.

EAR 83. *Leaming* (157; small yellow dent); crossed with *Golden Beauty* (185; large yellow dent). Length 8¼ inches, diameter 1 13/16 inches (at base 2 1/8 inches), well filled except at extreme tip, 16-rowed (at base 18-rowed); grains moderately indented and slightly wrinkled at summit, bright yellow; cob red, 1 1/8 inches in diameter.

The grains, rather shorter than in the typical Leaming, and in this respect perhaps slightly approaching the Golden Beauty.

EAR 84. *Leaming* (159; yellow dent); crossed with a *Red Dent* (281). Length 8½ inches, diameter 1 7/8 inches; very well filled; 14-rowed, rows regular but slightly spiral; grains moderately or deeply indented, slightly wrinkled at summit, rather broader than in the typical Leaming, pale yellow color; cob light red, 1 1/8 inches in diameter.

No evidence of cross.

EAR 85. *Leaming* (160; yellow dent); crossed with *Chester County Mammoth* (215b; white dent). Length 8 inches, diameter 2 3/16 inches; the tip for 2½ inches destitute of grains, otherwise well filled; 16-rowed; grains moderately and deeply indented, more or less wrinkled at summit, light yellow; not so long as the parental types; cob light red, 15/16 inch in diameter.

No clear evidence of cross; the ear is proportionately thicker than in the Leaming, but not enlarged at butt end as in Chester County Mammoth.

EAR 86. *Leaming* (161; yellow dent); crossed with *King of the Earliest* (314; yellow dent). Length 6¾ inches, diameter 1 15/16 inches; not well filled at tip; 14-rowed, rows regular; grains orange yellow with paler summits, moderately indented, much wrinkled at summit, with projecting parts on the chit side as in King of the Earliest, which. however are not so long as in the typical grains of the latter; cob deep red, 1 1/8 inches in diameter.

Evidence of cross in the wrinkled and rough summits of the grains — slightly approaching, in this respect, the male parent.

EAR 87. *Farmers' Favorite* (163; large yellow dent); crossed with *Pride of the North* (115; small yellow dent). Length 10 inches, diameter 1½ inches; not well filled; grains wanting toward the base for a distance of 2 inches; 12-rowed, all the rows defective, but better filled near the middle and upper parts; grains yellow, slightly to moderately indented, not wrinkled at summit, intermediate in size and shape between the parental types; cob very light red, 1 inch in diameter.

Cross evident in character of grains.

EAR 88. *Farmers' Favorite* (165; yellow dent); crossed with *Big Buckeye* (270; yellow dent). Length 10¼ inches, diameter 1 7/8 inches, well filled, 12-rowed, rows regular, not compact, light yellow; grains deeply dented and wrinkled at summit, broad but not so thick as in typical Farmers' Favorite; cob pink, 1¼ inches in diameter.

No evidence of cross.

EAR 89. *Farmers' Favorite* (166; yellow dent); crossed with *Shannon's Big Tennessee White* (356; dent). Length 10¼ inches, diameter 2 inches, well filled except at extreme tip; 14-rowed, very light yellow grains, rather small, broad, moderately indented and slightly wrinkled at summit; cob white, 1 5/16 inches in diameter.

No evidence of cross except in light color of grains.

EAR 90. *Farmers' Favorite* (167; yellow dent); crossed with *Red Cob Ensilage* (363; white dent). Length 7½ inches, diameter 1 7/8 inches, not well filled at base or tip, and slightly smutted at tip, 12-rowed, the rows more or less irregular, white with many yellowish grains interspersed; the grains resemble the typical Farmer's Favorite in being broad, thick and somewhat quadrangular, also in the indentation and wrinkling of the summit, but unlike in color, being white or in many cases, yellowish ; cob pure white, 1 3/16 inches in diameter.

No evidence of cross except in color of the grains.

EAR 91. *Farmers' Favorite* (169; yellow dent); crossed with *Mammoth Cuban* (320; yellow dent). Length 7¾ inches, diameter 2 inches, well filled, 12-rowed, rows regular; grains light golden yellow, very broad, deeply indented and much wrinkled at summit; cob white, 1 1/4 inches in diameter.

No evidence of cross.

EAR 92. *Farmers' Favorite* (170; yellow dent); crossed with *Maryland White Dent* (292). A very imperfect ear 7¾ inches long, having irregular rows of slightly indented light yellow grains, only on the upper half of the red cob, which is 15/16 inch in diameter.

Not distinctly resembling either parental type, hence no evidence of cross.

EAR 94. *Farmer's Favorite* (172; yellow dent); crossed with *Glick's Yellow* (347; dent). Length 9 1/2 inches, diameter 2 inches, not well filled at tip or butt, 16-rowed, but rows not compact; grains here and there wanting, color light yellow, summit of the grain nearly white, moderately to deeply indented and usually somewhat wrinkled; cob light red in color and 1 7/16 inches in diameter.

Evidence of perhaps some previous cross, but not between the two varieties named above.

EAR 95. *Farmer's Favorite* (173; yellow dent) ; crossed with *Cranberry White* (332; dent). Length 11½ inches, diameter 1¾ inches, but little more than half the grains developed on the lower half and not very well filled at tip, 12-rowed, rows regular but not compact; grains yellow, moderately indented but seldom wrinkled at summit; cob light red, 1 3/16 inches in diameter.

Varies from the typical Farmers' Favorite, but does not in any way approach Cranberry White.

EAR 96. *Farmers' Favorite* (174; yellow dent); crossed with *Shannon's Big Tennessee Yellow* (360; dent). Length 7¼ inches, diameter 2 inches, not well filled at tip, 14-rowed, rows regular; grains light yellow (many of them with nearly white summits), deeply indented, slightly or not at all wrinkled at summit, grains broad but smaller than in typical Farmer's Favorite; cob light red, 1¼ inches in diameter.

No evidence of cross except perhaps in color.

EAR 97. *Hickory King* (175; white dent); crossed with *Johnston's Mammoth Early White* (361; dent). Length 8½ inches, diameter 1 5/8 inches, not well filled at tip, 12-rowed, only 8 rows complete, the remaining four with less than a dozen grains toward the base; grains mostly white but very often light yellow, with light colored summits, moderately indented and wrinkled as in the male parent, shape and size of the grain approaching the typical Hickory King, but the summits are like the male parent; cob light red, 1 inch in diameter.

Possibly evidence of cross, but perhaps vitiated by some other cross of the previous year.

EAR 98. *Hickory King* (176; white dent); crossed with a *Red Dent* (284). Length 6 1/4 inches, diameter 1 5/8 inches, constricted and not well filled in the middle, 8-rowed; grains white, but many of them yellowish tinted, broad, crease-dented and somewhat wrinkled at summit, resembling the female parent; cob white, 11/16 inch in diameter.

No evidence of cross.

EAR 99. *Hickory King* (177; white dent); crossed with *Conscience* (333; white dent). Length 7¾ inches, diameter 1½ inches, well filled at tip and base, 8-rowed; grains white, very wide, moderately indented and wrinkled at summit, resembling the female parent; cob white, 7/8 inch in diameter.

No evidence of cross.

EAR 100. *Hickory King* (178; white dent); crossed with *Shannon's Big Tennessee White* (356; dent). Length 7 5/8 inches, diameter 1½ inches, well filled, 8-rowed; grains white, broad, indented and wrinkled at summit, in all respects resembling the female parent; cob white, ¾ inch in diameter.

No evidence of cross.

EAR 101. *Hickory King (179;* white dent); crossed with *Shannon's Big Tennessee White* (356; dent). Length 7½ inches, diameter 1½ inches, well filled, 8-rowed; grains pure white, broad, indented and wrinkled at summit, in all respects resembling the female parent; cob white, 13/16 inch in diameter.

No evidence of cross.

EAR 102. *Hickory King* (180; white dent); crossed with *Normandy Giant* (100; white dent). Length 7¼ inches, diameter 2 inches, well filled except the upper two inches, 14-rowed; grains long and narrow, indented and wrinkled at the white summits, more than half of the grains pure white, the remainder yellowish; cob light red, 1 inch in diameter.

Shape of grains unlike either parent, but the summits resemble the Normandy Giant; there may be partial evidence of cross, but it is probable that the seed planted was not pure.

EAR 103. *Hickory King* (184; white dent); crossed with *Maryland White Dent* (292). Length 63 inches, diameter 1 3/4 inches, 10-rowed, not well filled at tip; grains pure white, broad, indented and wrinkled at summit in all respects like the female parent; cob white, 1 1/8 inches in diameter.

No evidence of cross.

EAR 104. *Golden Beauty* (185; yellow dent); crossed with *Maryland White Dent* (290). Length 8½ inches, diameter 1¾ inches, well filled in the upper portion, but the grains wanting in the lower half; light yellow in color; summits of grains moderately indented and scarcely wrinkled; grains much smaller than in typical Golden Beauty, and somewhat wedge-shaped, in this respect unlike either parent; cob light red, 1 inch in diameter.

More or less doubtful evidence of cross, except in intermediate color.

EAR 105. *Golden Beauty* (186; *yellow* dent); crossed with *Big Buckeye* (270; yellow dent). Length 8¼ inches, diameter 2 inches, not well filled at tip, 14-rowed; grains bright yellow, moderately indented and wrinkled at summit, somewhat wedge-shaped, being intermediate in shape between the two parental types; cob red, 1 1/8 inches in diameter.

Evidence of cross in intermediate shape of grains.

EAR 106. *Golden Beauty* (187; yellow dent); crossed with *Murdock's* (212; yellow dent). Length 8¼ inches, diameter 1 7/8 inches, not well filled at tip, 12-rowed, rows regular and compact; grains deep yellow, deeply indented, much wrinkled at summit, rather large and sub-quadrangular, intermediate between the two parental types; cob light red, 1 1/8 inches in diameter.

Evidence of cross in characters of grains.

EAR 107. *Golden Beauty* (188; large yellow dent); crossed with *Leaming* (158; small yellow dent). Length 8¾ inches, diameter 1 13/16 inches, not well filled at tip nor at base, 10-rowed, rows mostly regular, slightly spiral, bright yellow; grains moderately indented and slightly wrinkled, short, nearly quadrate, thick; cob light red, 1 1/16 inches in diameter.

Varies from the typical Golden Beauty, yet does not resemble Leaming — perhaps due to seed impure by a cross of the previous year.

EAR 108. *Golden Beauty* (189; yellow dent); crossed with *Woodworth's Yellow* (276; dent). Length 8¼ inches, diameter 2 7/8 inches, not well filled at base and tip, 14-rowed, rows mostly regular and compact, deep yellow; grains slightly to moderately indented and somewhat wrinkled at summit, rather thick and somewhat wedge-shaped; cob light red, 1 1/16 inches in diameter.

More or less doubtful evidence of cross, since while it differs from the typical Golden Beauty, it does not show any unmistakable character of the Woodworth's yellow.

EAR 109. *Golden Beauty* (190; yellow dent); crossed with *Big Buckeye* (270; yellow dent). Length 7½ inches, diameter 2 inches, not well filled at tip, 12-rowed, rows regular, not compact; grains yellow, broad, deeply crease-dented and wrinkled at summit, in all respects like the female parent; cob red, 1 3/16 inches in diameter.

Evidence of cross not detected.

EAR 110 *Golden Beauty* (191; yellow dent); crossed with *White Flat Ensilage* (97; dent). Length 9 5/8 inches, diameter 2 inches, well filled, slightly flattened toward the tip, 18-rowed, rows somewhat irregular, compact, light yellow in color; grains moderately indented and scarcely wrinkled at summit, rather small and narrow and somewhat wedge-shaped; cob red, 1¼ inches in diameter.

Evidence of cross in character of grains.

EAR 111. *Golden Beauty (192; yellow* dent); crossed with *Mosby's Prolific* (298; white dent.) Length 8 inches, diameter 2 inches; well filled; 10-rowed, rows regular, not compact; grains very light yellow, or simply yellowish white, broad, deeply crease-dented, much wrinkled and somewhat pinched; cob white, 1 1/8 inches in diameter.

Evidence of cross in light color and character of summit of grains.

EAR 112. Golden *Beauty* (193; large yellow dent); crossed with *Leaming* (149; small yellow dent). Length 5 inches, diameter 2 1/8 inches; not well filled, 3 inches of the upper portion destitute of grains; 14-rowed, compact; deep yellow; grains thick, moderately indented, slightly wrinkled at summit; cob white, 1¼ inches in diameter.

Evidence of cross only in character of the summit of the grains.

EAR 113. *Golden Beauty* (194; *yellow* dent); crossed with *Murdock's* (209a; yellow dent). Length 7½ inches, diameter 1 7/8 inches; not well filled at tip; 10-rowed, rows somewhat irregular; golden yellow; grains broad, deeply indented and wrinkled at summit; cob light red, 1 1/16 inches in diameter.

Varies from the typical Golden Beauty, but presents no visible character of Murdock's.

EAR 114. *Golden Beauty* (196; yellow dent); crossed with *Woodworth's Yellow* (274; dent). Length 5½ inches, diameter 1 5/8 inches, not well filled at base or tip, 12-rowed, rows irregular and in places defective; bright yellow grains. thick, rather short, at summit rather deeply indented and usually somewhat wrinkled; cob white, 7/8 inch in diameter.

Not clearly intermediate between the two parental types; *i. e.*, evidence of cross doubtful.

EAR 115. *Golden Beauty* (195; yellow dent); crossed with *Big Buckeye* (269*b*; yellow dent). Length 9 inches, diameter 1 7/8 inches, not well filled at tip, 12-rowed, compact, smooth, deep yellow; grains rather large, somewhat quadrangular, slightly to moderately indented, slightly wrinkled at summit; cob red, 1 1/8 inches in diameter.

Evidence of cross in the intermediate grains.

EAR 116. *Golden Beauty* (198; yellow dent); crossed with *Mammoth Cuban* (320; yellow dent). Length 8 3/4 inches, diameter 1 7/8 inches, not well filled at base or tip, four inches of the upper portion destitute of grains, 12-rowed, rows somewhat irregular, not very compact; grains slightly reddish yellow, thick and broad, moderately indented and more or less wrinkled at summit; cob light red, 1 1/8 inches in diameter.

Grains thicker and of deeper color than the Golden Beauty, but not resembling the Mammoth Cuban.

EAR 117. *Golden Beauty* (199; yellow dent); crossed with *Glick's Yellow* (347; yelow dent). Length 7 inches, diameter 1 3/4 inches, a very imperfect ear with 3 sets of partially or wholly triple rows, separated by deeply dipping sulci; grains light yellow, irregular in shape, but mostly very broad and moderately indented and slightly wrinkled at summit; cob white, 7/8 inches in diameter.

Evidence of cross in color and shape of grains, the latter resembling more nearly the female type, though the two parents are not very different.

EAR 118. *Golden Beauty* (201; yellow dent); crossed with *Farmers' Favorite* (168; yellow dent). Length 7¾ inches, diameter 2 1/8 inches, not well filled at tip, 14-rowed, rows regular, not compact; grains nearly white, a few strongly yellow tinted; of medium size, often flattish, strongly indented, slightly wrinkled at summit (except near the butt), somewhat pinched; cob white, 1 1/8 inches in diameter.

Presents evidence of a previous cross, but none between the parents given above.

EAR 119. *Golden Beauty* (202; yellow dent); crossed with *Shannon's Big Tennessee Yellow* (360; dent). Length 10 inches, diameter 1 5/8 inches, upper half compact, well filled, 12-rowed, lower half with about 15 grains on one side near the base, color light yellow with summits of grains ranging from yellow to nearly white; grains rather small and short, moderately indented, slightly if at all wrinkled at summit; cob white, 1 inch in diameter.

NO evidence of cross.

EAR 120. *Golden Beauty* (203; yellow dent); crossed with a *Red Dent* (282). Very imperfect ear, 3 3/4 inches long, with about 2 dozen yellow grains at extreme tip, mouldy — so far as can be detected showing no signs of cross.

EAR 121. *Golden Beauty* (205; yellow dent); crossed with *Farmers' Favorite* (164; yellow dent). Length 8 ½ inches, diameter 1 ¾ inches, very imperfectly filled, 14-rowed, none of the rows complete; grains deep yellow, rather thick and short, deeply indented and often wrinkled at summit; cob very light red, 1 1/8 inches in diameter.

Slight evidence of cross, the grains somewhat resembling the Farmers' Favorite.

EAR 122. *Golden Beauty* (206; yellow dent); crossed with a *Red Dent* (280). Length 9½ inches, diameter 1 7/8 inches, not well filled, a small portion above the middle 14-rowed; grains yellow, rather short, moderately indented, wrinkled, with a slight projection on the chit side; cob light red, 1 1/8 inches in diameter.

Doubtful evidence of cross in the size of grains and in the character of summits.

EAR 123. *Golden Beauty* (207; yellow dent); crossed with a *Red Dent* (282). Length 9 1/4 inches, diameter 1 7/8 inches, 12-rowed, 3 of the rows irregular and imperfect; grains very broad, light yellow, deeply crease-dented and much wrinkled at summit; cob white, 1 1/8 inches in diameter.

No evidence of cross.

EAR 124. *Golden Beauty* (207*a*; yellow dent); crossed with a *Red Dent* (281). Length 9 1/8 inches, diameter 2 inches, 12-rowed, rows regular; grains broad, rather thick and shortish, deeply indented and much wrinkled at summit; cob pink, 1 ¼ inches in diameter.

No evidence of cross.

EAR 125. *Murdock's* (211; yellow dent): crossed with a *Red Dent* (281). Length 10¾ inches, diameter 1 7/8 inches; 14-rowed, regular, compact; grains slender, somewhat wedge-shaped, light yellow summits, nearly white, rather deeply dented and more or less wrinkled at summit; cob red, 1 inch in diameter.

Varies from the type in color, otherwise like the female parent, and no evidence of a cross.

EAR 126. *Chester County Mammoth* (214; yellowish white dent); crossed with a *Red Dent* (282). A very imperfect ear (length 4 inches), with about 75 inferior, whitish grains, mostly near the tip.

EAR 127. *Chester County Mammoth* (216; yellowish white dent); crossed with *Normandy Giant* (103; light yellow dent). Length 9¼ inches, diameter 2½ inches throughout except at the flattened tip; 24-rowed, rows not compact; dull or yellowish white; grains slender, wedge-shaped, deeply dented and mostly pinched at summits, grains at upper end much thicker and less dented; cob 1 5/8 inches in diameter, red.

Doubtful evidence of cross in color of grains.

EAR 128. *Angel of Midnight* (217; flint); crossed with *Early Red Blazed* (250; flint), Lenth 9¼ inches; 8-rowed, but with only 35 scattering grains, of a bright yellowish tint; cob white, 3/5 inch in diameter;

NO evidence of cross.

EAR 129. *Angel of Midnight* (218; flint); crossed with *Self-Husking* (128; flint). Lenght 7¼ inches, diameter 1 1/16 inches; well filled except at base and tip; very light yellow; grains small, flint; cob white, 5/8 inch in diameter.

No evidence of cross, except perhaps the reduced size of grains.

EAR 130. *Waushakum* (219; light yellow flint); crossed with *Early Red Blazed* (250; darker flint). Length 7¼ inches, diameter 1 3/16 inches, very imperfectly filled, about 60 grains; light yellow, flint, large; cob white, 3/4 inch in diameter.

No evidence of cross.

EAR 131. *Waushakum* (220; flint); crossed with *Riley's Favorite* (317; yellow dent). Length 9½ inches, diameter 1 9/16 inches, not well filled at tip, at base and on one side; 12-rowed, rows somewhat irregular and slightly spiral; grains deep yellow, glossy except at summit, medium sized with a height about equal to width, summits mostly rounded (flint-like) but in very many cases slightly indented; grains in section nearly or quite destitute of the corneus layer at summit; cob light red, 11/16 inch in diameter.

Evidences of cross in size of ear, size and color of grains, structure of grains as seen in section (strongly resembling or quite like the Dent), and in color of cob.

EAR 132. *Parker and Wood's Perfect Ensilage* (221; white dent); crossed with *Sheep's Tooth* (367; white dent). Length 7 1/6 inches, diameter 2¼ inches, well filled except at extreme tip, 20-rowed, not compact; grains wedge-shaped, deeply indented and much wrinkled at summit; cob pink, 1¼ inches in diameter.

No evidence of cross.

EAR 133. *Parker and Wood's Perfect Ensilage* (222; white dent); crossed with *Maryland White Dent* (293). Length 6 inches, diameter 2 inches,

—21

not well filled at tip, 14-rowed (16-rowed at the enlarged base), rows slightly irregular; grains white, rather short and somewhat wedge-shaped, deeply indented, much wrinkled at summit, sometimes pinched or pointed on the chit side; cob red, 1¼ inches in diameter.

No evidence of cross detected.

EAR 134. *Johnston's Early White Dent* (224); crossed with *Chester County Mammoth* (215; light yellow dent). Length 9½ inches, diameter 1 15/16 inches, not well filled at base and tip, 16-rowed, rows mostly regular, compact, light yellow, summits of grains nearly white; grains rather narrow, deeply pitted at summit, wrinkled and slightly pointed on the chit side; cob white, 1 1/16 inches in diameter.

Evidence of cross in character of grains.

EAR 135. *Johnston's Early White Dent* (225); crossed with *Early California* (327; yellow dent). Length 9 inches, diameter 2 1/16 inches, not firm, not well filled at tip, defective at base, 14-rowed; grains dull white, long, flat, wedge-shaped, deeply indented and very much wrinkled; cob light red, 1 1/8 inches in diameter.

No evidence of cross; the grains, however, differing somewhat from the female plant.

EAR 136. *Johnston's Early White Dent* (226; small white dent); crossed with *Pride of the North* (110*a*; small yellow dent). Length 6¾ inches, diameter 1 15/16 inches, not well filled at tip, 16-rowed, four of the rows defective in part on one side, white with a yellowish hue; grains rather long, thin, somewhat wedge-shaped, crease-dented and pinched at summit; cob pure white, 1 inch in diameter.

Varies from both parental types, but not intermediate between them.

EAR 137. *Southern Horse Tooth* (227; white dent); crossed with a *Red Dent* (280). Length 8 1/2 inches, diameter 1 11/16 inches, not well filled at base, 16-rowed, most of the rows irregular or partially defective, but the ear quite firm, white with a yellowish hue; grains somewhat wedge-shaped, moderately creased or dimple dented; cob white, 1 inch in diameter.

No evidence of cross.

EAR 138. *Southern Horse Tooth* (228; white dent); crossed with *Normandy Giant* (123; white dent, rather large). Length 6 3/8 inches, diameter 2 1/8 inch, not well filled at tip, 15-rowed, pure white; grains slightly quadrangular, rather deeply indented and much wrinkled at summit; cob white, 1 3/16 inches in diameter.

Grains less quadrangular than in Normandy Giant, though slightly resembling the latter and therefore showing to some extent the effect of the cross.

EAR 139. *St. Charles* (230; white dent); crossed with *Bullock's White Prolific* (246; white dent). Length 8 inches, diameter 2¼ inches, 2½ inches of upper portion destitute of grains, 20-rowed, very compact, smooth, white with a yellowish tinge; grains long and narrow, slightly indented, not resembling either parent; cob white, 1 5/8 inches in diameter.

No evidence of cross; seed perhaps not pure.

EAR 140. *St. Charles* (232; white dent); crossed with *Normandy Giant* (102; white dent). Length 7 inches, diameter 2 3/4 inches; fairly well filled at tip, 20-rowed, a few of the rows defective near the base, pure white, grains rather long, wedge-shaped, deeply dented and much wrinkled at summit; cob white, 1 1/4 inches in diameter.

In shape of grains varying from both parental types but not intermediate between the two.

EAR 141. *St. Charles* (233; white dent); crossed with *Mammoth White Dent* (297). Length 6 3/4 inches, diameter 1 7/8 inches, rather well filled except two or three defective rows on one side, 14-rowed, pure white; grains rather short, deeply indented but not much wrinkled at summit; cob white, 1 3/16 inches in diameter.

No visible evidence of cross.

EAR 142. *St. Charles* (235; white dent); crossed with *Red Cob Ensilage* (364; white dent). Length 4½ inches, a defective ear with six complete rows, and about four incomplete ones with inferior grains; about half the grains white, the remainder yellow with whitish summits; grains deeply indented and mostly much wrinkled at summit; cob pink.

Evidence of cross doubtful; perhaps seed impure.

EAR 143. *St. Charles* (236; white dent); crossed with *Bullock's White Prolifie* (247; white dent). Length 7 inches, diameter 2 inches, well filled except at extreme tip, 20-rowed, compact; grains narrow and long, moderately indented and mostly somewhat wrinkled at summit, pure white; cob light pink, 1 1/4 inches in diameter.

Varying from both parental types, but apparently not intermediate.

EAR 144. *St. Charles* (237; white dent); crossed with *Normandy Giant* (104; white dent). Length 8 inches, diameter 2 inches, not well filled at extreme tip, 16-rowed, compact; grains somewhat wedge-shaped, moderately indented and much wrinkled at summit, white, also many yellowish grains with white summits; cob pink 1¼ inches in diameter.

The variation in size and shape of grains not intermediate between the two parental types named above.

EAR 145. *St. Charles* (238; white dent); crossed with *Normandy Giant* (105; white den). Length 5 3/4 inches, diameter 2 1/8 inches, not well filled at tip and four rows on one side partially defective, pure white, grains mostly wedge-shaped, in the defective rows short and wide, moderately indented and slightly wrinkled at summit; cob white, 1 7/8 inches in diameter.

Evidence of cross not visible.

EAR 146. *St. Charles* (239; white dent); crossed with *Mammoth White Dent* (296). Length 10 inches, diameter 2 1/2 inches, not well filled, 3 inches of upper end destitute of grains, 24-rowed, compact, pure white; grains long and wedge-shaped, deeply indented and much wrinkled; cob pink, 1 3/8 inches in diameter.

No evidence of cross.

EAR 147. *St. Charles* (240; white dent); crossed with *Southern Horse Tooth* (227*a*; white dent). Length 9 inches, diameter 2 inches, not well filled at base and tip, 14-rowed, rows somewhat irregular; grains rather short and thick, moderately indented and much wrinkled at summit, white with a faint reddish tinge and about one-fifth the grains yellow; cob red, 1 1/8 inches in diameter.

No clear evidence of cross.

EAR 148. *St. Charles* (241; white dent); crossed with *Johnston's Mammoth Early White* (361*a*; dent). Length 9 1/8 inches, diameter 2 1/4 inches, well filled at tip, 20-rowed, a few of the rows irregular, white; grains wedge-shaped, deeply indented and much wrinkled at summit; cob white, 1 5/8 inches in diameter.

Different from either parental type, but no clear evidence of cross.

EAR 149. *St. Charles* (242; white dent); crossed with *Red Cob Ensilage* (363; white dent). Length 7¼ inches, diameter 2¼ inches, fairly well filled at tip, compact, 16-rowed, rows mostly regular, pure white; grains rather small, somewhat wedge-shaped, moderately indented and much wrinkled at summit; cob white, 1¼ inches in diameter.

No clear evidence of cross.

EAR 150. *St. Charles* (243; white dent); crossed with *Normandy Giant* (106; white dent). Length 7 1/8 inches, diameter 2 1/8 inches, not well filled, especially at tip, 14-rowed; grains irregular, often somewhat wedge-shaped, moderately indented and wrinkled at summit, not pure white, many of the grains yellow or yellowish with lighter summits; cob red, 1 3/16 inches in diameter.

No evidence of cross; seed perhaps impure.

EAR 151. *Yellow Mammoth (244, yellow* dent); crossed with *Maryland White Dent* (291). Length 10½ inches, diameter 1 7/8 inches, well filled, 14-rowed, compact and rough; grains somewhat wedge-shaped, rather small, deeply indented, much wrinkled and tipped at summit, light yellow with lighter summits; cob red, 1 inch in diameter.

Evidence of cross in intermediate color.

EAR 152. *Yellow Mammoth* (244; dent); crossed with *Blount's Prolific Ensilage* (263; white dent). Length 8 1/8 inches, diameter 2 1/8 inches; not well filled at tip, compact and rather rough; 16-rowed, rows regular; grains rather slender, somewhat wedge-shaped, moderately indented, slightly wrinkled, and very slightly tipped, light yellow; cob red, 1 1/4 inches in diameter.

Evidence of cross in intermediate color.

EAR 153. *Bullock's White Prolific* (246; smooth dent); crossed with *Golden Beauty* (195; yellow dent). Length 7 3/4 inches, diameter 1 3/16 inches; fairly well filled at tip, smooth but not compact; 12-rowed, rows mostly regular, light yellow; grains small, somewhat flint-like in appearance, rounded at top and only slightly indented; cob white, 1 inch in diameter.

Evidence of cross in color and character of grains.

EAR 154. *Early Red Blazed* (249; flint); crossed with *King Philip* (135; flint). An imperfect ear (the upper portion smutted), with only two flint grains.

EAR 155. *Early Red Blazed* (250; flint); crossed with *Early Yellow Hathaway* (257; dent). Length 4 1/2 inches, diameter 1 1/4 inches; imperfectly filled, especially toward the base; 8-rowed; grains flint, resembling the female parent; cob white, 3/4 inch in diameter,

No evidence of cross.

EAR 156. *Early Red Blazed* (251; flint); crossed with *Early Yellow Hathaway* (258; dent). Length 7 3/4 inches, diameter 1 1/4 inches; well filled, compact; 8-rowed; deep yellow; grains flint, like the female parent.

No evidence of cross.

EAR 157. *Early Yellow Hathaway* (253; dent); crossed with *Compton's Early* (131 ; flint). Length 7 7/8 inches, diameter 1 7/8, not well filled at tip, compact and smooth, 18-rowed; rows irregular toward the base, yellow; grains slender, moderately indented and scarcely wrinkled at summit; cob light red, 1 1/8 inches in diameter.

No evidence of cross unless in the less deeply dented and smoother summits of the grains.

EAR 158. *Early Yellow Hathaway* (254; dent); crossed with *Pride of the North* (112; yellow dent). Length 6 3/4 inches, diameter 1 3/4 inches, very imperfectly filled, only the middle and one side of the lower portion bearing grains, yellow; grains mostly rounded from lack of pressure, moderately dimple-dented; cob red, 1 3/16 inches in diameter.

No clear evidence of cross.

EAR 159. *Early Yellow Hathaway* (255; dent); crossed with *Champion White Pearl* (108*a*; dent). Length 5 7/8 inches, diameter 2 1/4 inches, fairly well filled, compact, rough, 20-rowed; grains short and deeply dented, much wrinkled and pinched at summits, yellowish white and yellowish below; cob bright red, 1 1/8 inches in diameter.

No evidence of cross.

EAR 160. *Early Yellow Hathaway* (258; dent); crossed with *Longfellow* (122; flint). Length 5 7/8 inches, diameter 2 inches, well filled, compact and smooth, 20-rowed, rows somewhat irregular; grains slender, rather small, moderately indented, scarcely wrinkled at summits; cob bright red, 1 1/8 inches in diameter.

No clear evidence of cross.

EAR 161. *Blount's Prolific Ensilage* (262; medium white dent); crossed with Golden *Beauty* (195; large yellow dent). Length 6 inches, diameter 2 inches, imperfectly filled at base and apex, 12-rowed, rows irregular; grains yellowish white, large, varying from wedge-shaped to quadrangular, deeply crease-dented and usually much wrinkled; cob white, 1 1/8 inches in diameter.

Evidence of cross distinctly visible in size, shape and color of grains.

EAR 162. *Mason's Flour Corn* (265; white, soft); crossed with *Big Buckeye* (271; yellow dent). Length 5 5/8 inches, diameter 1 1/2 inches, well filled except at extreme tip and at one side of base, 10-rowed, rows regular; grains round, like the female parent except of a dirty yellowish color; cob white, 13/16 inch in diameter.

Evidence of cross only in color of grains.

EAR 163. *Mason's Flour Corn* (266; white, soft); crossed with *Blount's Prolifie Ensilage* (264; white dent). Length 3 1/8 inches, diameter 1 3/8 inches, not well filled at tip, 10-rowed; grains like the female parent but smaller; cob white; 3/4 inch in diameter.

No evidence of cross.

EAR 164, *Mason's Flour Corn* (267; white, soft); crossed with *Conscience* (334; white dent). Length 4 5/8 inches, diameter 1 1/4 inches, imperfectly filled, rows irregular and mostly triple in four sets on the ear; grains small, otherwise like the female parent; cob white, 3/4 inch in diameter.

No evidence of cross.

EAR 165. *Mason's Flour Corn* (268; white, soft); crossed with *Southern Horse Tooth* (229; white dent). Length 3 3/8 inches, diameter 1 1/4 inches; about 10-rowed, rows very irregular; grains like the female parent but smaller; cob white, 2 inch in diameter.

No evidence of cross.

EAR 166. *Big Buckeye* (271; yellow dent); crossed with *Cranberry White* (332; pinkish white dent). Length 6 inches, diameter 2 5/8 inches, fairly well filled at tip, very rough, not compact, 28-rowed; grains long and wedge-shaped, deeply indented and pointed at summit, light yellow; cob deep red, 1 5/8 inches in diameter.

No clear evidence of cross.

EAR 167. *Cook's* (272; white dent); crossed with *Mammoth White Dent* (297). Length 8 inches, diameter 2 inches, not well filled at tip, compact, rough, 14-rowed, four rows imperfect; grains rather short, deeply indented and much wrinkled at summit, very light yellow with white summits; cob red, 1 1/16 inches in diameter.

No evidence of cross.

EAR 168. *Cook's* (273; white dent); crossed with *Early California* (328; yellow dent). Length 6 1/2 inches, diameter 2 inches, uppermost portion (2 inches) destitute of grains, 16-rowed; grains rather broad, wedge-shaped, moderately indented and slightly wrinkled at summits, yellowish white with white summits; cob light red, 1 1/4 inches in diameter.

No clear evidence of cross, unless in the yellowish color.

EAR 169. *Beard's Pearl White (278;* white dent); crossed with *Riley's Favorite* (318; yellow dent). Length 6 3/4 inches, diameter 2 3/16 inches, well filled, 20-rowed, not compact, very rough; grains long, slender, wedge-shaped, deeply crease-dented and pinched, yellowish white with white summits; cob white, 1 3/16 inches in diameter.

No clear evidence of cross.

EAR 170. *Red Dent* (279); crossed with *Riley's Favorite* (318; yellow dent). Length 8 1/8 inches, diameter 2 1/4 inches, not well filled at tip, very compact and firm, smooth, 14-rowed; grains broad and thick, moderately indented, not wrinkled at summit, light yellow; cob white, 1 1/2 inches in diameter.

Evidence of cross only in yellow color.

EAR 172. *Parish White* (289; dent); crossed with *Red Dent* (284). Length 7 1/8 inches, diameter 2 1/8 inches, not well filled at tip, not compact, 14-rowed. rows regular; grains broad, slightly wedge-shaped, deeply crease-dented and much wrinkled, sometimes pinched at summit, nearly pure white; cob red, 1 3/16 inches in diameter.

Evidence of cross doubtful.

EAR 173. *Mammoth White Dent* (294); crossed with *Riley's Favorite* (318; yellow dent). Length 6 1/8 inches, diameter 2 1/8 inches, not well filled at tip, 16-rowed, two of the rows imperfect; grains broad, rather short, moderately indented, not at all or but slightly wrinkled at summit, yellowish white with white summits; cob white, 1 1/4 inches in diameter.

Evidence of cross possibly in the yellowish color of grains.

EAR 174. *Mosby's Prolific (298;* white dent); crossed with *Mason's Flour Corn* (269; white soft). Length 6 1/4 inches, diameter 1 9/16 inches, very imperfectly filled, none of the rows complete; grains pure white, slightly to moderately indented; cob white, 1 1/16 inches in diameter,

Differing from both parental types, but scarcely intermediate — perhaps evidence of cross in the smoother grains.

EAR 175. *Mosby's Prolific* (299; white dent); crossed with *Conscience* (335; white dent). Length 7 1/4 inches, diameter 1 15/16, not well filled at tip, not compact, very rough; grains white, more or less wedge-shaped, deeply indented, much wrinkled at summit and often pinched, differing but little (if any) from the female parent; cob white, 15/16 inch in diameter.

Evidence of cross doubtful.

EAR 176. *Mosby's Prolific* (300; white dent); crossed with *Shannon's Big Tennessee White* (357; dent). Length 7 inches, diameter 2 inches, not well filled at tip, very rough, not compact, 12-rowed, pure white; grains long and flat, very deeply crease-dented and pinched at summit; cob small, white, 7/8 inch in diameter.

No clear evidence of cross.

EAR 177. *Mosby's Prolific* (301; white dent); crossed with *St. Charles (243a;* white dent). Length 7 13/16 inches, diameter 1 1/8 inches, imperfectly filled, the lower half destitute of grains, 12-rowed, rows imperfect; grains white, rather small, moderately indented, not wrinkled at summit; cob white, 1 inch in diameter.

No evidence of cross.

EAR 178. *Mosby's Prolific* (302; white dent); crossed with *Shannon's Big Tennessee White* (358; dent). Length 7 inches, diameter 1 11/16 inches, not well filled at tip, 12-rowed, not compact; grains white, deeply dented, wrinkled at summit and somewhat pinched; cob white, 3/4 inch in diameter.

NO clear evidence of cross.

EAR 179. *Mosby's Prolific* (303; white dent); crossed with *Red Dent* (288). Length 6 7/8 inches, diameter 1 1/2 inches, well filled at tip, 12-rowed, six of the rows imperfect toward the base; grains white, rather small, somewhat wedge-shaped, deeply indented, wrinkled and pinched at the summit; cob white, 3/4 inch in diameter.

No evidence of cross.

EAR 180. *Mosby's Prolific* (304; white dent); crossed with *Red Cob Ensilage* (365; white dent). Length 6 7/8 inches, diameter 15/16 inch, not well filled at tip, very rough, not compact; grains subtriangular, white, deeply crease-dented and pinched at summit; cob white, 7/8 inch in diameter.

No evidence of cross.

EAR 181. *Mosby's Prolific* (305; white dent); crossed with *Brazilian Flour* (223; white soft). Length 6 1/2 inches, very imperfectly filled with distant rounded white, dimple-dented grains; cob white, 3/4 inch in diameter.

No evidence of cross.

EAR 182. *Mosby's Prolific (306;* rough white dent); crossed with *Bullock's White Prolific* (248; smooth dent). Lenth (6 7/8 inches, diameter 1 7/8 inches, well filled at tip, 16-rowed, rows somewhat irregular or defective toward the base; grains white, slender, wedge-shaped, deeply crease-dented and usually pointed at summit; cob white, 15/16 inch in diameter

No evidence of cross.

EAR 183. *Thoroughbred White Flint* (309); crossed with *Longfellow* (120; yellow flint). Length 7 3/4 inches, diameter 1 5/16 inches, not well filled at tip, defective at base, 8-rowed; grains flint, light yellow; cob white, 3/4 inch in diameter.

Evidence of cross only in color.

EAR 184. *Thoroughbred White Flint* (310); crossed with *Early California* (326; yellow dent). Length 6 5/8 inches, diameter 1 3/16 inches, well filled, 8-rowed; grains light yellow, flint; cob white, 9/16 inch in diameter.

No evidence of cross except in color of grains.

EAR 185. *Blount's Prolific* (311; white dent); crossed with *Red Dent* (280). Length 7 5/8 inches, diameter 1 13/16 inches, not well filled at tip, smooth firm; grains wedge-shaped, large, moderately indented, not wrinkled at summit; cob white, 1 1/16 inches in diameter.

No evidence of cross.

EAR 186. *King of the Earliest (314;* yellow dent); crossed with *Early Yellow Hathaway* (259; dent). Length 7 inches, diameter 1 3/4 inches, imperfectly filled at tip, 12-rowed, rows irregular and some of them defective; grains reddish yellow, thick, rather short, moderately indented and slightly wrinkled; cob red, 1 inch in diameter.

Like the female parent, but smooth; no evidence of cross.

EAR 187. Riley's *Favorite* (317; yellow dent); crossed with *Mason's Flour Corn* (269*a*; white soft). Length 9 3/8 inches, diameter 2 1/16 inches, not well filled at tip, compact and smooth, 20-rowed; grains bright yellow, rather slender, dimple-dented, in section often showing more starch than in the common dents; cob deep red, 1 1/4 inches in diameter.

Evidence of cross doubtful.

EAR 188. *Riley's Favorite (319;* yellow dent); crossed with a *Red Bent* (282). Length 6 15/16 inches, diameter 1 15/16 inches, not well filled at tip, 14-rowed; grains reddish yellow, rather broad, moderately indented and somewhat wrinkled at summit; cob red, 1 1/16 inches in diameter.

No evidence of cross.

EAR 190. *Mammoth Cuban (323;* yellow dent); crossed with *Red Dent* (282). Length 7 inches, diameter 2 5/16 inches, not well filled at tip, 18-rowed, rows irregular toward the slightly enlarged base, bright yellow;

grains moderately indented and wrinkled at summit; cob red, 1 1/4 inches in diameter.

No evidence of cross.

EAR 191. *Early California* (324; yellow dent); crossed with *King Of the Earliest* (316; yellow dent). Length 7 7/8 inches, diameter 2 1/16 inches, very well filled at tip, 18-rowed; grains bright yellow, rather deeply indented and much wrinkled at summit; cob light red, 1 1/4 inches in diameter.

Evidence of cross not detected.

EAR 192. *Early California* (325; yellow dent); crossed with *Cranberry White* (330; dent.) Length 7 5/8 inches, diameter 2 inches, not well filled at tip, 18-rowed; grains light yellow, summits often nearly white, rather slender, deeply indented and usually much wrinkled; cob red, 1 1/4 inches in diameter.

No clear evidence of cross.

EAR 193. *Early California (328;* yellow dent); crossed with *Cranberry White* (330; dent). Length 8 inches, diameter 2 inches, fairly well filled at tip, 14-rowed, some rows very irregular; grains light yellow, summits often nearly pure white, scarely wedge-shaped, moderately indented and much wrinkled at summit; cob red, 1 inch in diameter.

No evidence of cross detected.

EAR 194. *Cranberry White* (329; dent); crossed with *Clarage Yellow* (342; dent.) Length 7 inches, diameter 2 inches, fairly well filled at tip, 20-rowed; grains white, often tinged with reddish, rather slender, moderately indented and wrinkled at summit; cob white, 1 1/4 inches in diameter.

No clear evidence of cross.

EAR 195, *Cranberry White* (330; dent); crossed with *Early California* (325; yellow dent). Length 6 1/2 inches, diameter 2 1/16 inches, fairly well filled at tip, rough, not compact, 16-rowed, rows nearly regular; grains slender, white or yellowish white, slightly tinged with red, deeply crease-dented, much wrinkled at summit and often pinched; cob white, 1 1/16 inches in diameter.

No evidence of cross.

EAR 196. *Cranberry White* (331; dent); crossed with *Early California* (325; yellow dent). Length 5 1/2 inches, diameter 2 inches, not well filled at tip, 18-rowed, rows irregular; grains flat, white or yellowish white, tipped with reddish, deeply indented and much wrinkled or pinched; cob white, 1 inch in diameter.

No evidence of cross,

EAR 197. *Conscience* (332; white dent); crossed with *Mosby's Prolific* (307; white dent). Length 6 7/8 inches, diameter 1 15/16 inches, only the upper part bearing imperfect, white, dented grains not sufficient for comparison, EAR 198. *Conscience* (335; white dent); crossed with *Pride of the South* (308; white dent). Length 6 3/8 inches; grains too immature (also mouldy) for description or comparison.

EAR 199. *Clarage Yellow* (328; dent); crossed with *Pride of the North* (115; yellow dent). Length 5 1/2 inches, diameter 1 inch, imperfect, smutted at tip, 12-rowed, grains yellow, small, short and broad, deeply crease-dented, but not wrinkled at summit; cob red, 7/8 inch in diameter.

No clear evidence of cross.

EAR 200. *Clarage Yellow* (339; large dent); crossed with *Leaming* (162; medium yellow dent). Length 4 3/4 inches, diameter 1 11/16 inches, imperfect at tip and on one side, not compact, about 12-rowed; grains short, thick, not broad, scarcely quadrangular, moderately indented, slightly if at all wrinkled at summit, reddish yellow; cob deep red, 1 inch in diameter.

Perhaps indistinct evidence of cross in the shape of grains.

EAR 201. *Clarage Yellow* (340; large dent); crossed with *White Flat Ensilage* (97; smooth dent). Imperfectly developed, about two inches long, with about forty light yellow grains on one side, not sufficient for full comparison.

EAR 202. *Clarage Yellow* (341; dent); crossed with *Early Yellow Hathaway* (261; dent). Length 3 1/2 inhes, diameter 1 5/8 inches, 12-rowed; grains yellow with nearly white summits, moderately indented, not much wrinkled at summit; cob red, 1 1/8 inches in diameter.

Not resembling either parent, but not intermediate, and hence no evidence of cross.

EAR 203. *Clarage Yellow* (343; dent); crossed with *King of the Earliest* (316*a*; yellow dent). Length 5 7/8 inches, diameter 1 13/16 inches, not well filled at tip, 14-rowed, four of the rows defective; grains deep (or slightly reddish) yellow, subquadrangular, moderately indented, and slightly wrinkled at summit; cob red, 1 1/16 inches in diameter.

NO evidence of cross.

EAR 204. *Clarage Yellow* (344; dent); crossed with a *Red Dent* (282a). Length 7 3/16 inches, diameter 1 1/8 inches, fairly well filled at tip, 14-rowed, rows nearly regular; grains rather small, not broad, moderately indented, and slightly wrinkled at summit; cob red.

Perhaps evidence of cross in shape of grains.

EAR 205. *Clarage Yellow* (346; dent); crossed with *Cranberry White* (332a; dent). Length 6 1/8 inches, diameter 1 7/8 inches, well filled at summit; 14-rowed, rows regular; grains light yellow with nearly white summits, rather broad and nearly wedge-shaped, moderately indented, and wrinkled at summit; cob light pink, 1 3/16 inches in diameter.

Doubtful evidence of cross in shape and color of grains.

EAR 206. *Glick's Yellow* (347; large dent); crossed with *Leaming* (162; small yellow dent). Length 7 1/8 diameter 2 1/16 inches, not well filled at tip, 14-rowed, light yellow; grains very broad, subquadrangular, crease-dented, often pinched at summit; cob white, 1 1/4 inches in diameter.

No evidence of cross.

EAR 207. *Glick's Yellow* (348; dent); crossed with *Normandy Giant* (106a; white dent). Length 5 1/4 inches, diameter 2 1/8 inches, not well filled at tip, 14-rowed; grains mostly white or yellowish, broad, subquadrangular, moderately crease-dented and somewhat wrinkled at summit; cob very light pink, 1 3/16 inches in diameter.

Evidence of cross in color of grains.

EAR 208. *Glick's Yellow* (349; dent); crossed with a *Red Dent* (288). Length 7 1/16 inches, too immature and imperfect for description and comparison.

EAR 209. *Prairie King (350;* yellow dent); crossed with *Glick's Yellow* (347a; dent). Length 7 3/8 inches, diameter 1 7/8 inches, fairly well filled at tip, 20-rowed; grains yellow, rather small and long, wedge-shaped, dimple-dented, slightly -wrinkled at summit; cob red, 1 1/8 inches in diameter.

Not exactly like either parent, but no evidence of cross between the two.

EAR 210. *Prairie King* (353; yellow dent); crossed with *Cranberry White* (332; dent). Length 8 1/2 inches, diameter 1 11/16 inches, not filled at tip, smooth and compact, 14-rowed; grains light yellow, rather small, somewhat wedge-shaped, very slightly indented and smooth at the summit; cob deep red, 1 inch in diameter.

Differing much from either parental type, but presenting no distinct evidence of cross between the two.

EAR 211. *Early White Dawn* (354; dent); crossed with *Murdock's* (212; yellow dent.) Length 7 1/2 inches, diameter 1 7/8 inches, not well filled at base and tip, 12-rowed, several of the rows imperfect; grains short, thick, subquadrangular, moderately indented, yellowish with white summits; cob light red, 1 inch in diameter.

Evidence of cross only in color of grains.

EAR 212. *Early White Dawn* (354; dent); crossed with a *Red Dent* (283). Length 7 1/4 inches, diameter 2 inches, upper two inches destitute of grains, 16-rowed, not compact, white; grains slender wedge-shaped, deeply indented, much wrinkled or pinched at summit; cob red, 1 1/8 inches in diameter.

Doubtful evidence of cross in shape of grains.

EAR 213. *Shannon's Big Tennessee White* (359; dent); crossed with a *Red Dent* (287). Length 7 1/2 inches, diameter 1 7/8 inches, lower portion destitute of grains, rows sixteen, not complete; grains white, moderately indented, not wrinkled at summit; cob red, 1 3/10 inches in diameter.

No evidence of cross.

EAR 214. *Shannon's Big Tennessee White* (360); crossed with a *Red Dent* (286). Length 4 1/8 inches, diameter 1 15/16 inches, not sufficiently matured for complete description and comparison, though the grains somewhat resemble the female parent in shape, and approximate the male parent in color.

Evidence of cross only in color.

EAR 215. *Johnston's Mammoth Early White* (362; dent); crossed with a *Red Dent* (288). Length 7 inches, diameter 1 1/8 inches, imperfect, having only about 50 white, rounded, dimple-dented scattering grains; cob white, 1 1/16 inches in diameter.

No evidence of cross.

EAR 216. *Red Cob Ensilage* (363; white dent); crossed with *Woodworth's Yellow* (277; dent). Length 6 1/2 inches, diameter 2 1/8 inches, not well filled at tip, 14-rowed, several rows defective; grains slightly yellowish with pure white summits, rather broad, deeply indented and much wrinkled at summit; cob light red, 1 1/8 inches in diameter.

No clear evidence of cross.

EAR 217. *Red Cob Ensilage* (366; white dent); crossed with *Early California* (326; yellow dent). Length 5 1/2 inches, diameter 2 7/16 inches, no grains on the upper portion, 22-rowed; grains white, rather narrow and often nearly wedge-shaped, deeply indented and usually much wrinkled; cob deep red, 1 1/2 inches in diameter.

No evidence of cross.

EAR 218. Sheep's *Tooth (368;* white dent); crossed with *Early California* (324*a*; yellow dent). Length 5 1/4 inches, diameter 2 1/8 inches, imperfectly filled at apex and on one side toward the base, compact and smooth, 18-rowed; grains white, rather broad at the summit, mostly wedge-shaped, slightly indented, not wrinkled at summit.

No evidence of cross.

EAR 219. *Sheep's Tooth* (369; white dent); crossed with *Early California* (325; yellow dent). Length 7 inches, diameter 1 15/16 inches, not well filled at tip; 18-rowed; grains white, slightly yellowish tinged. but summits pure white, rather slender and somewhat wedge-shaped, moderately indented and slightly tipped on the chit side; cob white, 1 1/8 inches in diameter.

No clear evidence of cross.

EAR 220. A *White Dent* (370); crossed with *Maryland White Dent* (290). Length 9 inches, diameter 2 7/16 inches, not well filled at tip; 20-rowed;

grains pure white, subquadrangular or slightly wedge-shaped, deeply indented and much wrinkled at summit; cob white, 1 1/2 inches in diameter.

No clear evidence of cross.

EAR 221. *Johnston's Mammoth Early White (371);* crossed with *Mammoth White Dent* (295). Length 5 7/8 inches, diameter 2 1/16 inches, imperfectly filled at base and tip; 16-rowed, rows irregular and partially defective; grains pure white, very thick, moderately indented and pointed at summit on the chit side; cob white, 1 7/16 inches in diameter.

No clear evidence of cross.

CROSSED CORN THE SECOND YEAR.

Of the crosses obtained the previous year (1888),* those with sound kernels (twenty-three in number) were this year (April 4, 1889) planted in small plats adjacent to each other. They were arranged as far as practicable so that the plants of contiguous plats discharged their pollen at different times, thereby lessening the chances of intermixing.† The growing crop was carefully cultivated; the season was very favorable and all the plats yielded well.

The numbers designating each kind are those given to the corresponding ears obtained the previous year.‡ The efffect of the crossing the first year is also quoted, in each case, from the Annual Report referred to.

In the descriptions are given the time in days of flowering, the time of arriving at the milk-stage and of ripening, any striking peculiarity of growth noted during the season, the character of the stalks, whether suckered or not, their height; the number of ears, their height from the ground, whether drooping or erect, variable or uniform, smooth or rough, tapering or cylindrical, their size, whether well filled or otherwise, character of the butts and tips; the size and color of the cobs, the diameter of the juncture where the cob joins its stalk; the number and character of the rows, whether the space between them (sulcus) is marked or slight; whether the kernels are firm on the cob or otherwise, their shape, size, color, and whether dent, flint, soft, pop, or sweet.

In the remarks following the descriptions the points are given in which the ears differ from the female parent; these are to be understood as variations toward the male parent unless otherwise stated. The type of variation is also given.

By the phrase "*Variation of type I*" is meant that all of the kernels on

* First Annual Report Kas. Exp. Station, 1888, page 316.

† It was not practicable to separate them to a great distance from each other and from other varieties. Yet it is not likely that there was intermixing to such an extent as to interfere with characters due to the crossing of the previous year.

‡ First An. Rep. Kas. Exp. Station, 1888, page 331.

a single ear are alike or nearly so; the ears, however, may differ more or less among themselves. Examples of this type of variation are given in Plate XI, Nos. 25, 26 and 41.

By *"Variation of type II,"* is meant that the kernels on a single ear vary considerably, usually approaching both parents, but for the most part intermediate. Variation of type II is shown in Plate XI, Nos. 24 and 38.

VARIETIES FROM WHICH THE CROSSES WERE OBTAINED.

The following list gives in alphabetical order the names of the varieties crossed in 1888, so far as they show the parentage of the crosses planted this year (1889). Following the name are given the most obvious characters of the kernels (not ears):

Adams' Early Table: White, nearly smooth soft dent.
Brick's Boston Market Ensilage: Medium, white dent.
Brick's Premier Sugar: Small white sweet.
Bullock's White Prolific: White dent.
Calico: Nearly white dent, irregularly streaked with red.
Champion White Pearl: Large white dent.
Compton's Early: Yellow flint.
Early Golden Lenawee: Small yellow dent.
Early Landreth Market: Smooth white soft.
Early Red Blazed: Yellow flint, often tinged with red.
Early White Dent: White dent.
Early Yellow Hathaway: Light yellow dent.
Ellm's Early Yellow: Yellow flint.
Extra Early Adams' Table: Nearly smooth soft dent.
Golden Pop Corn: Yellow smooth.
King Philip (eastern seed): Red brown flint.
King Philip (western seed): Red semi-dent, tipped with white.
Landreth Sugar: Long white sweet.
Longfellow: Yellow flint.
Mammoth White Surprise: Medium, white dent.
Normandy Giant: Long white dent.
Northern Pedigree: Small white sweet.
Pride of the North: Small yellow dent.
Queen of the Prairie: Small yellow dent.
Rice Pop Corn: Small white pointed.
Sanford's Ensilage: White flint.
Self-Husking: Reddish or brownish yellow flint.
Silver Lace Pop Corn: Large white smooth.
White Flat Ensilage: Medium, white dent.
Yellow Mammoth: Yellow dent.

DESCRIPTIONS.

No. 2. KING PHILIP crossed with LONGFELLOW.

First An. Rep., p. 331: "Did not show any signs of crossing."

In flower 61 days, in milk 77, ripe 122. Stalks rather slender, somewhat suckered, 4 1/2 -6 1/2 ft. high; ears pendent or erect, 1–2 ft. from ground, with husks clean or somewhat leafy, nearly uniform, slightly tapering, smooth, 6½—9½ in. long, 1¼—1½ in. diam.; butts squarely rounded, tips well filled, acute; cobs white, $\frac{3}{4}$-$\frac{7}{8}$ in. diam.; juncture $\frac{5}{6}$-$\frac{7}{8}$ in. diam.; rows 8, regular, sulcus very slight; kernels firm on cob, oval or suboval, $\frac{3}{5}$ in. long, $\frac{7}{16}$ diam., $\frac{3}{16}$ -$\frac{1}{4}$ in. thick, dark yellowish red to reddish yellow, flint.

Differs from King Philip in having larger and lighter-colored kernels. Nos. 2 and 3 look much alike, except 2 is usually darker.

Variation of type I, (*i.e.*, kernels uniform on each ear.)

No. 3. KING PHILIP crossed with EARLY RED BLAZED.

First An. Rep., p. 331: "Showed no evidence of crossing."

In flower 62 days, milk 77, ripe 147. Stalks leafy, suckered, 4 $\frac{1}{2}$-5 $\frac{1}{2}$ ft. high; ears pendent or erect, 1 on the stalk, 1-2 $\frac{1}{2}$ ft. from ground, with clean husks, uniform, smooth, very slightly tapering, nearly cylindrical, 6 $\frac{1}{2}$-10 $\frac{3}{8}$ in. long, 1 $\frac{1}{8}$–1 $\frac{5}{8}$ in. diam.; butts squarely rounded, tips roundly acute, often not fully filled; cobs white, $\frac{7}{8}$–1 in. diam. ; juncture $\frac{3}{4}$–$\frac{7}{8}$ in. diam.; rows 6–10, regular, sulcus slight; kernels firm on cob, oval, $\frac{5}{16}$-$\frac{3}{8}$ in. long, $\frac{7}{16}$ wide, $\frac{3}{16}$ thick, yellowish red to yellow.

Differs from King Philip in that the kernels have rather less starch, and are nearly always lighter in color as well as slightly larger. Some of the grains show a slight reddish tinge somewhat like Early Red Blazed.

Variation of type II. (*i.e.*, kernels variable on each ear.)

No. 4. KING PHILIP crossed with EARLY YELLOW HATHAWAY.

First An. Rep., p. 331: "Looked exactly like King Philip."

In flower 65 days, in milk 78, ripe 120. Stalks slightly or often not at all suckered, rather slender, 5 $\frac{1}{2}$-6 $\frac{1}{2}$ ft. high; ears pendent or sub-erect, 1 or 2 on a stalk, 2–3 ft. from ground, with clean husks, variable, smooth, tapering, 5 $\frac{1}{8}$–11 $\frac{3}{8}$ in. long, 1 $\frac{1}{2}$– 1 $\frac{7}{8}$ in diam; butts abruptly rounded, tips not very well filled, acute; cobs red, 7/8—1 in. diam; juncture $\frac{3}{4}$-$\frac{13}{16}$ in. diam; rows 8–14, mostly 10 or 12, regular, sulcus slight; kernels suboval to nearly triangular, $\frac{7}{16}$-$\frac{1}{2}$ in. long, $\frac{3}{8}$-$\frac{1}{2}$ wide, $\frac{3}{16}$-$\frac{1}{4}$ thick, deep yellowish red (like King Philip) to light, slightly reddish yellow, like a flint on the darker red ears, and varying to a slightly-creased hard dent on the yellow ears.

Differs from King Philip in having red cobs, larger, more tapering ears, and kernels varying to yellow color and to a dent character. A well blended and promising variety.

Variation plainly of type I.

No. 5. LONGFELLOW crossed with EARLY YELLOW HATHAWAY.

First An. Rep., p, 331: "Looked exactly like Longfellow."

In flower 67 days, in milk 87, ripe 127. Stalks rather slender, somewhat suckered, 5–7 ft. high; ears pendent or erect, 1 on a stalk, 2–3 feet from ground, with husks very slightly leafy, variable, tapering smooth, 6-8 $\frac{3}{4}$ in. long, 1 $\frac{1}{2}$–2 in. diam.; butts squarely rounded, tips acutely rounded and usually quite well filled: cobs red, 1 $\frac{1}{8}$–1 in. diam. ; juncture $\frac{3}{4}$–$\frac{7}{8}$ in.

diam.; rows 8–14, mostly 12-14, usually regular, sulcus very slight; kernels not very firm on cob, varying from nearly round to wedge-shaped, usually tapering from base and rounded at top, from light yellow to yellow in color, from flint-like to dent in kind, summits of dent creased, $\frac{1}{2}$-$\frac{7}{16}$ in. long, $\frac{3}{8}$-$\frac{7}{16}$ wide, $\frac{3}{16}$ thick.

Differs from Longfellow in that the ears are shorter, thicker, cobs red, kernels longer, thinner, some are dent-like and they are lighter, creased at tip, and contain more starch.

Variation of type I.

No. 7. LONGFELLOW crossed with EARLY WHITE DENT.

First An. Rep., p. 331: "Looked exactly like Longfellow."

In flower 84 days, in milk 98, ripe 128. Stalks not at all or scarcely suckered, erect, rather leafy, $6\frac{1}{2}$–$8\frac{1}{2}$ ft. high; ears pendent or erect, 1 or 2 on a stalk, $1\frac{1}{2}$–$3\frac{1}{2}$ ft. from ground, with smooth husks, uniform, smooth, cylindrical, $4\frac{3}{8}$–10 in. long, $1\frac{3}{8}$-$1\frac{5}{8}$ in. diam., butts somewhat gradually rounded, tips acute, not very well filled; cobs white, $\frac{7}{8}$ - $\frac{15}{16}$ in diameter, juncture $\frac{5}{8}$ - $\frac{11}{16}$ in diam.; rows 8–10, regular, sulcus very slight; kernels firm on cob, wedge-shaped to nearly round, $\frac{7}{16}$-$\frac{1}{2}$ in. long, $\frac{3}{8}$–$\frac{7}{16}$ wide, $\frac{3}{16}$ thick, light yellow to yellowish white, flint-like to dent, with creased summits.

Differs from Longfellow in having ears with less glossy kernels, with more starch, more wedge-shaped, and having a crease at summit. Kernels varying from yellow to nearly white occur on the same ear. The yellow kernels were as often dented as the white ones.

Variation of type II.

No. 8. PRIDE OF THE NORTH crossed with MAMMOTH WHITE SURPRISE.

First An. Rep., p. 331 "The kernels were yellow, somewhat like Pride of the North, but had a slight reddish tinge unlike either of the varieties. In shape the kernels showed no evidence of a cross."

In flower 85 days, in milk 103, ripe 151. Stalks not suckered, $8\frac{1}{2}$-11 ft. high; ears pendent or rarely erect, 1 or rarely 2 on a stalk, $2\frac{1}{2}$–6 ft. (often $4\frac{1}{2}$ ft.) from ground, with clean husks, uniform, rough, nearly cylindrical, $7\frac{3}{4}$-$9\frac{1}{2}$ in. long, $1\frac{7}{8}$-$2\frac{1}{2}$ diam., butts somewhat gradually rounded, tips generally not well filled, bluntly rounded; cobs white or red, $1\frac{1}{8}$-$1\frac{1}{4}$ in. diam.; juncture $\frac{1}{2}$–$\frac{5}{8}$ in. diam.; rows 12–18, mostly 12–16, regular, sulcus slight; kernels firm on cob, wedge or narrow wedge-shaped, $\frac{9}{16}$-$\frac{5}{8}$ in. long, $\frac{5}{16}$-$\frac{3}{8}$ wide, $\frac{1}{8}$-$\frac{3}{16}$ thick, yellowish white or yellow mixed, pinched, crease-dented.

Differs from Pride of the North in having ears thicker, somewhat more abruptly rounded at tips, less abruptly rounded at butts; cobs sometimes white; kernels lighter in color, larger, generally pinched at tips. Resembles in general appearance Mammoth White Surprise more than Pride of the North.

Variation of type I.

—22

No. 9. BULLOCK'S WHITE PROLIFIC crossed with GOLDEN POP CORN.
First An. Rep., p. 332: Some of the kernels showed a yellow coloration, which was, however, also observed in the ears raised on the College farm; otherwise there were no signs of crossing."

In flower 82 days, in milk 92, ripe 157. Stocks leafy above as well as below the ear, not suckered, 8-10 1/2 ft. high; ears drooping or erect, 1 or 2 on a stalk, 3 1/2-5 1/2 ft. from ground, with clean husks, uniform, smooth, tapering, 8–10 3/8 in. long, 1 1/2-2 in. diam.; butts abruptly rounded, tips not well filled, bluntly rounded; cobs white, 7/8–1 in. diameter; juncture 1/2-13/16 in. diam.; rows 10–14, regular; sulcus very slight; kernels rather firm on cob, oval to narrow wedge-shaped, 7/16 in. long, 1/4-3/8 wide, 3/16 thick, rather light yellow to white, some dent, with creased tip, some like flint, sharply rounded at tip.

Differs from Bullock's White Prolific in having more slender and more glossy ears, kernels with less starch, of a narrower, sharply-rounded form, and often flint-like.

Variation of type II. Kernels of all colors from white to yellow occurring on the same ear, but the type of' kernel is the same on whole ear, and varies on different ears, in this respect approaching type I.

No. 11. CHAMPION WHITE PEARL crossed with NORMANDY GIANT.
First An. Rep., p. 332: "The two varieties looked so much alike that it was difficult to decide whether there was any evidence of crossing or not."

In flower 87 days, in milk 103, ripe 147. Stalks upright, rather leafy, not suckered, 7 1/2-9 ft. high; ears becoming pendent, 1 or 2 on stalk, 2 1/2-4 ft. from ground, uniform except in size, rough, nearly cylindrical, 6 1/8-10 in. long, 2–2 3/8 in. diam., butts gradually rounded, tips somewhat abruptly rounded, not quite filled; cobs white, 1 1/8-1 3/8 in. diam.; juncture 1/2-7/8 in. diam.; rows 12–16, somewhat irregular, sulcus none; kernels firm on cob, from nearly wedge-shaped to nearly square, white or yellowish white, dent like, pinched, (the tips of kernels near base of ear less strongly pinched.)

Differs from Champion White Pearl in that the kernels are generally wider and thiner, pinched instead of dimpled. Looks more like Champion White Pearl than like Normandy Giant. The parents being both white, the slight yellowish tinge cannot be accounted for except on the ground of impure seed.

Variation of type I.

No. 14. EARLY WHITE DENT crossed with GOLDEN POP CORN.
First An. Rep., p. 332: "Perhaps there was evidence of the cross in this case. . . . It is probable that the seed was not pure."

In flower 72 days, in milk 97, ripe 147. Stalks not suckered, or if so, suckers as tall as parent stem, 6–8 ft. high; ears pendent, 1 or 2 on a stalk, 3 1/2-4 1/2 ft. from ground, with clean husks, somewhat variable, nearly cylindrical, or slightly tapering, 7–10 3/8 in. long, 1 1/2-2 in. diam., butts gradually rounded, tips abruptly rounded, not well filled; cobs white, 3/4-7/8 in. diam.; juncture 1/2-3/4 in. diam.; rows 12–18, mostly 14, usually regular, sulcus very slight; kernels firm on cob, varying from nearly round to narrow wedge-shaped, 3/8-7/16 in. long, 1/4-5/16 wide, 1/8-3/16 thick, light yellow or white in color, intermediate between dent and pop corn, creased or dimpled at tip.

Differs from Early White Dent in having longer ears and having kernels smaller, yellow in color, shinier, not pinched at tip, with more corneous material.

Variation of type II in color, but all the kernels on an ear are otherwise of the same character, though the different ears vary. In this respect it approaches type I.

No. 15. EARLY YELLOW HATHAWAY crossed with SANFORD'S ENSILAGE.
First An. Rep., 333: "Showed no signs of the cross."

In flower 60 days, in milk 72, ripe 122. Stalks somewhat suckered, 5-7 ft. high; ears pen dent, 1 or 2 on a stalk, 1 1/2-3 ft. from ground, with leafy husks, nearly uniform, smooth, tapering, 5 3/4–9 in. long, 1 5/8–2 in. diam., butts somewhat rounded, tips roundly acute, well filled; cobs dark red or light red, 1–1 1/8 in. diameter; juncture 5/8–1 in. diameter; rows 8–14, mostly 12, regular, sulcus slight; kernels not firm on cob, tapering oval to sub-triangular, 7/16-9/16, in. long, 5/16-7/16 wide, 5/32 thick, yellow above, deep orange to reddish on sides, varying to dull white on summit, and shining, usually somewhat tinted white on sides, smooth, flint or crease-dented, hard dent, except one ear which is plainly pinched dimple-dented and is not at all flinty.

Differs from Early Yellow Hathaway in having probably 1/4 of the kernels white and many intermediate in color, and in the marked flinty character of all but one ear, which was nearly white. A mostly well blended cross of some promise, as the ears are large for so early a variety.

Variation of type II.

No. 17. EARLY RED BLAZED crossed with EARLY WHITE DENT.
First An. Rep., p. 333: "Showed all the characters of the kernels of the Early Red Blazed planted, even to the occasional tinge of red."

In flower 72 days, in milk 87, ripe 147. Stalks slender, somewhat suckered, 6–6 1/2 ft. high; ears pendent or erect, 1 on a stalk, 2–3 1/2 ft. from ground, with clean husks, not uniform, smooth to somewhat rough, very slightly tapering, nearly cylindrical, 7 3/4–12 1/4 in. long, 1 3/4–2 1/8 in. diam.; butts rather squarely rounded, tips sometimes well filled, sometimes not, bluntly rounded; cobs white 1–1 1/8 in. diam.; juncture 3/4–7/8 in. diam.; rows regular, 8-14, mostly 10–12, sulcus slight; kernels not firm on cob, elliptical to bluntly wedge-shaped, 5/16-7/16 in. long, 3/16-1/4 thick, light yellow to yellowish white in color, frequently tinged with a peculiar red, varying from a slightly-creased dent to nearly a flint.

Differs from Early Red Blazed in that the ears are greater in diameter, kernels creased, longer, usually lighter in color, with rather more starch and less corneous material. There is great variation in form and size of kernels in this variety. Most ears show the peculiar red of Early Red Blazed.

Variation of type I, but in color it approaches type II.

No. 19. YELLOW MAMMOTH crossed with QUEEN OF THE PRAIRIE.
First An. Rep, p. 333: "There was no evidence of crossing."

In flower 72 days, milk 102, ripe 147. Stocks not suckered, 6 $^1/_2$-10 $^1/_2$ ft. high; ears drooping or erect, 1 or more rarely 2 ears on a stalk, 3 $^1/_2$-5 ft. from ground, with clean husks, uniform, slightly tapering, some rough, others smooth, 6 $^1/_2$–10 $^3/_8$ in. long, 1 $^7/_8$–2 $^1/_4$ in. diam.; butts somewhat gradually rounded, tips abruptly rounded, quite well filled; cobs white or red, 1 $^1/_8$–1 $^1/_4$ in. diam.; juncture $^5/_8$-$^3/_4$ in. diam.; rows 12-18, mostly 14–16, regular, sulcus none or slight; kernels not firm on cob, oval or abruptly rounded at base and flattened at summit, $^7/_{16}$–$^1/_2$ in. long, $^5/_{16}$-$^3/_8$ wide, $^3/_{16}$-$^1/_4$ thick, yellow, or reddish-yellow, with light yellow summits.

Differs from Yellow Mammoth in that the ears are longer and the kernels often darker, sometimes more strongly pinched. Since the parents were both of the same color, no important variation of color was seen.

variation of type I.

No. 20. YELLOW MAMMOTH crossed with KING PHILIP (Eastern).
First An. Rep., p. 333: "Showed no signs of the Cross."

In flower 67 days, milk 94, ripe 147. Stalks upright, scarcele if at all suckered, 6–7 ft. high; ear pendent, 1 or rarely 2 on a stalk, 2-3 $^1/_2$ ft. from the ground, with clean husks, not uniform, nearly cylindrical, smooth, 5 $^7/_8$-9 in. long, 1 $^3/_8$-2 in. diam., butts gradually rounded, in one or two cases slightly swollen, tips somewhat abruptly rounded, not entirely filled; cobs red, $^{15}/_{16}$-1 in. diam.; juncture $^1/_2$-$^3/_4$ in. diam.; rows 8–14, mostly 10-12, regular, sulcus very slight; kernels not firm on cob, wedge-shaped to nearly square, $^3/_8$-$^1/_2$ in. long, $^3/_8$ in. wide, $^1/_8$-$^3/_{16}$ in. thick, yellow to reddish yellow, summits lighter in color, flint.

Differs from Yellow Mammoth in having more glossy, smooth ears, also kernels are thinner, not pinched or creased, often darker in color. It resembles King Philip more than Yellow Mammoth in general appearance. This is a promising variety.

Variation of type I.

No. 21. SELF-HUSKING crossed with EXTRA EARLY ADAMS' TABLE.
First An. Rep., p. 333: "There was no evidence of crossing."

In flower 67 days, in milk 92, ripe 122. Stalks somewhat suckered, 4-7 ft. high; ears pendent, one on a stalk, 1-2 ft. from ground, with leafy husks, uniform, smooth, varying from cylindrical to tapering, 9–11 in. long, 1 $^1/_2$-2 in. diam., butts sometimes slightly swollen, tips rather abruptly rounded, sometimes completely filled, sometimes not; cobs white or red, 1 1/8 diam.; juncture 5/8-3/4 in. diam.; rows 8-12, usually regular, sulcus slight; kernels quite firm on cob, varying from oval to thick wedge-shaped, 3/8 in. long, 3/8–7/16 wide, 3/16-1/4 in. thick, yellow or reddish yellow in color, flint-like.

Differs from Self-Husking in having lighter, larger kernels.

Variation of type I.

No. 24. WHITE FLAT ENSILAGE crossed with LANDRETH SUGAR.

> First An. Rep., p. 334: "Some of the kernels showed a tinge of yellow, but otherwise there was no evidence of the cross. Perhaps this yellow coloration was due to impure seed."

In flower 72 days, in milk 102, ripe 157. Stalks not suckered very leafy, (leaves unusually broad,) 6 1/2-8 1/2 ft. high; ears pendent or suberect, 1 or 2 ears on a stalk, 3–4 1/2 ft. from ground, with leafy husks, uniform, tapering, 4 1/2-9 1/2 in. long, 1 5/8-2 1/8 in. diam., butts somewhat gradually rounded, tips subacute, not well filled; cobs white, 1-1 1/8 in. diam.; juncture 1/2–5/8 in. diam.; rows 12–18, mostly 14–16, quite irregular, sulcus very slight; kernels not firm on cob, narrow, wedge-shaped, rounded at summit, white, very slightly dented at summit, or wrinkled like sweet corn, but differing in color from Landreth Sugar, 7/16-9/16 in. long, 1/4-5/16 wide, 1/8-3/16 thick.

Differs from White Flat Ensilage in that the ear consists of about one-fourth sweet corn, and the remaining kernels are more or less dented at summit. Out of a large number of ears one or two have a few yellow kernels not accounted for.

Variation plainly of type II; see Plate XI, No. 24.

No. 25. CALICO crossed with ADAMS' EARLY TABLE.

> First An. Rep. p. 334: "Showed no effects of cross."

In flower 72 days, in milk 82, ripe 127. Stalks upright, slightly suckered, 6-8 1/2 ft. high; ears pendent or upright, 1 or 2 on a stalk, 3-4 ft. from ground, with clean husks, variable, smooth or somewhat rough, tapering, 6 1/8-8 3/8 in. long, 2–2 1/4 in. diam., butts gradually or bluntly rounded, sometimes slightly swollen, tips bluntly rounded, usually well filled; cobs white or (on small ears) mixed white and red, 1–1 1/4 in. diam.; juncture 9/16-3/4 in. diam.; rows 12–16, often irregular, sulcus very slight; kernels not firm on cob, wedge-shaped, light yellow or nearly white, sometimes streaked with red like Calico, dent-like with summits very slightly creased or pinched, 7/16-1/2 in. long, 5/16-3/8 wide, 1/8-3/16 thick.

Differs from Calico in having ears either large and white or small with red streaked kernels. The cobs of large white ears are white, these of the others mixed, while the kernels of the white are longer and thinner.

Variation of type I; Plate XI, No. 25.

No. 26. ADAMS' EARLY TABLE crossed with KING PHILIP (western form). First An. Rep., p. 334: "There was no evidence of the cross."

In flower 72 days, in milk 87, ripe 128. Ears very uniform, smooth, cylindrical, 6 1/2–9 in. long, 1 15/16–2 in. diam.; butts rather abruptly rounded, tips abruptly pointed, not filled; cobs white, 1 in. diam; juncture medium, 5/8–1/2 in diam.; rows 10–12, very often irregular, sulcus slight; kernels firm on cob, sub-triangular, flatly rounded on top, tapering slightly, 7/16-1/2 in. long, 3/8-7/10 wide, 3/16 thick, white on summit, quite deep red on sides, smooth, crease or dimple-dented.

Differs from Adams' Early Table in having larger ears and kernels tinged with red; much like King Philip, except that the ears are perhaps smaller, and the kernels have more white on the summit and are not so dark a red on the sides. A fine example of ears almost perfectly intermediate, and showing scarcely any variation.

Variation of type I; see Plate XI, No. 26.

No. 27. EXTRA EARLY ADAMS' TABLE crossed with ELLM'S EARLY YELLOW. First An. Rep., p. 334: it "In this case there seemed to be some effect of the cross visible the first year."

In flower 50 days, in milk 65, ripe 106. Stalks not very leafy, 5-61/2 ft. high; ears upright, 1 or 2 on a stalk (usually 1 large, 1 small), 1 1/2–2 ft. from ground, with slightly leafy husks, variable, tapering, 4 5/8–8 1/2 in. long, 1½–1¼ in. diam.; butts squarely rounded, tips evenly rounded, well filled; cobs white, 1 1/8 in. diam.; juncture 3/4–7/8 in. diam.; rows regular, 8–10, sulcus very slight; kernels not very firm on cob, tapering from the base, slightly rounded or flattened on summit, somewhat triangular in shape, yellow or very light yellow in color, varies gradually from a flint to a dent, summit of dent simply creased.

Differs from Extra Early Adams' Table in having kernels darker colored and flint-like, or, if dent-like, less strongly dented at tip, usually with less flour and more corneous material. On one ear the kernels are slightly tinged with red, on another kernels are wrinkled at side. It resembles Ellm's Early Yellow most.

Variation intermediate in type. Plainly of type II in color, but the different ears vary in regard to the amount of starchy matter in the kernels, though all of the kernels on a single ear are alike in this respect as in type I.

No. 28. EARLY LANDRETH MARKET crossed with EARLY GOLDEN LENAWEE. First An. Rep., p. 334: "The effect of the cross could be plainly seen."

In flower 67 days, in milk 87, ripe 118. Stalks rather slender, not suckered, 6-7 1/2 ft. high; ears erect or pendent, 1 on a stalk, 1 1/2-2 1/2 ft. from ground, with slightly leafy husks, uniform, smooth, tapering slightly, 7 1/2–9 7/8 in. long, 1 1/2-1 3/4 in. diam., butts abruptly rounded, tips rather acute, well filled; cobs red, 7/8–1 in. diam., juncture 5/8-3/4 in. diam.; rows 14–18, mostly 10 or 12, regular, sulcus slight; kernels short, tapering, summit evenly rounded, 7/16-1/2 in. long, 3/8–7/16 in. wide, 3/32-3/16 in. thick, yellowish white to light yellow, varying from a soft flint to a crease dent or to sweet.

Differs from Early Landreth Market in the large proportion (probably 3/4) of yellow kernels, which were in most cases crease-dented and have more corneous material; the ears are also much larger. No explanation can be given for the occurrence of sweet kernels, which likewise vary from white to yellowish. This variety has good-sized ears considering the time of ripening, but has only one on a stalk.

Variation of type II.

No. 38. BRECK'S PREMIER SUGAR crossed with COMPTON'S EARLY.
First An. Rep., p. 336 "This affords a very good example of the visible effects of the cross seen the first year."

In flower 65 days, milk 72, ripe 115. Stalks with a few perfect suckers or none, not very leafy, 5–6 ft. high; ears upright, 1 on a stalk, 8 in.–2 ft. from ground, with somewhat leafy husks, uniform, smooth, slightly tapering, 7 5/8-8 3/8 in. long, 1 5/8–1 7/8 in. diam., butts ending abruptly, tips somewhat pointed, well filled; cobs large, firm, white, 1–1 1/4 in. diam.; juncture rather large, ¾–1 in. diam.; rows 8–12, regular, sulcus none; kernels not firm on cob, rather flatly rounded, tapering but slightly, very short, but of fair width, 6/16-3/8 in. long, 3/8-7/16 wide, 1/8-3/16 thick, light yellow flint to dull white flint, and mostly yellow, but many white sweet.

Differs from Breck's Premier Sugar in being mostly a yellow flint and in having in most cases a yellow tinge in the sweet kernels. Looks some like Compton's Early, but shows both parents and intermediates on same ear. Probably seven-eighths of the kernels were flint.

Variation of type II; Plate XI, No. 38.

No. 39. BRECK'S PREMIER SUGAR crossed with SILVER LACE POP CORN. First An. Rep., p. 336: "Again there is clear evidence Of crossing seen the first year."

In flower 67 days, in milk 77, ripe, 127. Stalks not very leafy, slender, suckered, 4 1/2–5 1/2 ft. high; ears upright or drooping, 2 or even 3 on a stalk, 1–1 1/2 ft. from ground, with quite leafy husks, uniform, cylindrical, smooth, 6 1/8-8 3/4 in. long, 1–1 1/4 in diam.; butts not rounded, square, tips abruptly rounded, well filled; cobs white, 3/4-7/8 in. diam.; juncture large, 1/2-7/8 in. diam.; rows 8–10, generally regular, sometimes defective, sulcus slight; kernels firm on cob, elliptical to wedge-shaped, quite thick, light yellow to nearly white in color, 1/4–3/8 in. long, 5/16-3/8 wide, 3/16-1/4 thick, in kind varying from a sweet to a flint, somewhat larger than the pop corn.

Differs from Breck's Premier Sugar in that most of the kernels are smooth, glossy, flint-like, not so wide but thicker. On each ear usually about one-eighth is yellow, shaped like flint, about-the same amount is sweet, the rest like pop corn only larger. The yellow kernels vary from both parents, but some ears are nearly free from them.

Variation plainly of type II.

No. 40. NORTHERN PEDIGREE crossed with ELLM'S EARLY YELLOW. First An. Rep., p. 336: "It is somewhat doubtful whether in this instance any effect of the cross could be seen."

In flower 62 days, milk 72, ripe 108. Stalks slender, 2 $^1/_2$-4$^1/_2$ ft. high (mostly 3-4 ft.); ears erect, mostly 2 on a stalk, 1-1 $^1/_2$ ft. from ground, with clean husks, not uniform, rough, slightly tapering or nearly cylindrical, 3 $^7/_8$-6 $^5/_8$ in. long, l $^1/_4$–1 $^5/_8$ diam.; butts squarely rounded to somewhat gradually rounded, tips abruptly rounded, not well filled; cobs white, $^7/_8$ in. diam.; juncture $^9/_{16}$–$^5/_8$ in diam.; rows 8–12, regular, sulcus not large; kernels not very firm on cob, elliptical to irregularly bluntly wedge-shaped, $^3/_8$ in. long, $^3/_8$-$^7/_{16}$ wide, $^3/_{16}$-$^7/_{32}$ thick, light yellow in color, flint-like or sweet.

Differs from Northern Pedigree in sometimes approaching a flint. (See First Annual Report, p. 336.) Some ears are almost entirely sweet corn. The more flint-like kernels have more starch.

Variation of type II.

No. 41. RICE POP CORN crossed with BRECK'S BOSTON MARKET ENSILAGE. First An. Rep,. p. 336: "The kernels showed no evidence of the cross, except perhaps in being slightly larger than the Rice Pop Corn."

In flower 72 days, milk 97. Stalks large, 7–8 ft. high; ear pendent or becoming so, only one ear on a stalk, 2 $^1/_2$–4 ft. from the ground, with husks somewhat leafy, uniform, tapering slightly, smooth, 6 $^1/_2$–9 in. long, 1 $^1/_2$–2 in. diam., butts gradually rounded, tips well filled, but not to the extreme tip, bluntly rounded; cobs white, small, yet firm, $^3/_4$-1 $^1/_2$ in. diam.; juncture small, $^3/_8$–$^5/_8$ in diam.; rows 10–18, mostly 12–16, regular in most cases, sulcus slight; kernels rather firm on cob, wedged-shaped, sometimes sharply rounded at summit, $^3/_8$ in. long, $^1/_4$–$^5/_{16}$ wide, $^1/_8$-$^3/_{16}$ thick, nearly white, lighter at summit. A few yellow kernels on some ears, almost entirely flint to nearly dent, mostly intermediate, dent kernels slightly creased.

Differs from Rice pop corn in that the ear is longer and larger; the kernels are larger, not pointed at tip, and with more starch.

Variation of type I; Plate XI, No. 41.

SUMMARY AND CONCLUSIONS.

In every case the effect of the cross could be plainly seen. This was true, both for those which did not show and for those which did show the effect of the cross the first year. In no case, therefore, did the ears exactly resemble either parent. The cross resembled the one and sometimes the other parent more closely, with apparent capriciousness.

There were two well-marked types of variation, namely, I: in which the kernels on each ear were uniform, and II: in which the kernels were more or less variable; but a few numbers were intermediate. Of these of type I, the majority were intermediate between the parental varieties, but in many cases a few ears could be found which were more like one or the other parent, and often showed little influence of the cross. Some, as illustrated in No. 26, Plate XI, were almost exactly intermediate and quite uniform. No. 25, on the other hand, showed two distinct kinds of ears (Plate XI). The latter is a remarkable cross, as the ears, which approached *Adams' Early Table* (the male parent) in being smaller and having smoother kernels, showed to some extent the characteristic red-striped coloration of the *Calico* (the female parent). On the other hand, the large ears, approaching *Calico* in size and character of kernels, were like the *Adams' Early Table* in color, being pure white. It is noteworthy that the small ears with the red-striped kernels had cobs spotted with red; the large ears had pure white cobs.

Of those of type II, some ears were nearly uniform, while others varied considerably. In some cases, kernels almost like one or the other parent constituted the bulk of the ear, while the strictly intermediate ones formed but a small proportion. An example of this is seen in No. 24, *White Flat Ensilage* crossed with *Landreth Sugar.* Even in this case, however, the white kernels differed from *White Flat Ensilage* in being much less dented. More often the crosses of this type had ears composed for the most part of kernels intermediate in character between the two parents. No. 38, *Brick's Premier Sugar* crossed with *Compton's Early,* shows many more intermediate kernels than No. 24, and some crosses were more exactly intermediate than No. 38.

All of the numbers planted which showed the effects of the cross the first year presented the variation of type II. Of the six numbers which showed doubtful evidence of the cross last year, two (24 and 40) showed variation plainly of type 11; three (8, 11 and 41) were of type I; and one (14) was intermediate. Of the remaining fourteen numbers, three (3, 7 and 15) showed variation of type 11; eight (2, 4, 5, 19, 20, 21, 25 and 26) showed type I; and three (9, 17 and 27) were intermediate.

These results seem to suggest that when the effects of the cross are manifest the first year, the variation is more likely to be of type H the second year, but if they are not manifest, the variation to be expected is oftener of type I.

The following table shows the type of variation of the crosses arranged according to the different kinds crossed. The first name in the first column gives the race of the female parent, the second the male; the numbers in the next columns refer to the previous descriptions:

KINDS CROSSED.	Type I. "Grains on the ear uniform."	Type II. "Grains on the ear various."	Type intermediate.
Dent with dent	8, 11, 19, 25, 26	28	....
Dent with flint	20	15	27
Dent with pop	....	....	9, 14
Dent with sweet	....	24	....
Flint with dent	4, 5, 21	7	17
Flint with flint	2	3	....
Pop with dent	41	....	....
Sweet with flint	....	38, 40	....
Sweet with pop	....	....	39
Total	11	7	5

It is quite probable that several of these crosses will prove to be of value, and accordingly an effort will be made to fix or retain their important characteristics in the product of successive years.

BIBLIOGRAPHY OF CROSS-FERTILIZATION OF VARIETIES OF CORN.

There are here included all the important articles in relation to crossing varieties of corn that have come under our notice. They are arranged chronologically, and a brief summary of each article is given.

1724. P. DUDLEY, Esq.: An Observation on Indian Corn. Oct. 1724. Philosophical Transactions. Abridgment. Vol. VI, part II, pp. 204-5.

"Indian corn is of several colours, as blue, white, red and yellow; if these sorts are planted by themselves, so that no other be near them, they will produce their own colour; but if you plant the blue corn in one row of hills, as we term them; and the white or yellow in the next row, they will mix and interchange colours; that is, some of the ears in the blue corn rows shall be white or yellow; and some again in the white or yellow rows shall be blue. Our hills of corn are generally about four foot asunder, and so continued in a streight line as far as the field will allow; but this mixing and interchanging of colours has been observed when the distance between the rows of hills has been several yards; and a worthy clergyman of this province assures me that he has observed it even at the distance of four or five rods; and that too, where there was a broad ditch of water betwixt the hills. Some of our people, but especially the ab-origines impute this to the small fibres of the roots reaching to and communicating with one another; but this must certainly be a mistake, considering the great distance; for the smallest fibres of the roots of our Indian corn cannot extend above four or five foot, especially cross a canal of water. I am therefore of opinion that the principles of this wonderful copulation or mixing of colours are carried by the wind, when the corn is in the earing and while milk is in the grain; for then the corn is in a sort of æstuation and emits a strong scent. This is confirmed by an observation of a neighbour, that a close, high board fence between two fields of corn of different colours entirely prevented any mixture or alteration of colour in either of them."

1868. CHARLES DARWIN: Animals and Plants under Domestication. Vol. I., Second Edition, pp. 430, 431.

"As long ago as 1751 it was observed that when differently colored varieties of maize grew near each other they mutually affected each other's seeds, and this is now a popular belief in the United States. Dr. Savi [1816] tried the experiment with care: he sowed yellow and black-seeded maize together, and on the same ears some of the seeds were yellow, some black, and some mottled, the differently colored seeds being arranged irregularly or in rows. Prof. Hildebrand has repeated the experiment [1868], with the precaution of ascertaining that the mother plant was true. A kind bearing yellow grains was fertilized with the pollen of a kind having brown grains, and the two ears produced yellow grains mingled with others of a dirty violet tint. A third ear had only yellow grains, but one side of the spendle was tinted of a reddish brown; so that here we have the important fact of the influence of the foreign pollen extending to the axis. Mr. Arnold, of Canada, varied the experiment in an interesting manner: 'A female flower was subjected first to the action of pollen from a yellow variety, and then to that from a white variety; the result was an ear, each grain of which was yellow below and white above.' [1874.] With other plants it has occasionally been observed that the crossed offspring showed the influence of two kinds of pollen, but in this case the two kinds affected the mother plant."

1877. W. J. BEAL: Report of the Professor of Botany and Horticulture (Mich. Agr. College). Sixteenth An. Rep. State Board Agr., Mich., 1878, p. 56.

"In several cases tried by myself and one of my students, I found that flint corn does not show the effect of pollen from dent corn in the first year."

1878. W. J. BEAL: The Improvements of Grains, Fruits and Vegetables. Seventeenth An. Rep. State Board Agr., Mich., 1878, p. 450.

"In the spring of 1877 I planted a small piece of a small, early, eight-rowed yellow dent corn. called Yankee or Jersey Dent. In the midst of this piece I planted a single row of Smut-nose Yellow Flint Corn. Before flowering, the tassels of' the flint corn were carefully and thoroughly removed. The flint corn was a trifle earlier than the dent, so the fertilization of the flint corn was imperfect. There was scarcely a full ear in the lot, but all that there was looked just like flint corn. There was no sign of any cross with the dent. This flint corn, which I knew was crossed, was planted by itself this summer, and here I show you some of the ears. There are all grades, from what looks like pure flint corn to pure Yankee Dent corn."

W. J. BEAL: Experiments and other work of the Horticultural Department (Mich. Agr. College). Eighteenth An. Rep. State Board Agr., Mich., 1879, p. 198.

"During the past year I planted near each other three hills of the following kinds of corn, well mixed together, viz. : Waukashum, White Flint, Black Pop Corn, Early Minnesota Sweet, King Philip, and Black Sugar. Every ear showed a mixture produced by pollen from one or more of the varieties, except those of the King Philip variety."

1882. W. R. LAZENBY: Improvements or modification of varieties by crossing or hybridizing. First An. Report Ohio Agr. Exp. Station, for 1882, pp. 66-68.

" The object being to find what effect is produced by the cross-fertilization of different well-matured varieties the first year," crosses were made as follows: (1) Flint on Dent, (2) Dent on Flint, (3) Dent on Sweet, (4) Sweet on Dent, (5) Flint on Sweet, (6) Sweet on Flint, (7) Red on White, (8) White on Red. Plan of crossing: A row of the variety destined to yield the ears was planted between two rows of another variety, which, later, was to furnish the pollen. The tassels of the middle row were removed before maturity, thus preventing self-fertilization, or fertilization by plants of the same variety, and insuring fertilization by the plants of the two outside rows, Result: Ears were generally found upon each stalk, though they were uniformly smaller and less perfect than the ears of the same variety from the outside rows. . . "In scarcely a single instance was the effect of the cross shown, and in no instance was the change more marked than that seen when the variety was planted by itself."

1882. E. LEWIS STURTEVANT: Corn Hybridization. Report of the Board of Control of the N. Y. Exp. Station, for the year 1882, p. 54.

No data obtained to verify the "belief . . . that the influence of growing varieties together is to be seen in the hybridized kernels, or the ears of the same year's yield."

1883. W. R. LAZENBY: Crossing varieties of corn. Second An. Rep. of the Ohio Agr. Exp. Station for 1883, pp. 63-65.

Work of 1882 continued, and some crosses made. Dent crossed with Flint of 1882, gives in 1883 a crop that " shows no exact resemblance to either parent, but takes some of the characteristics of both. "Flint crossed with Dent of 1882 gives in 1883 a product that " bears but little resemblance to the Flint parent; the kernels are nearly all dented, . . . about evenly divided between light and yellow." Sweet crossed with Flint of 1882 gives in 1883 two-thirds white and yellow Flint kernels and one-third Sweet-corn kernels; Flint crossed with Sweet in 1882 gives in 1883 about one-fifth Sweet corn kernels and four-fifths Flint kernels. Crosses of 1883: Plan of crossing same as in preceding year; six crosses made with Yellow Dent varieties; product generally resembled the female parent; in one case some red-streaked and pure red kernels.

1883. E. LEWIS STURTEVANT: Directors' Report Second An. Rep. Board of Control N. Y. Agr. Exp. Station. Botanical notes; pp. 37-56.

" Corn, the maize plant, shows in its kernels the influence of cross-fertilization of the same year. Some varieties seem to possess the power of resisting either cross-fertilization or the changes induced thereby."

Dent corn, p. 44. Twenty-five varieties planted side by side; amount of hybridization and its character given; six of the varieties did not indicate hybridization.

Flint corn, p. 46. Twelve varieties planted side by side; one variety showed no hybridization.

Sweet corn, p.47. Twenty-seven varieties planted side by side; "showed mixture in every case."

Soft or Tuscarore type of corn, p. 49. Tuscarore and Mandan (5 colors); variously hybridized.

Common Pop corn, p. 50. Four varieties, planted side by side; all hybridized.

Pearl Pop corn, p. 51. Four forms planted side by side; all hybridized.

Golden Pop corn, p. 51. A diminutive variety. Fifty perfect and seven imperfect ears obtained; all normal, except one ear with a few sweet and flint kernels.

Rice Pop corn, p. 51. Seven forms planted side by side; all variously hybridized.

Hybrid corn, pp. 52, 53. Four known crosses obtained from the Ohio Experiment Station, (Prof. Lazenby) were used; also a number of forms whose hybrid was assumed for character of kernels. Full descriptions given of the product in each case.

1884. E. LEWIS STURTEVANT: A Study of Maize. Third An. Rep. Board of Control, N. Y. Agr. Exp. Station, pp. 124-188.

"The data we possess for our present study, is that furnished by 127 varieties growing together in our plat in 1883. and 134 varieties grown in like manner in 1884. The yields carefully studied ear by ear, and the observations noted at the time, and afterwards verified by sample ears selected for the purpose and retained for further examination." The general results are given as follows: Maize does not in general show the effects of current cross-fertilization, the exception being sweet. The agricultural species have a strong tendency to resist cross-fertilization with each other. Cross-bred corn has a greater tendency to current cross-fertilization than purely-bred corn. There is a resistance to current hybridization between the "races of a species." Current cross-fertilization is facile between varieties of the same race. The tendency is to produce both parental types and not towards intermediates. Color can pass through current hybridization very freely from one agricultural species to another. Red is the strongest of the colors in resisting the action of current hybridization, Kernels can be partly fertilized by several kinds of pollen. Spots in a crop from hybridized seeds are not common.

1884. W. R. LAZENBY: Corn Experiments; test of varieties. Third An. Rep. Ohio Agr. Exp. Station, 1884, p. 64.

"Varieties of corn, unlike wheat, mix or cross-fertilize very freely when planted near each other."

1885. E. LEWIS STURTEVANT: A Study of Maize. Fourth An. Rep. Board of Control, N. Y. Agr. Exp. Station pp. 95, 96.

This includes an "attempt at forming a new variety" by selection from Pod corn, and considerations as to "variations from seed." Plants of 148 different selections were planted, "four or five hills of a kind, in a compact plat, and so arranged as to secure the greatest natural admixture possible through the prevalence of the pollen of each variety throughout." Notes on the crop, together with the seed used, are given.

1885. E. LEWIS STURTEVANT: Indian Corn and the Indian. American Naturalist. Vol. XIX, No. 3, March, 1885, p. 233.

"At the time of the discovery of the various regions of our country in detail, the Indians had already accomplished in the matter of improvement of varieties of maize what are at present using, and we have no evidence, (I speak after careful research) that any new forms of maize have appeared from our two centuries or more of civilized cultivation. The various agri–cultural species of maize, the flints, dente, softs, sweets and pops appear to be original forms; the subdivisions of these into local forms appear to have been about as well accomplished by the Indians as by ourselves. The leading forms of maize in all the cases where sufficient material has been collected for examination, can be referred to an Indian original, and a more careful examination into all the forms seems to indicate that the Indian origin is common with all."

1885. E. LEWIS STURTEVANT: An Observation in the Hybridization and Cross-Breeding of Plants. American Naturalist. Vol. XIX No. 11, NOV. 1885, p. 1041.

"*Maize*—Seed of one kind often produces samples of other kinds of corn in the crop, and these varieties can usually be distinctly referred by name to varieties with which the original seed might have been crossed. Purposely hybridized seed has produced the original parentage without intermediate types, and seed exposed to hybridization during two years with many sorts of corn, has yielded ears of the types of corn with which cross-breeding or hybridization has been effected without appearance of intermediate forms."

1885. W. R. LAZENBY: Experiments with Corn: Cross-fertilization. Fourth An. Rep. Ohio Experiment Station for 1885, p. 31.

"From many tests conducted, especially to investigate this point, the conclusion is reached that well-established varieties do not show the effect of cross-fertilization the first year to any appreciable extent. This applies to well-established varieties which have long been kept pure from foreign pollen. In no instance has a variety failed to show the effect of foreign pollen in the crop next succeeding the cross, where the plant was deprived of its own variety pollen."

1886. E. LEWIS STURTEVANT: Indian Corn. Fifth An. Rep. Board of Control, N. Y. Agr. Exp. Station, pp. 58-66.

Diagnosis of the six agricultural species, the races and tribes, followed by generalizations, among which are the following: . . . "one of the most striking reflections must be the permanency even in variety characters. King Philip, ... apparently unchanged by its thirty or more years of culture in different climates and by different farmers. . . . Varieties of the same general character cross-breed very readily, and this also seems to be the case as between varieties of the same tribe within a race, and between varieties occupying like positions of classification in different races. . . . There is a resistance to cross-fertilization as between the tribes. . . . A like resistance to crosses has also been observed as between the races. . . . From current hybridization one agricultural species can pass to another, but not uniformly in both directions. . . . The tendency is very strongly towards the production of the parentage without intermediates; so much so that it is doubtful if intermediates are often produced. . . . Repeated crossings, however, seem to destroy this tendency towards a close reproduction of the parentage. . . . I believe our general experience warrants the statement, [that] the tendency of a cross bred is to purge itself of its cross, and to gradually become nearly thoroughbred. . . .The resistance to crossings as between the races and tribes seems as great as between the agricultural species. . . . In some rather rare cases, the characteristics of two agricultural species occur on the came kernel, but the lines of demarkation are then very distinct, there being no blending."

1887. A. A. CROZIER: Some Crosses in Corn. Procedeedings 8th Annual Meeting, Soc. Promotion of Agr. Science, 1887, p. 91.

Cross between Stowell's Evergreen and Yellow Hathaway. "These observations show that foreign pollen affects the appearance of the crossed kernels the first season, but also that an unusual appearance may be due to a cross of the previous year."

1887. A. A. CROZIER: Immediate Influence of Cross-Fertilization upon the Fruit. Dept. of Agriculture, Report 1887, p. 312.

Gives summary of evidence, and in concluding says: "The writer is disposed to think that the evidence is still insufficient to show that there is an observable effect of a cross upon the ovary or fruit the first year, except in Indian corn."

1887. T. J. BURRILL: Annual Horticultural Report, Dec. 10, 1887, in the Fourteenth Report of the Board of Trustees of the University of Illinois, for the two years ending September 30, 1888, p. 84.

"In this case [with maize] the effects of crossing show conspictiously in the kernels the first year. May 19 there were planted in each of three well-separated plats two kinds of corn, viz.: A red pop corn and Murdock, a well-known yellow dent variety. In the first plat there were five rows, four rods long—two of Murdock and three of pop corn, planted alternately. The tassels were carefully removed from the Murdock, but as there was about ten days difference in the time of flowering of the two varieties there was little chance for crossing. A plat of white dent stood fourteen rods away and tasseled about the same time as the pop corn. At the harvest about one-third of the ears from the pop-corn stalks were white, sparsely mixed with yellow kernels. The others were red, and both had the true pop-corn appearance.

"A second plat contained two rows of pop corn and two of Murdock, but was only five rods northwest of a small plat of white dent corn. In this second plat the tassels were pulled out of the pop corn and left in the Murdock. About one-third (17 to 36) the ears from pop-corn stalks were red pop corn and two-thirds white or white and yellow mixed. It is remarkable that the red ears had very rarely a kernel of another color.

"Plat No. 3 consisted of two rows of the red pop corn and Murdock mixed, five rods north of white dent corn. Tassels all allowed to mature. Ears proved to be, on pop-corn stalks, in the proportion of 15 to 38 red and white, or white and yellow mixed. In no case did the Murdock variety or the white dent show signs of the pop-corn cross. This red pop corn had been grown on the farm the year preceding, and was believed to be pure seed. The Murdock was taken from seed that yielded pure corn elsewhere.

"Now while the grain of the pop corn showed unmistakably the results of foreign pollen, the cob retained its characteristic size and appearance."

1888. W. A. KELLERMAN and W. T. SWINGLE: Experiments in Cross-Fertilization of Corn. First An. Rep. Kans. Exp. Station, 1888, p. 316.

Ears were inclosed with cloth sacks before the silk appeared, and tassels were inclosed before the discharge of the pollen. When the pistils (silk) were in a receptive condition, the pollen was artificially applied, and thus crosses were made or at least attempted between varieties, as desired. The number of cases of cross-fertilization attempted was sixty-five, of which thirty-nine were successful and twenty-seven unsuccessful. Twenty-three of the successful cases were made on flint and dent varieties, of which eighteen presented no evidence whatever of the cross; in five cases doubtful evidences were detected. Of three successful crosses of soft corn, two presented unmistakable evidence of the cross, and the third showed no such effects. Of ten crosses of sweet corn, six showed plainly evidences of the cross, two were doubtful, and two presented no evidence whatever. Of three successful cases of pop corn, one presented no evidence of the cross, and the other two ears were accidentally destroyed before examination.

1888. W. W. TRACY: Experiments in Crossing Corn, Tomatoes, and Carrots. Eighteenth An. Rep. State Horticultural Society of Mich., 1888, p. 43.

In 1881, Cuzco corn, a soft variety, from Brazil, was fertilized with pollen from Black Mexican. As a result there were "obtained two quite good ears, many of the grains being black and wrinkled like sweet corn, others being white but wrinkled, still others being white and smooth like the variety. In 1882 the white wrinkled grains were planted where there was little chance of mixture. The tassels were carefully removed as they appeared, and in due season the silk was fertilized with Early Minnesota pollen, The result was quite a lot of ears, some showing all sweet grains, some nearly all of the Cuzco type; but I think none of them black, although some of them showed considerable red. The best ear was selected and the sweet grains planted in 1883 and the silk again fertilized with Early Minnesota. This season there was considerable black corn, there being much more color than in 1882. The best two ears were selected and planted and left to fertilize themselves. There was much less color shown this season than any year previous. In 1885 the best were planted, and no color appeared. In 1887 the best ears were planted, and no color showed. In 1888 the best two were planted, and this season a good many grains were as black as the Mexican, and some ears are as much marked with red or black as is the ordinary red blazed. I could not find that there was any red or black within a mile."

1889. WILLET M. HAYS: Improving Corn by Cross-Fertilization and by Selection. Bulletin No. 7, Minn. Exp. Station, pp. 27-33.

"About one hundred ears were covered with bags a few days before the silks appeared. The pollen from selected stalks was dusted upon the silks after these had reached the stage to receive it; the bags were then readjusted and left until all danger of other pollen entering had passed." . . . No ears were well filled, some were partially filled, and others produced no grains. Figures given of five ears obtained by crossing varieties of sweet with dent and flint, all of which showed the effects of the cross. . . .

"Many other interesting crosses were produced, some of which will be propagated and tested as to their value."

1889. R. P. SPEER: Experiments with Corn. Bulletin No. 7, Iowa Agr. Exp. Station. Nov. 1889, p. 53.

" Last July and August, 1 cross-fertilized and self-fertilized more than five hundred ears of corn, of different varieties. The work was performed carefully and all of the ears were covered at the proper times with very thin paper sacks; but when they were ripe, I did not save more than one-third of them for seed, as I found that I had made mistakes in using pollen of the inferior Arlene and McLain corn freely." Results, in general, as to effect of crossing, not reported.

PRELIMINARY STUDY OF THE RECEPTIVITY OF CORN SILK.

The following limited number of trials and observations were incidentally made in connection with other work on the corn plant.

The plot was of the Leaming variety, planted early, and, as the season was very favorable, it gave a very large yield; the ears inclosed in the sacks, however, were not so large as those not thus treated — a uniform result in all our experiments where the ears were inclosed for a time.

Cloth sacks used to prevent contact of pollen except as desired, were similar to those used in the experiments in cross-fertilization of varieties of corn heretofore reported.

The cases may be arranged as follows:

I. Silk exposed (and not reinclosed)

— 2 days after its first appearance. . . . *Result.* Ear well filled; length 7 5/8 inches; diameter 2 inches.

— 2 days after its first appearance. . . . . *Result.* Ear well filled, except at tip, length 7 inches, diameter 2 inches.

— 6 days after its first appearance. . . . . *Result.* Ear with but few scattering and imperfect grains on middle portion; length 9 inches.

— 8 days after its first appearance. . . . . *Result.* Ear with 34 grains scattered along the middle portion and tip; length 7 inches; smutted at tip.

— 10 days after its first appearance. . . . *Result.* Ear imperfectly filled on one side and tip, grains loose and inferior in size; length of ear 9 1/4 inches.

II. Silk exposed (during one day, then reinclosed)

— on the day of its first appearance. . . *Result.* Ear imperfectly filled at the tip, rows irregular; length 8 1/6 inches, diameter 2 1/8 inches.

— 2 days after its first appearance. . . . . *Result.* Ear fairly well filled, except at apex; length 6 1/2 inches.

— 3 days after its first appearance. . . . . *Result.* Ear not well filled at base, tip and on one side; length 6 3/4 inches, diameter 1 3/4 inches.

— 3 days after its first appearance. . . . *Result.* Ear not well filled in the upper half; length 5 5/8 inches, diameter 1 7/8 inches.

III. Silk exposed until 1 1/2 inches long, then inclosed

— Ear destitute of grains on middle portion of one side, length 3 1/4 inches, diameter 1 1/2 inches.

— Ear imperfectly filled at base, apex and one side of middle portion, length 4 3/4 inches, diameter 2 inches.

— Ear with 18 grains at base and one side of lower half of cob, length 6 1/4 inches, diameter 1 3/4 inches.

IV. Silk exposed by splitting down the husks, pollen applied, then inclosed

— Ear imperfectly filled at the very base, otherwise the lower portion (3/5) well filled and compact, upper 2/5 destitute of kernels, length 7 1/4 inches, diameter 2 1/8 inches, [On the fourth day after inclosure the silk was fresh. The sack was pushed up by the growing ear, and possibly did not exclude pollen.]

V. Silk exposed (to which an abundance of pollen was applied, and then the ear inclosed)

— when only 15 pistils (silks) protruded, *Result.* Ear with four scattered grains; length of cob 3 inches, diameter 1 1/8 inches.

— when only 25 pistils protruded. . . . . . *Result.* Ear with 13 scattered grains in middle portion; length 3 1/8 inches, diameter 1 1/4 inches.

— when 30 pistils protruded. . . . . *Result.* Ear with 32 grains clustered on one side of the middle portion; length 3 1/4 inches.

VI. Silk cut off and exposed (not previously in closed)

— when 1 1/2 inches long . . . . *Result.* Ear not well filled at base and along one side of lower half; length 5 5/8 inches, diameter 1 5/8 inches.

— when 6 inches long . . . . *Result.* Ear flattened and imperfectly filled at apex, middle portion imperfectly filled on one side; length 7 7/8 inches, diameter 2 inches.

— when 2 inches long . . . . *Result.* Ear not well filled at tip, otherwise grains compact; length 7 1/2 inches, diameter 2 1/8 inches.

— when 3 1/2 inches long . . . . *Result.* Ear imperfectly filled at base and on the upper third; length 8 7/8 inches, diameter 2 inches.

VII. Silk cut off and exposed (previously in closed)

— when 4 inches long	*Result.*	Ear imperfectly filled at base and tip, only a few scattering grains on the middle portion; length 7 7/8 inches, diameter 1 1/8 inches.
— when 5 to 6 inches long.	*Result.*	Ear well filled and compact, except a few imperfect grains in lower portion; length 8 inches, diameter 2 1/16 inches.

SUMMARY.

While the above trials are entirely too few in number upon which to base generalizations, it may yet be noted that some of the results accord with common observations.

Thus as seen in section I, the best results are obtained when the silk receives the pollen within a few days after its first emergence; after six or eight days the ears obtained are not perfect.

Exposure of the silk but one day as seen in section II, does not suffice for the fertilization of all the grains.

When the silk was exposed until 1 1/2 inches long and then inclosed so as to prevent farther pollination (see Sec. III), the ears were imperfectly filled.

In one case (Sec. IV) the silk was exposed by splitting down the husks, yet many of the pistils (silks) proved to be receptive.

When (Sec. V) a few pistils only protruded, and were dusted with pollen, still fewer grains were produced in two cases; in the third case two more grains were produced than the number of protruding pistils.

When the tips of the pistils (silks) are cut off, fertilization is not prevented (Sec. VI and VII); normal fertilization, however, is usually interfered with, but in some cases nearly perfect ears may result.

EXPLANATION OF THE PLATES.

PLATE I.—LOOSE SMUT OF OATS, *Ustilago Avenæ* (Persoon) Jensen.

All of the figures were drawn one and one-third natural size, and were reduced in photo-engraving to natural size.

Fig. 1 Head or panicle of oats, with all but the uppermost grains smutted.
Figs. 2, 3. small panicles, with all the grains smutted.

PLATE II.— LOOSE SMUTS OF WHEAT AND BARLEY, *Ustilago Tritici*, *U. Hordei*, and *U. nuda.*

All of the figures (except fig. 6) were drawn one and one-third natural size, and were reduced in photo-engraving to natural size. Figure 6 was drawn with a magnification of 8, and was reduced to 6 diameters.

Figs 1, 2 Loose Smut of Wheat, *Ustilago Tritici* (Persoon) Jensen.
Fig. 1. Minnesota specimen. (Coll. J. M. Holzinger, July 15, 1889, Winona.) A head smutted below, but sound above.
Fig 2 German specimen. (Coll. W. A. Kellerman, July 10, 1880, Göttingen) A completely-smutted head, much weathered.
Figs. 3-6, Covered Barley Smut, *Ustilago Hordei (Persoon)* Kellerman & Swingle.
Fig. 3. Kansas specimen. (Coll. Kellerman & Swingle, No. 1933, June 27, 1889, Manhattan.) A completely-smutted head.
Fig. 4 Denmark specimen. (Coll J. L. Jensen, 1889?) A completely-smutted head.
Figs. 5, 6. Canada specimens. (Coll, Jas, Fletcher, July 10, 1889, Ottawa, Can.) Fig.5, a smutted head yet partially held by the sheath of the highest leaf; fig, 6, a smutted spikelet magnified six diameters. All of the parts shown were somewhat smutted at the base.
Figs. 7-11 Naked Barley Smut, *Ustilago nuda* (Jensen) Kellerman & Swingle.
Fig. 7. Ohio specimen. (Coll W. A. Kellerman, May 30,1883, Lancaster.) A completely-smutted head, which has as yet lost but little smut.
Fig. 8. Denmark specimen. (Coll. J, L. Jensen, 1889?) A very much weathered smutted head, which has lost almost all its smut.
Fig. 9. Michigan specimen. (Coll. W. J. Beal, June 6, 1889, Eaton Co.) A completely-smutted head, which has shed a part of its spores.
Fig. 10. Austrian specimen. (Coll. F. de Thumen, June, 1874, Bayreuth, Franconia.) A very long awned head, smutted at the base and sound above.
Fig 11. Minnesota specimens. (Coll, J. M. Holzinger, June 15, 1889, Winona.) A completely-smutted head, with rather well-developed awns.

PLATE 111.—STINKING SMUT OF WHEAT *(Tilletia fcetens* and *T. Tritici).*

Figures 1 and 2 were drawn one and one-third natural size, and were reduced in photo-engraving to natural size. Figures 3-8 were drawn with a magnification of 8 diameters, and were reduced to 6 diameters.

Fig. 1. *Tilletia fœtens* (B. & C.) Trel Indiana specimens. (Coll. J. C. Arthur, July 17, 1889, Haw Patch.) A completely-smutted beardless head.
Fig. 2. *Tilletia fœtens* (B. & C.) Trel. lowa specimens. (Coll. E. W. Holway, August, 1884, Decorah; Ellis, N. A. F. 1497.) A completely-smutted bearded head.
Figs.3,4. Sound grains of wheat. Fig 3 in pro file., Fig 3 in pro file., fig. 4 in section.
Figs. 5-3. Smutted grains of wheat. Figs. 5 and 6 in profile; figs. 7 and 8 in section.

PLATE IV.—GERMINATION OF OAT SMUT, *Ustilago Avenæ* (Persoon) Jensen.

All of the figures were drawn with a Zeiss 2 mm. immersion apochromatic objective and 12 compensation ocular by means of an Abbe camera, giving a magnification of 2,000 diameters. They were reduced one-fourth in photo-engraving, so in the plate all are now magnified 1,500 diameters. All the specimens were from Manhattan, Kansas, and all the figures were drawn from spores germinated in water.

Fig. 1. Spore showing promycelium bearing a single sporidium; seen in profile.
Fig. 2 Showing one-septate promycelium, spore in profile.
Fig. 3. Showing beginning of a knee-joint; spore in profile.
Fig. 4. Showing simple promycelium,; spore in profile.
Figs. 5-15. Germinating spores seen in optical section.
Fig. 5. Showing narrow smooth-walled spore with branched promycelium.
Fig. 6. Showing germ-pore and the two layers of the cell-wall.
Fig. 7. Showing markings of the epispore and a perfect knee-joint.
Fig 8. Spore beginning to germinate.
Fig. 9. Spore showing plainly the germ-pore and broad promycelium.
Figs 10, 11, 12. Showing long simple Promycelium.
Fig 13 Showing long promycelium with a small knee-joint and a small vacant space.
Fig. 14. Promycelium showing an empty segment.
Fig. 15. Showing a remarkably long simple promycelium and epispore with markings.

PLATE V.—OAT SMUT, *Ustilago Avenæ* (Persoon) Jensen.

All the figures were drawn with a Zeiss 2 mm. immersion apochromatic objective and 12 compensation ocular by means of an Abbe camera, giving a magnification of 2,000 diameters. They were reduced two-fifths in photo-engraving, so in the plate all are now magnified 1,200 diameters.

Fig. 1. Kansas specimens, '88, 6 days in 25 per cent. sugar sol. at 23° C. An unusually light-colored spore, producing two short and swollen promycelia.
Fig. 2. Kansas specimen, '88, 67 hours in nutrient gelatine (Müncke) at 23° C.; see fig.15. A detached fragment of a promycelium having an opened knee-joint, and an outgrowth from near the original septum.
Fig. 3. Canada specimen, '89, 24 hours in mod. Cohn sol. at 23° C.; see figs. 8, 9, 10, 11, 22, 27, 30, 35, 36. A simple sporidium of the usual shape.

Fig. 4. Kansas specimen, '88, 46 hours in 10 per cent. sugar SOL at 23° C. A detached promycelium with empty base and swollen tip. Shows a knee-joint with outgrowth.
Fig. 5. Kansas specimen, '88, same cult. as in fig. 2, but in nutrient gelatine 3 days at 23° C. See fig. 24. Two sporidia united by a short tube.
Figs. 6, 7. Kansas specimens, '88, same cult. as in fig. 1, but in 25 per cent. sugar sol. only 5 days at 23° C. See figs. 20, 23, 26, 3, and 33.
Fig. 6. A dark-colored spore bearing two swollen, guttate promycelia; fig. 7, a spore with a swollen promycelium, and with its wall partly dissolved.
Figs. 8–12. Canada specimens. '89. same cult. as in fig.3 (24 hrs. in mod. Cohn sol at 23° C.). See figs. 22, 27, 30, 35, 36.
Fig. 8. A sporidium budded; fig. 9, a sporidium farther advanced in budding; figs. 10, 11, 12, simple sporidia.
Fig. 13. Kansas specimen '88, 44 hours 15 per cent. sugar sol. at 27° C. A sporidium (?) producing two germ tubes, which are appressed to the wall of the sporidium for a part of its length.
Fig. 14. Kansas specimen, '88, 22 hours in mod. Cohn sol. at 23° C. A spore with a short, sporidium-like

Fig. 15. Kansas specimen, same cult. as in fig. 2, 67 hours in nutr. gelatine at 23°C. A strongly-bent portion of a promycelium, having an evened knee-joint with a small outgrowth arising inside, as in fig. 2.
Figs. 16,17. Kansas specimens, '88, 24 hours in mod. Cohn sol. at 23° C. See fig. 21. A simple sporida.
Fig. 16. A rather unusually-pointed sporidium.
Fig. 18. Kansas specimen, '88, 21 days in weak sugar sol., which gradually evaporated until it became a thick syrup. A spore showing one very short promycelium and one long one filled with highly-refractive protoplasm
Fig. 19. Kansas specimen, '88, same cult. as in fig. 14, but 24 hours in mod. Cohn sol. at 23° C. A spore producing a three-septate promycelium, which bears sporidia at the septa. A very common form.
Fig 20. Kansas specimen, '88, same cult. as in figs. 6 and 7 (5 days in 25 per cent. sugar sol. at 23° C.). See figs. 23, 26, 31, and 33. Two tubes curiously twisted about each other, making 1½ turns. The one ending blankly, probably extended further, but could not be followed.
Fig. 21. Kansas specimen, '88, same cult. as in figs. 16 and 17 (24 hours in mod. Cohn sol. at 23° C.). A single very small sporidium.
Fig. 22. Canada specimen, same cult. as in figs. 3, 8, 9, 10, and 11 (24 hours in mod. Cohn sol at 23° C.). See figs. 27, 30, 35, 36. A sporidium with a long, slender bud.
Fig. 23. Kansas specimen, '88, same cult. as in figs 6, 7, and 20 (5 days in 25 per cent. sugar sol. at 23° C.). See figs. 26, 31, and 33. A detached promycelium distorted and grown out into several tubes.
Fig. 24. Kansas specimen, '88, same cult. as in fig. 5 (3 days in nutrient gelatine at 23° C.). Two sporidia fused by a short tube, *as* in fig.5.
Fig. 25. Kansas specimen. '88. same cult. as in fire. 14 and 19, but 40½ hours in mod. Cohn sol. at 23° C. See fig. 32. An unusually sharp-pointed sporidium.
Fig. 26. Kansas specimen, '88, same cult. as in figs. 6, 7, 20, 23 (5 days in 25 per cent. sugar solution at 23° C.). See figs. 31 and 33. A curiously distorted and swollen detached promycelium.
Fig. 27. Canada specimen, '89, same cult. as in figs 3, 8, 9, 10, 11, 22 (24 hours in mod. Cohn sol. at 23° C.). See figs 30, 35, 36. A germinated sporidium.
Figs. 28, 29. Kansas specimens, '88, 4 days in mod. Cohn sol. at 23-25° C.
Fig. 28. A Sporidium sending out a germ thread. Fig. 29, two sporidia sending out germ threads, which have fused.
Fig. 30. Canada specimen, '89, same cult. as in figs. 3, 8, 9, 10, 11, 22, 27 (24 hours in mod. Cohn. sol at See figs. 35, 36. Detached segments, or a sporidium which has become septate.
Fig. 31. Kansas specimen, 86, same cult. as in figs. 6, 7, 20, 23, 26 (5 days in 25 per cent. sugar sol. at 23° C); see fig. 33. A much bent swollen an promycelum.
Fig. 32. Fig. 32. Kansas specimen, '88, same cult. as in fig. 25 (40½ hours in mod. Cohn sol. at 23° C.) Two sporidia, or perhaps two segments, fused by an angled tube.
Fig. 33. Kansas specimen, '88 same cult. as in figs. 5. 6, 7, 20, 23, 26, 31 (5 days in 25 per cent. sugar sol. at 23° C). A bent and swollen detached promycelium.
Fig. 34. Kansas specimen, "88 me cult. as in figs. 25 and 32 (40½ hours in mod. Cohn sol. at 23 °C.). A single spordium with homogenous contents.
Figs. 35, 36. Fogs. 35., 36 Canada specimens, '89 same cult. as in figs. 3, 8, 9, 10, 11, 22, 27, 30 (24 hours in mod. Cohn sol. at 23° C.). Sporidia starting to bud or germinate into tubes.
Fig. 37. Kansas specimen, "88, same cult. as in figs. 25, 32, 34 (40½ hours in mod. Cohn sol. at 23° C.). A spore with promycelium which has an opened knee-joint and an attempted (?) knee-joint fusion.
Fig. 38. Kansas specimen, '88, grown in mod. Cohn sol. at 23° C. A very long, attached Promycelium, angled strongly at the two knee-joints, which have opened.
Figs 39-44. Kansas specimens (Manhattan, July 14, '89). spores in water; figs. 40 and 43, in optical section, fig. 43 showing the two layers of wall only on dark side.
Fig. 42. Shows a shrunken spore.
Figs. 45-49. German specimens. (Göttingen, July 10, 1880.) Spores in water. Fig. 46, a small shrunken spore; figs. 47 and 49 in optical section.
Fig. 50-55. Kansas specimens. (Manhattan, July 20, 1889.) Spores in water. Figs. 51, 53, 55, deformed

Figs. 56,57. *Ustilago Avenæ*, var. LEVIS. New Hampshire specimens. (Shelburne, N. H., Aug., 1882, N. A. F. 1091.) Spores in water, Fig. 57, in optical section, shows the thick, apparently simple wall, and a central granule in the protoplasm.
FIgs. 56-60. *Ustilago Avanæ*. Kansas specimens. (Manhattan, July 19, 1889.) Spores in water. Fig. 60, in optical section, shows two layers of the wall only on the dark side.

PLATE VI-LOOSE SMUT OF WHEAT, *Ustilago Tritici* (Persoon), Jensen.

Figures drawn as in Plate V, magnified 2,000 diameters, and reduced to 1,200 diameters. All the figures are of Ustilago Tritici, except 15 and 33, which are of Ustilago Avenæ.

Figs. 1-3. Minnesota specimens, '89, (J. M. Holzinger, Winona, July 15.) Spores treated with chloriodide of zinc one-half hour.
Fig. 1. A spore deeply stained; fig. 2, a spore which failed to stain, collapsed, seen from above; fig. 3, same from side.

Figs. 4-8. Italian specimens, '89, (Briosi e Cavara, F. par. No. 54.)
Figs 4 and 6 in optical section. In fig. 6 the wall can be seen only on the dark side.

Fig. 9. New York specimen. '89, (Underwood & Cooke. Cent. of Illust. Fungi. No. 56.) 17 hours in pure water at 236 C, See fig.11, a spore producing a simple one-septate promycelium.

Fig. 10. New York specimen '89, 4 days in mod. Cohn sol. at 23°C. See figs. 12, 16, 18, 34, and 36. A detached segment budding at both ends? There is some doubt as to whether this is from the wheat smut or not.

Fig. 11. New York specimen, same cult. as in fig 9 (17 hours in pure water at 23° C.). A spore having a two-septate promycelium, which has the terminal and basal segments vacant.

Fig. 12 New York specimen, same cult, as in fig. 10 (4 days in mod. Cohn sol. at 23° C.). See figs 16, 18, 34, 36. A segment germinating? This, like fig. 10, is doubtful.

Fig. 13. New York specimen, same cult, as in figs, 10 and 12, but in mod. Cohn sol. only 46 hours at 23°C. A promycelium of the typical form, showing slender branches and several vacant segments.

Fig. 14. Minnesota specimen, 24 hours in mod. Cohn sol at 23° C. See figs. 17, 19, 35, 37. A long and swollen promycelium with a sterile base.

Fig. 15. Oat Smut, *Ustilago Avenæ*, Kansas specimen, in 25 per cent. sugar sol. See fig. 33. A much-swollen promycelium. This figure, as well as fig. 33, was included in this plate by mistake.

Fig. 16. *Ustilago Tritici*, New York specimen, same cult. as in figs. 10 and 12 (4 days in mod. Cohn Sol. at 24°C.). See figs. 18, 34, 36. Apparently a detached promycelium, each segment of which sent out tubes.

Fig. 17. Minnesota specimen, same cult. as in fig. 14 (24 hours in mod. Cohn sol. at 23°C.). See figs. 19, 35, 37. A fine attached promycelium of the usual form, showing excessive branching and curved growth.

Fig. 18. New York specimen, same cult. as in figs. 10, 12 and 16 (4 days in mod. Cohn sol. at 23° C.). See figs. 34,36, Apparently segments germinating. The forms represented in figs. 10, 12, 16, 18, 36 were seen only in one culture. and may possibly have come from some impurity in that culture.

Fig. 19. Minnesota specimen, same cult. as in figs. 14 and 17 (24 hours in mod. Cohn sol. at 23° C.). See figs. 35, 37. A spore swollen and cracked.

Figs. 20-22. German specimens, (Gottingen, July 10, 1880.) Spores in water. Fig. 20 has collapsed.

Figs. 23-26, Minnesota specimens. Spores in water. Fig. 26, in optical section.

Figs. 27-32. New York specimens. Spores in water. Figs. 28 and 29, in optical section. In fig. 29 the walls can be seen only on the dark side.

Fig. 33. Oat Smut, *Ustilago Avenæ*. Same as fig. 15. A swollen promycelium, with highly–refractive contents.

Fig. 34. *Ustilago Tritici.* New York specimen, same cult. as in figs. 10, 12, 16, 18 (4 days in mod. Cohn sol at 23°C.). See fig. 36. A fine promycelium with two main branches, one of which bears two slender branches with slihtly-swollen tips

Fig 35. Minnesota specimen, same cult. as in figs. 14, 17, 19 (24 hours in mod. Cohn sol at 23°C.). See fig. 37. A typical promycelium, much like the one shown in fig, 17, except smaller.

Fig. 36. New York specimen, same cult. as in figs. 10, 12, 16, 18, 34 (4 days in mod. Cohn sol at 23°C.). A detached segment? Doubtful.

Fig. 37. Minnesota specimens, same cult. as in figs, 14, 17, 19, 35 (24 hours in mod. Cohn sol. at 23°C.). A spore with a very short, swollen promycelium. The wall of the spore is apparently simple.

PLATE Vll.—COVERED BARLEY SMUT, Ustilago Hordei (Persoon) Kellerman & Swingle.

The figure drawn as in Plate V, magnified 2,000 diameters, and reduced *to 1,200 diameters. All the figures are of Ustilago Hordei on cultivated barley.*

Fig. 1-13. Kansas specimens,'89, 10 days in mod. Cohn sol; after this, again started, and figured after being 20 hours in mod. Cohn sol. at 23°C. See figs. 17, 31, and 53. sporidia of various forms; figs, 1, 2, 7, 10 and 13 are in various stages of budding; fig. 6 has a very delicate hyaline piece (of promycelium?) attached to one end; fig. 10 is septate, and is, perhaps, a part of a promycelium.

Fig. 14. Kansas specimen, '89, same cult. as in figs. 1-13, but 8 days in mod. Cohn sol at 23° C. See figs. 24, 29, A swollen sporidium, with a smaller daughter cell.

Fig. 15. Denmark specimen. '89, 66 hours in mod. Cohn sol. at 23°C. See figs. 18, 28, 56. A large budding sporidium.

Fig. 16. Canada specimen, 89, 21½ hours in mod. Cohn sol. at 23°C. See figs. 42, 55, 57. A spore showing the opening where the promycelium arises from the inside (by optical section). The attached promycelium shows two knee-joints, both grown out to some length.

Fig. 17. Kansas specimen, same cult. as in figs. 1-13 (10 days in mod. Cohn sol., then again started in fresh mod. Cohn sol., and figured after 20½ hours at 23°C.). See figs. 31 and 53. A detached, very much swollen promycelium, just producing a sporidium from one side.

Fig. 18. Denmark specimen, same cult. as in fig. 15 (66 hours in mod, Cohn sol. at 23° C.). See figs. 28 and 56. A sporidium just budding.

Fig. 19. Kansas specimen, 21½ hours in mod. Cohn sol at 23°C. See figs. 25, 26, 30, 44, 47, 49, and 52. A more showing a dark band across the middle, and two light areas. Promycelium swollen, curiously branched.

Figs. 20, 21. New Hampshire specimens. (Ellis N. A. F. 1091.) See figs. 32-39, and 54. Spores in water. Fig, 20, a distorted spore showing a narrowed end. (The unnumbered spore between figs. 16 and 19 is also from this locality.)

Figs. 22, 23. Denmark specimens. Same culture as in figs. 15 and 18, but 71 hours in mod. Cohn sol. at 23°C. See fig. 46. Densely granular, much-swollen segments of promycelium, or else sporidia.

Fig. 24. Kansas specimen. Same cult. as in fig. 14 (8 days in mod, Cohn sol. at 23° C.). See fig. 29. Germinated sporule or segment of promycelium.

Figs. 25,26, Kansas specimens. Same cult. as in fig. 19 (21½ honrs in mod. Cohn sol. at 23° C.). See figs. 30, 44, 47, 49, and 52.

Fig. 25. A germinated spore showing two promycelia, and having a dark band across the middle and two light areas.

Fig. 26. Sporidia or segments, one of which is beginning to sprout.

Fig. 27. Kansas specimen, 21½ ,hours in pure water at 23° C. See figs.43, 45. A common form, showing a branched promycelium, and a sporidium just starting to grow.

Fig. 28. Denmark specimen. Same culture as in figs. 15 and 18 (66 hours in mod. Cohn sol. at 23° C.). See fig. 56. A small sporidium.
Fig. 29. Kansas specimen. Same cult. as in figs. 14 and 24 (8 days in mod. Cohn sol. at 23° C.). A distorted promycelium having only a single living segment, which is much swollen.
Fig. 30. Kansas specimen. Same cult. as in figs. 19, 25, and 26 (21½ hours in mod. Cohn sol. at 23° C.). See figs. 44, 47, 49, and 52. A germinated spore with wall about promycelium dissolved away. The promycelium is much swollen, but is narrowly contracted (where it originally passed through the wall).
Fig. 31. Kansas specimen, same cult. as in figs. 1-13, and 17 (10 days in mod. Cohn sol., then again started, and figured after being 20½ hours in mod. Cohn sol at 23° C.). See fig. 53. A curiously swollen distorted promycelium just giving rise to a sporule.
Figs. 32-39. New Hampshire specimens. (EIlis, N. A. F. 1091.) Same as in figs. 20 and 21. See fig.54. Spores in water. Figs. 32, 35, and 39 in optical section; fig. 35 is abnormal—is really a double spore.
Figs. 40, 41. Kansas specimens, treated with reägents.
Fig. 40. Treated with chlor-iodide of zinc a short time. The contents are strongly colored. Fig. 41 treated with nitric acid 24 hours. Shows swollen spore with contents consolidated at the center.
Fig. 42. Canada specimen, same cult. as in fig. 16 (21½ hours in mod. Cohn sol. at 23° C.). See figs. 55 and 57. A typical promycelium from which two sporidia are growing.
Fig. 43. Kansas specimen, same cult. as in fig.27 (21½ hours in pure water at 23° C.). See fig.45. Shows a slender tube arising at the base of the promycelium, and fusing with it twice (?). A common form.
Fig. 44. Kansas specimen, same cult. as in figs. 19, 25, 26, and 30 (21½ hours in mod. Cohn sol. at 23° C.). See figs. 47, 49, and 52. A pair of detached segments united in knee-joint fusion.
Fig. 45. Kansas specimen, same cult. as in figs.27 and 43 (21½ hours in pure water at 23° C.). A promycelium with a slender branch arising from its base. which fuses with another detached promy-

Fig. 46 Denmark specimen, same cult. as in figs. 22 and 23 (71 hours in mod. Cohn sol. at 23° C.). An enormously swollen promycelium, with a knee-joint fusion.
Fig. 47. Kansas specimen, same cult. as in figs. 19, 25, 26, 30, 44 (21½ hours in mod. Cohn sol. at 23° C.). See figs. 49 and 52. Spore with swollen promycelium starting to grow out from the end.
Fig. 48. Denmark specimen, same cult. as in figs. 15, 18, 28, but in mod Cohn sol only 41 hours at 23° C. A large, swollen, many-septate, branched promycelium.
Fig. 49. Kansas specimen, same cult. as in figs. 19, 25, 26, 30, 44, 47 (21½ hours in mod. Cohn sol. at 23° C.). See fig. 52. A promycelium sending out two slender tubes, one from the tip and one from the base
Figs. 50,51. Denmark specimens, same cult. as in figs.15, 18, 28, 48, but in mod. Cohn sol. only 22 hours at 23° C. A fine fusion between two promycelia that are still attached.
Fig. 52. Kansas specimen, same cult. as in figs. 19, 25, 26, 30, 44, 47, 49 (21½ hours in mod. Cohn sol. at 23° C.). A fusion between an attached and a detached promycelium.
Fig. 53. Kansas specimen, same cult. as in figs. 1-13, 17, and 31 (10 days in mod. Cohn sol, then again started in fresh mod. Cohn sol, and figured after 201/2 hours at 23°C.). A swollen, detached promycelium, from which a primary sporidium has arisen and itself produced a secondary sporidium.
Fig. 54. New Hampshire specimen (Ellis, N. A. F., No. 1091); same as in figs. 20, 21, 32-39. A spore in optical section, showing a thick, apparently simple, wall.
Fig. 55. Canada specimen, same cult. as in figs. 16 and 42 (21½ hours in mod. Cohn sol at 23° C.); see fig.57. A sporidium just budding.
Fig. 56. Denmark specimen, same cult. as in figs. 15, 18, and 28 (66 hours in mod. Cohn sol. at 23° C.). Apparently a small segment of a promycelium.
Fig. 57. Canada specimen, same cult. as in figs. 16, 42, and 55 (21½ hours in mod. Cohn sol. at 23° C.). A detached fragment of a promycelium.
Fig. 58. Kansas specimen, same cult. as in figs. 14, 24, and 29 (8 days in mod. Cohn sol. at 23° C.). A swollen segment which has germinated.

PLATE VIII.—NAKED BARLEY SMUT *Ustilago nuda* (Jensen) Kellerman & Swingle.

The figures drawn as in Plate V, magnified 2,000 diameters, and reduced to 1,200 diameters. All the figures are of Ustilago nuda on cultivated barley.

Figs. 1,2. Minnesota specimens, '89, 28 hours in mod. Cohn sol. at 23° C. See figs. 7, 8, 10, 13, 17. Germinated spores with short simple promycelia. Fig. 1 in optical section. Fig. 2 shows wall partially dissolved.
Figs. 3, 4. Michigan specimens, '89, 42 hours in pure water at 23° C. Germinated spores with simple promycelia fig. 4 in optical section, promycelium remarkable long.
Figs. 5, 6. Michigan specimens, 27 hours in mod. Cohn sol. at 23° C. See fig. 16.
Fig. 5. A fusion between the tip of the promycelium and a tube arising at its base. Fig. 6. A slightly swollen promycelium having two knee-joints.
Figs, 7, 8. Minnesota specimens, same cult. as in figs. 1 and 2 (28 hours in mod. Cohn sol. at 23° C.). See figs. 10, 13, 17.
Fig. 7. Spore in optical section with a long, somewhat branched promycelium. Fig, 8, a much-branched detached promycelium.
Fig. 9. Michigan specimen, same cult. as in figs. 5 and 6, but 75 hours in mod. Cohn sol. at 23° C. See figs. 12, 14, 15. A detached promycelium with characteristic much-swollen ends.
Fig. 10. Minnesota specimen, same cult. as in figs. 1,2, 7, and 8 (26 hours in mod. Cohn sol. at 23° C.). See figs. 13 and 17. A swollen cracked spore.
Fig. 11. Michigan specimen, 46 hours in 25 per cent. sugar sol. at 23° C. A spore in optical section with a promycelium of the common form.
Fig. 12. Michigan specimen, same cult. as in fig. 9 (75 hours in mod. Cohn sol at 23° C.). See figs. 14 and 15, A much-swollen attached promycelium apparently bent near end, and bearing short-crossed branches, spore in optical section.
Fig. 13. Minnesota specimen. Same cult. as in figs. 1, 2, 7, 8, and 10 (28 hours in mod. Cohn sol at 23° C.). See fig. 17. A somewhat swollen detached promycelium about to fall to pieces.
Figs. 14, 15. Michigan specimens. Same culture as in figs. 9 and 12 (75 hours in mod. Cohn sol. at 23° C.).

Fig. 14. A spore in optical section bearing a promycelium consisting of two main branches extended in opposite directions in the same line. The upper branch shows an irregular contour: fig. 15, a spore in optical section bearing a strongly angled promycelium with a much-swollen-tip.

Fig. 16. Michigan specimen. Same culture as in figs. 5 and 6 (27 hours in mod. Cohn sol. at 23° C.). A remarkably bent, branched promycelium.

Fig. 17. Minnesota secimen, same cult. as in figs. 1, 2, 7, 6, 10 and 13 (24 hours in mod. Cohn sol. at 23° C,). A spore in optical section bearing a branched promycelium, which is vacant except at the base.

Figs. 18-21, Michigan specimens; spores in water. Figs. 18 and 21, unusually long and narrow spores; fig, 21, a very light-colored spore.

Figs. 22-27. New York specimens, '86; spores in water. Figs. 22 and 26, in optical section; fig. 24, a spore abnormal in shape; fig. 27, a narrow spore.

Figs. 28-30. Denmark specimens. (From a much weathered head; see Plate 11, fig. 8.) Spores in water. Fig. 28, an optical section showing the germ spore; figs. 29 and 30, profile views showing the same.

Figs. 31-33, Iowa specimens, '84. Spores in water. Fig. 32, a collapsed spore; fig. 33, an optical section.

Figs. 34-38. Ohio specimens, '83. Spores in water. Fig. 34, a spore in optical section.

PLATE IX.—NATURAL ENEMIES OF SMUTS.

Fig,. 1-14 and 16-19 were drawn magnified 800 *diameters, and reduced in photo-engraving to 600* diamelers. *Fig. 16 was drawn at 400, and reduced to 300. Figs. 20-22 were magnified 20 diameters, and reduced to 15.*

Figs. 1,2. Mycelium of *Fusurium Ustilaginis*, Kell. & Sw.
Figs. 3,4. Simple spores of the same.
Figs. 5-13. Septate spores of the same.
Fig. 14. Young spore of *Macrosporium utile Kell & Sw*
Figs. 15-17. Hyphae of the same.
(Fig. 15 magnified 300 diameters.)
Figs. 18 and 19. Mature spores of the same.
Fig. 20. A smut-eating beetle, *Brachytarsus variegatus* Say.
Fig. 21. A smut-eating beetle, *Phalacrus* sp.
Fig. 22. Same, side view.

PLATE X.—CROSSED CORN THE FIRST YEAR.

From phonograph; the scale at the margin gives size in inches.

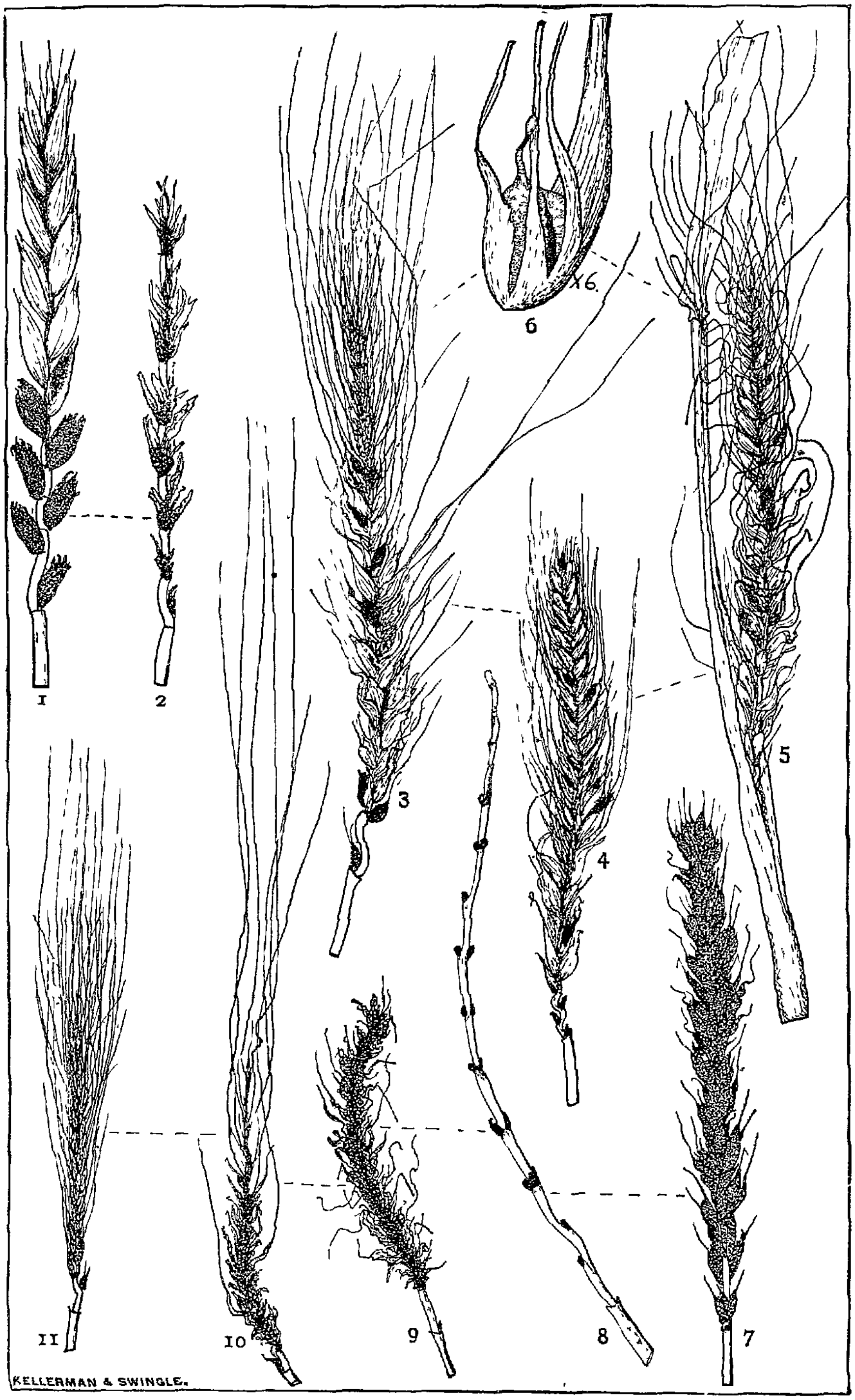
No. 57. Longfellow fertilized with pollen from Normandy Giant.
No. 59. Self-Husking fertilized with pollen from Comptons Early.
No. 88. Farmer's Favorite fertilized with pollen from Big Buckeye.
No. 89. Farmer's Favorite fertilized with pollen from Shannon's Big Tennessee White
No. 144. St. Charles fertilized with pollen from Normandy Giant.
No. 157. Yellow Mammoth fertilized with pollen from Maryland White Dent.

PLATE XI.—CROSSED CORN THE SECOND YEAR.

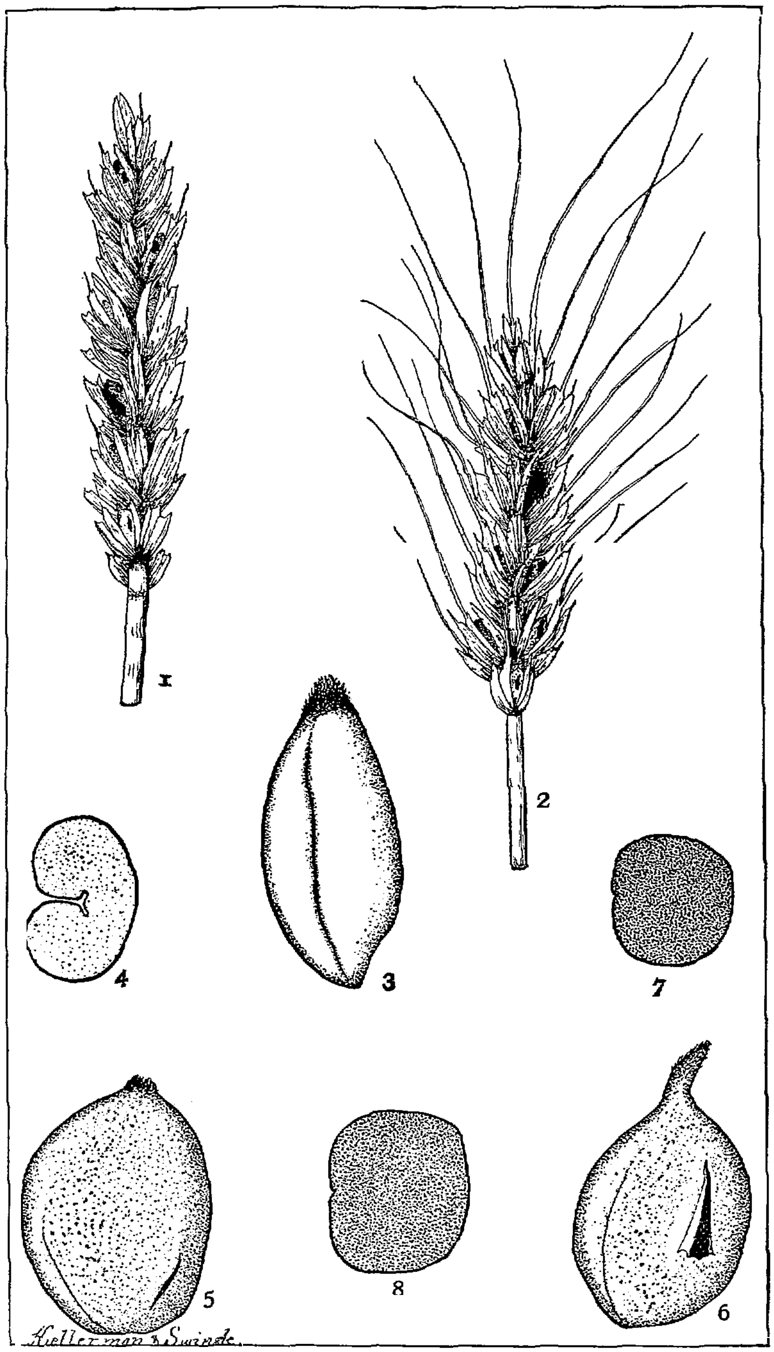
From photograph; the scale in the center indicates size in inches.

No. 24. From seed of White Flat Ensilage fertilized with pollen from Landreth Sugar.
No. 25. From seed of Calico fertilized with pollen from Adams's Early Table.
No. 26. From seed of Adams's Early Table fertilized with pollen from Western King Philip.
No. 38. From seed of Breck's Premier Sugar fertilized with pollen from Compton's Early.
No, 41. From seed of Rice Pop-Corn fertilized with pollen from Breck's Boston Market Ensilage.

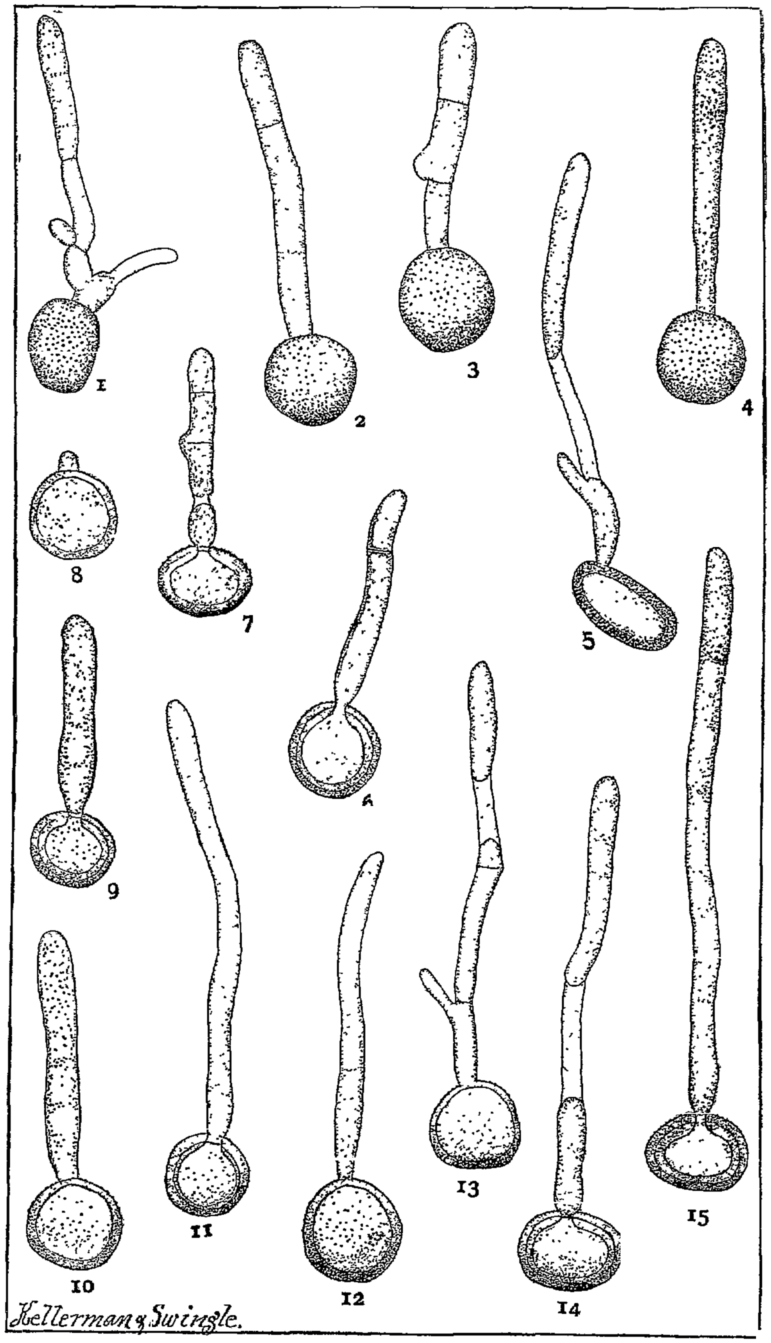
SMUT OF OATS.



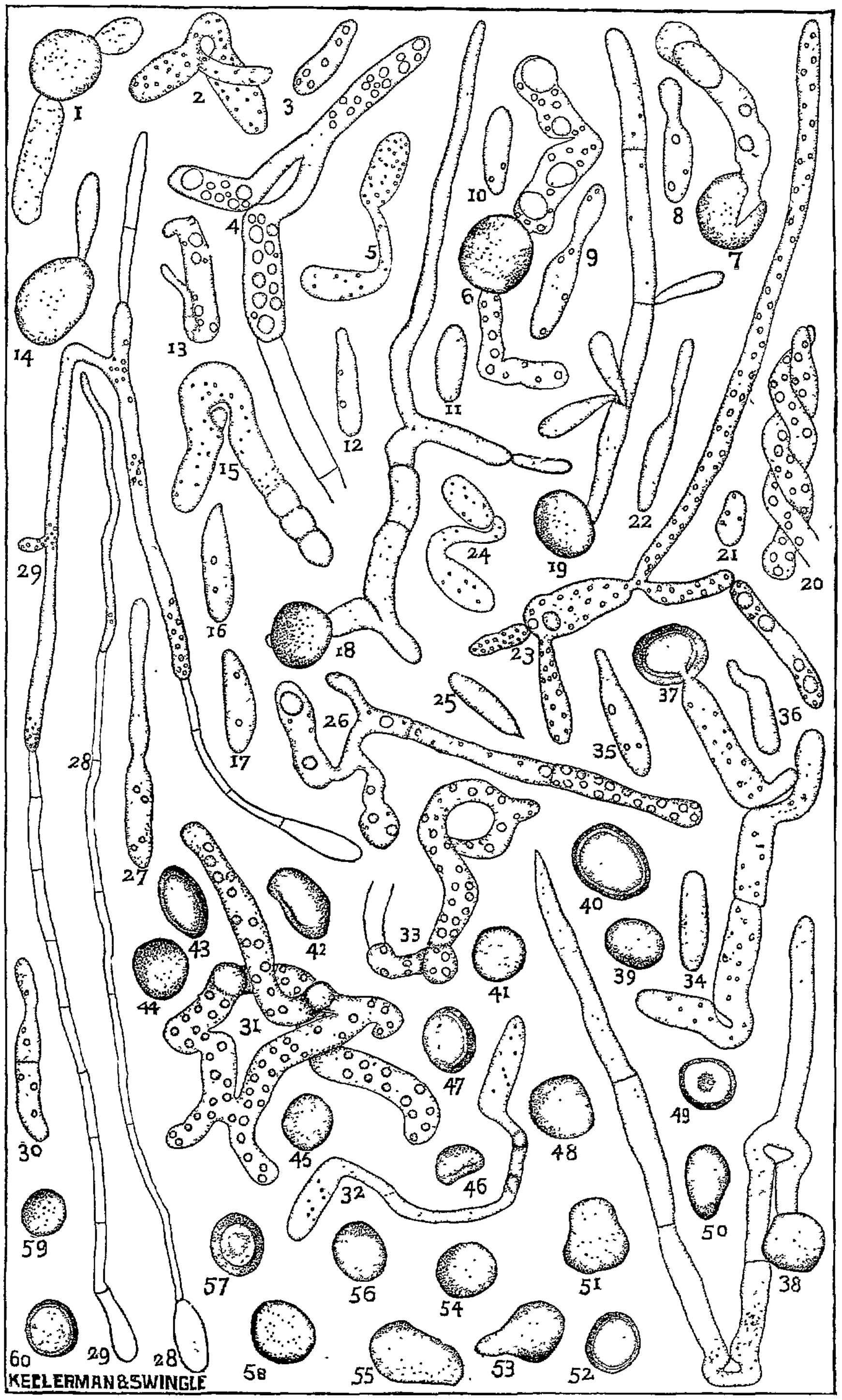
LOOSE SMUTS OF WHEAT AND BARLEY.



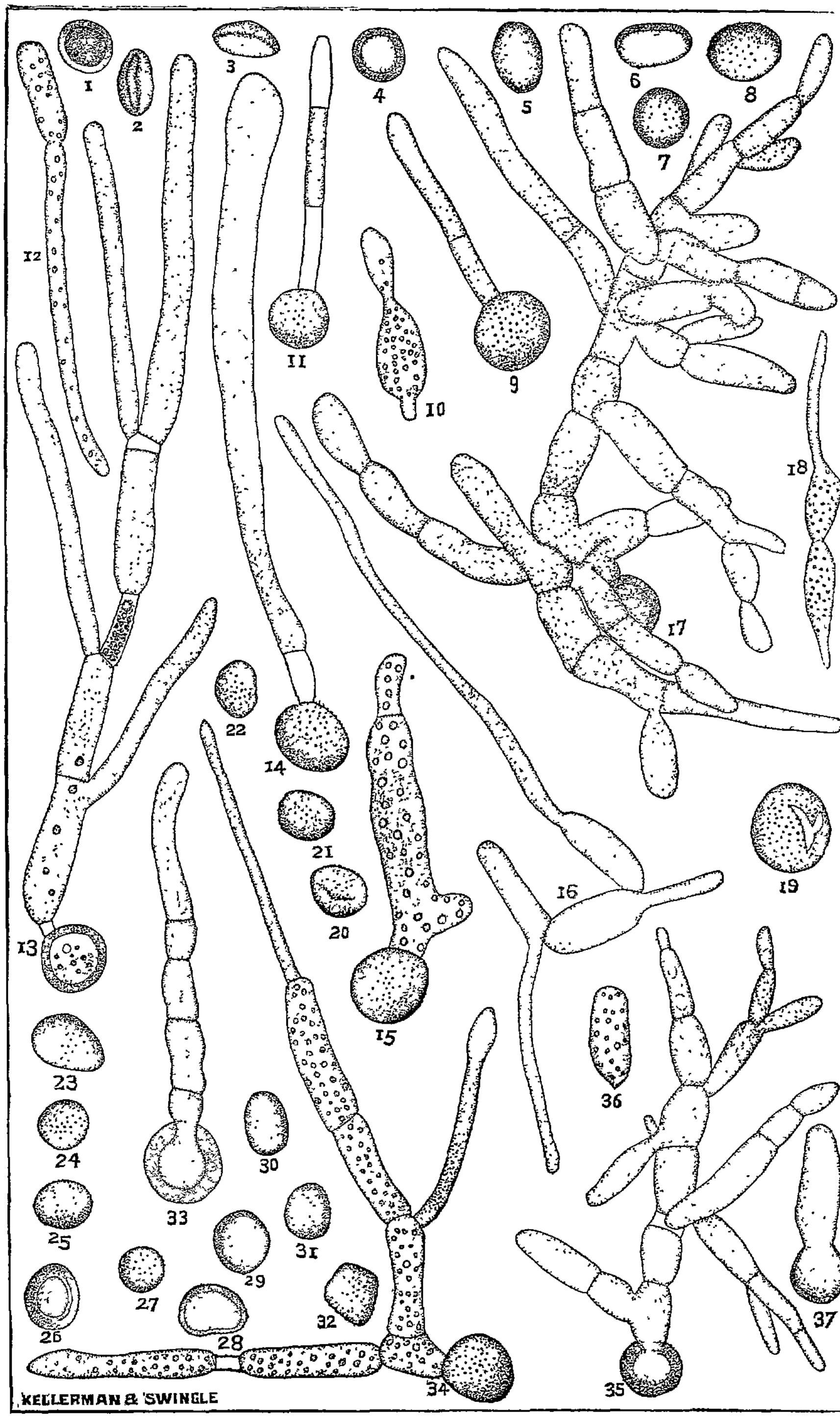
STINKING SMUT OF WHEAT.



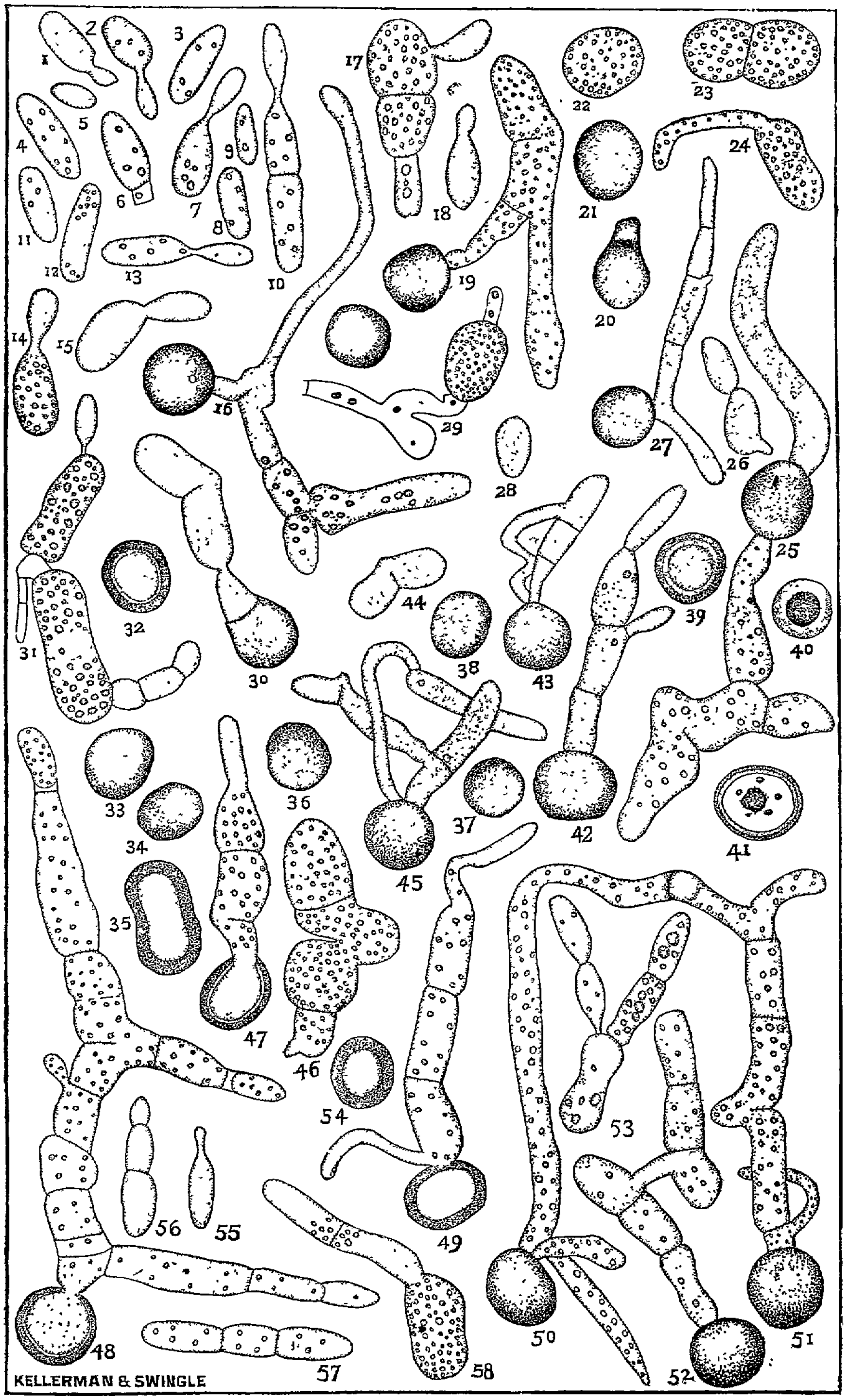
GERMINATION OF OAT SMUT.



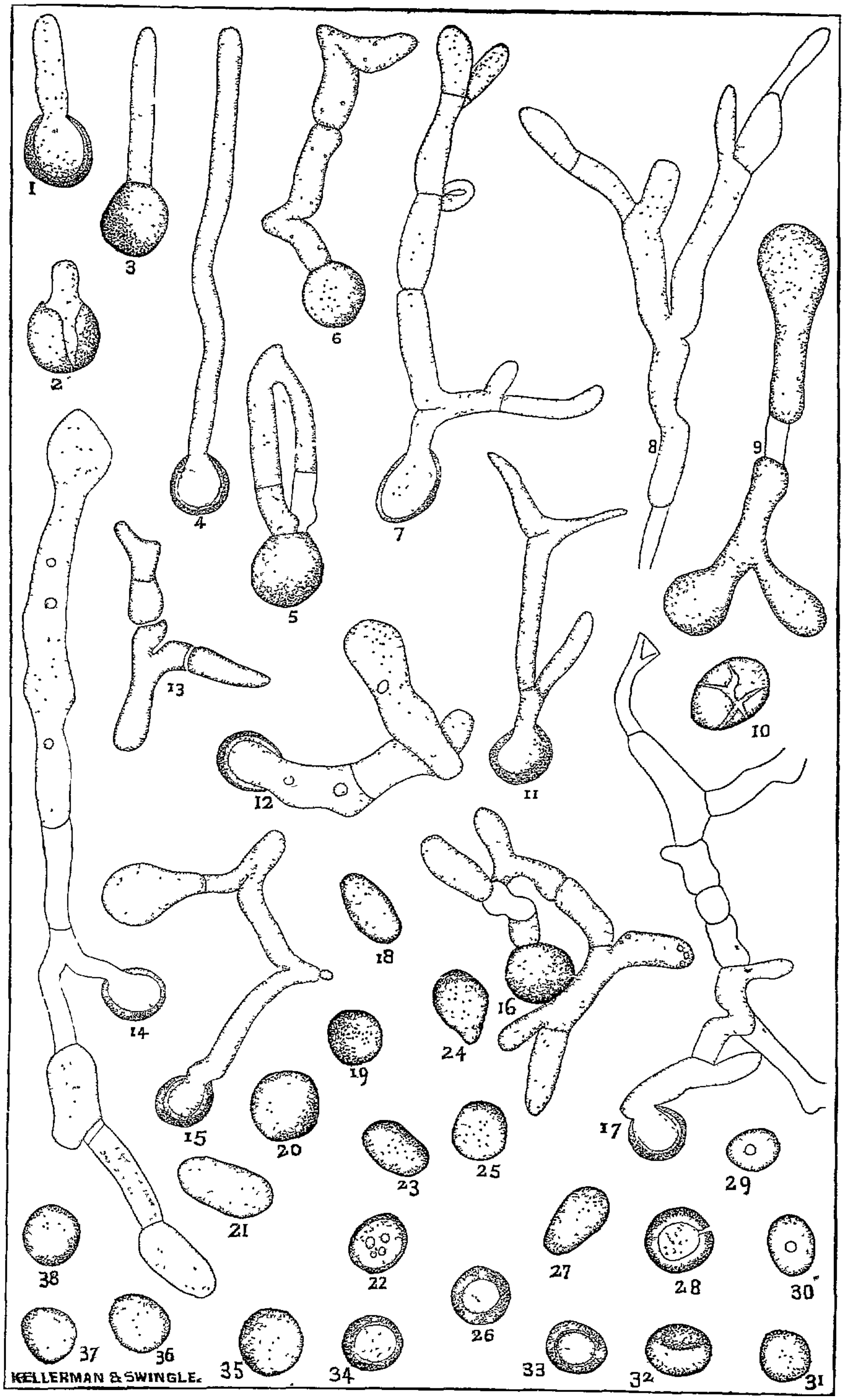
GERMINATION OF OAT SMUT.



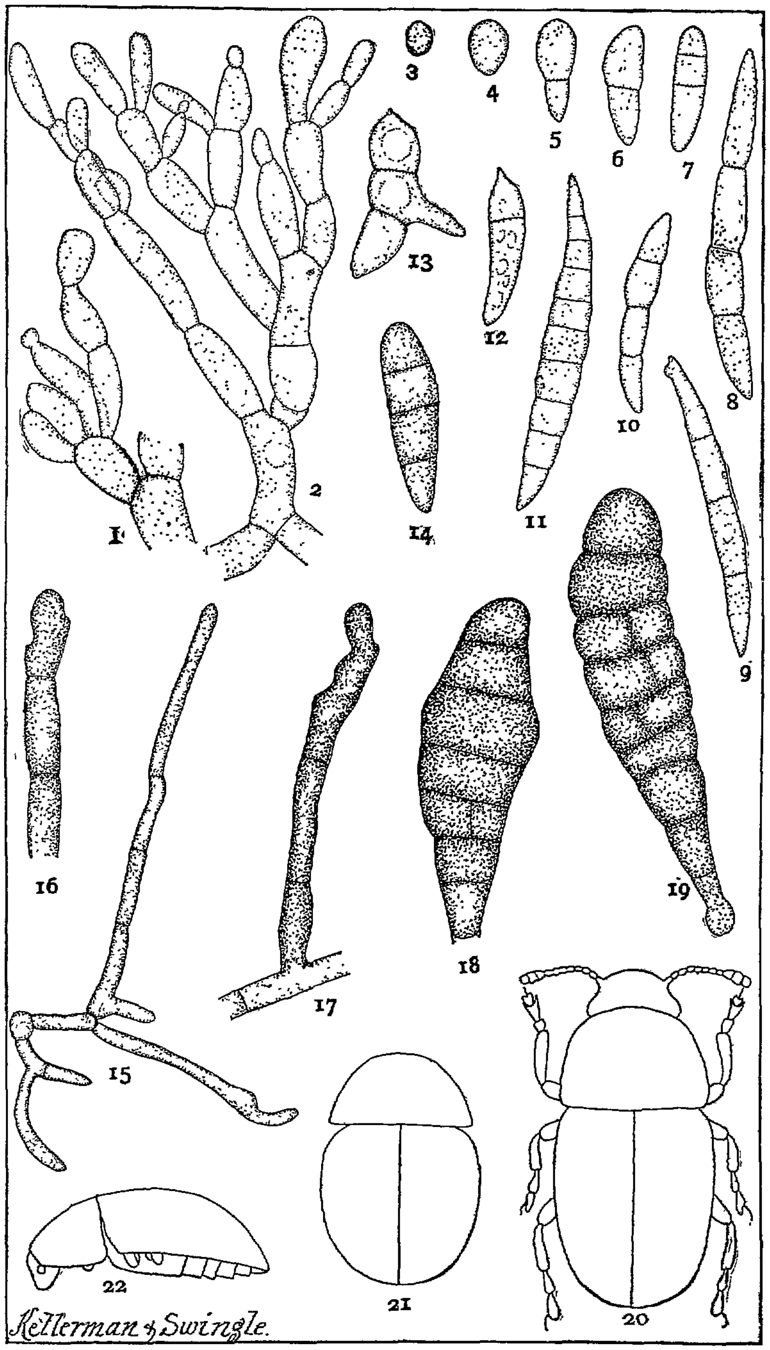
GERMINATION OF LOOSE SMUT OF WHEAT.



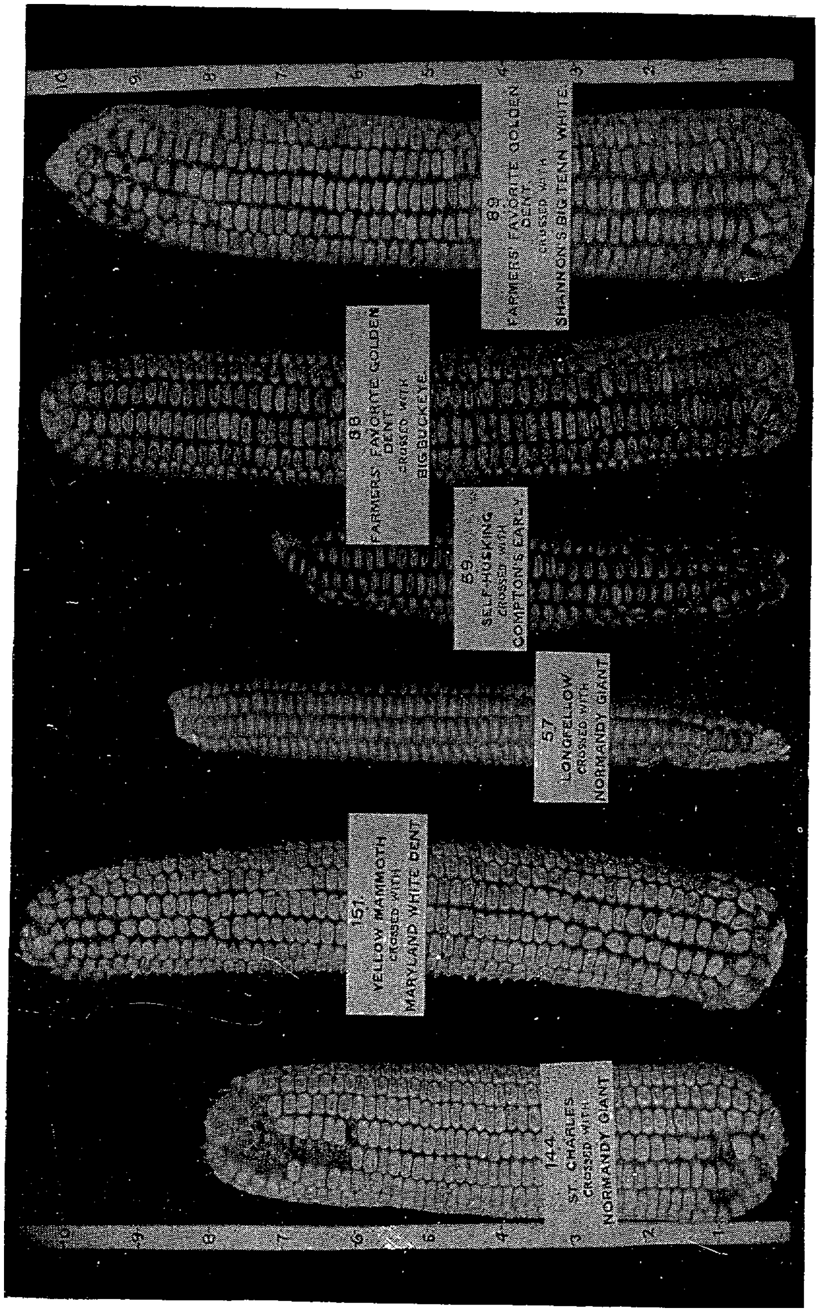
GERMINATION OF COVERED BARLEY SMUT.



GERMINATION OF NAKED BARLEY SMUT.

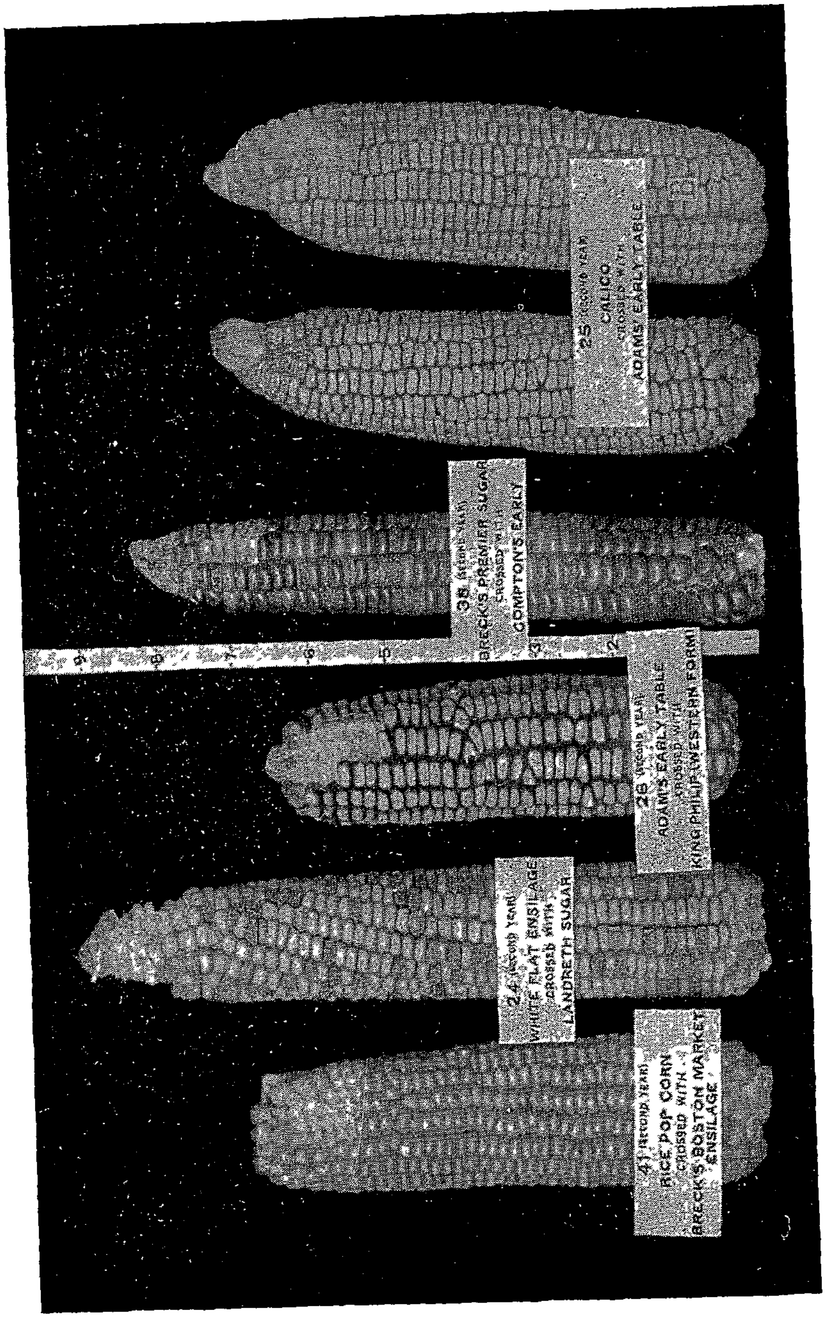


NATURAL ENEMIES OF SMUT.



[Photographed by Kellerman & Swing.]

CROSSED CORN-FIRST YEAR.



[Photographed by Kellerman & Swingle.]

CROSSED CORN–SECOND YEAR.