UNIVERSITY OF MINNESOTA.

EXPERIMENT STATION

OF THE

COLLEGE OF AGRICULTURE,

ST. ANTHONY PARK, RAMSEY CO., MINN.

APRIL, 1889.

BULLETIN NO. 7.

AGRICULTURE:

SOIL TEMPERATURES. COMPARATIVE TESTS OF VARIETIES OF CORN FOR ENSILAGE. WARM AND COLD WATER FOR STOCK. SELECTION AND CROSS-FERTILIZATION OF CORN. WASHING AND SALTING BUTTER.

HORTICULTURE:

CONSTRUCTION OF GREEN-HOUSE WALLS. COMPARATIVE TESTS OF VARIETIES OF POTATOES.

CHEMISTRY:

THE CHEMISTRY OF WHEAT UNDER VARIOUS CONDITIONS.

VETERINARY:

INFLUENCE OF FOOD UPON THE FORMATION OF THE SKULL AND TEETH OF PIGS.

AGRICULTURAL
EXPERIMENT STATION
OF THE
UNIVERSITY OF MINNESOTA.

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ST. ANTHONY PARK, MINN., March 21, 1889.

Hon. H. H. Sibley, President of the Board of Regents of the University of Minnesota:

DEAR SIR:—Eight years ago you honored me with the charge of the chair of theoretical and practical agriculture in the above institution. During that period I have devoted my entire time and energies to the development of your experimental farm, the system of farmers' institutes, the school of agriculture, and the agricultural experiment station of the University of Minnesota. All these departments of my work are now fully organized and equipped with lands, buildings, stock, implements, machinery and men, and are in successful operation. The expansion of the work requires for the best results, a division of labor and responsibility, and in order to relieve the board of regents of any embarrassment, and to enable them to make such a redistribution of the work as will best serve the interests of agriculture in Minnesota, I hereby present my resignation, to take effect at such time, as the board of regents may deem advisable. With the best wishes for the success of the work in which we have been mutually engaged, I remain, yours respectfully,

EDWARD D. PORTER.

Professor of Agriculture and Director of Experiment Station.

MINNEAPOLIS, MINN., March 23, 1889.

Prof. Edward D. Porter, St. Anthony Park, Minn.

DEAR SIR:—At a meeting of the Board of Regents of the University of Minnesota, held at the Capitol, St. Paul, March 21, 1889, the following resolutions were unanimously adopted, after your resignation had been accepted:

Resolved, That, in accepting the resignation of Prof. E. D. Porter, as Director of the Experiment Station and Professor of Agriculture in the University of Minnesota, the Board of Regents are not unmindful of the valuable services which have been rendered by him to the University and to the cause of agricultural education, during his years of service. The Board desire to put on record their high sense of the untiring industry, energy and zeal exhibited by him in his work, of the sagacity and foresight with which he planned for the purchase and development of the University Farm and Experiment Station, of the great ability and learning which have enabled him successfully to meet the requirements of his exacting position, and of the honorable character and gentlemanly bearing exhibited by him in all his intercourse with the Board. Very Truly Yours,

CYRUS NORTHROP,

Corresponding Secretary of the Board of Regents.

At a subsequent meeting of the board of regents, Prof. N. W. McLain, apicultural agent of the department of agriculture, Washington, was elected Director of this station, and will enter upon his duties immediately; all communications relating to the general work of the station, should hereafter be directed to him, but letters and inquiries, concerning special lines of work, should be sent to the officer in charge of that division.

EDWARD D. PORTER, Director of Experiment Station,

St. Anthony Park, Ramsey Co., Minn.

DIVISION OF AGRICULTURE.

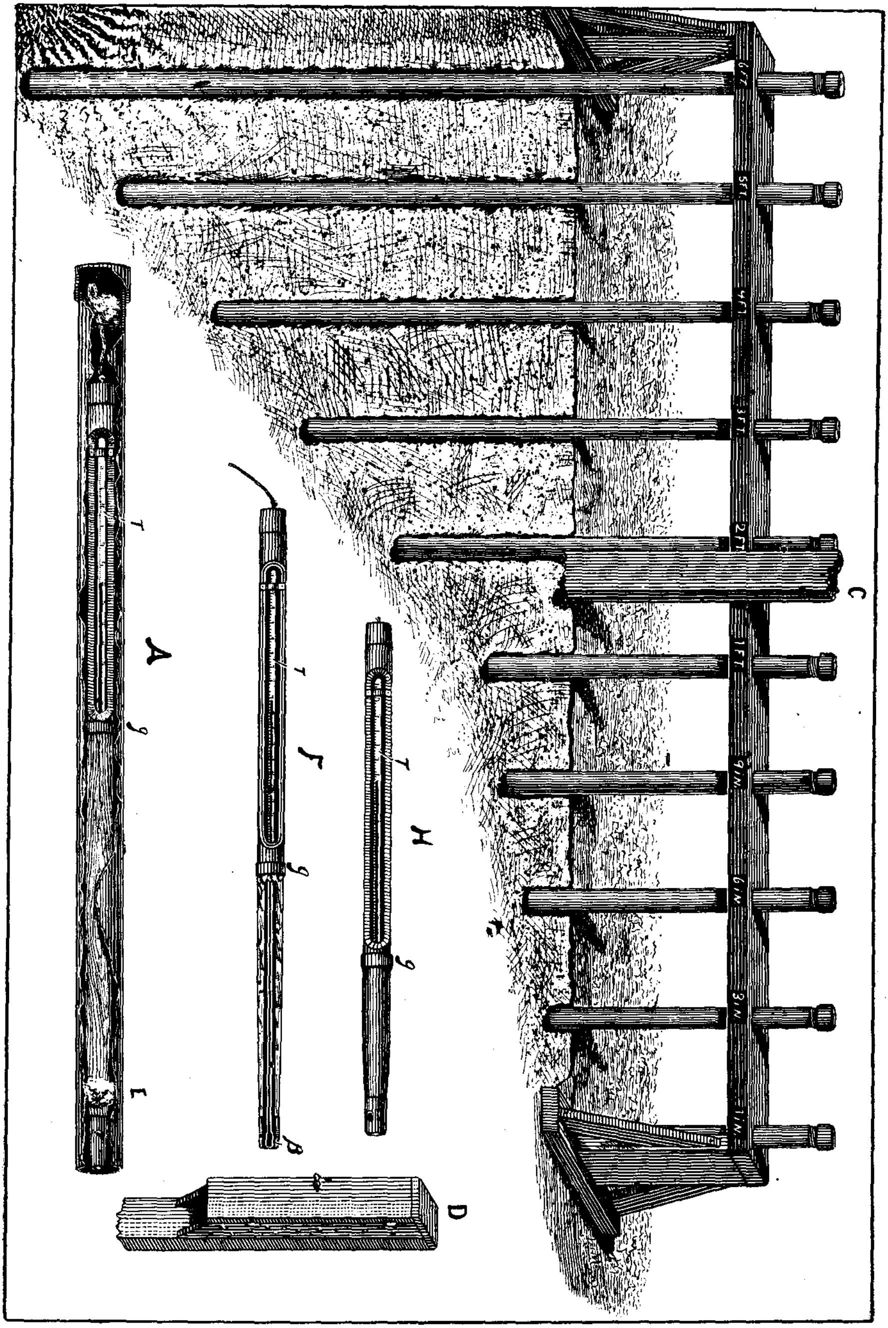
EDWARD D. PORTER.

SOIL TEMPERATURES.

January 1st, 1889, we began recording the temperatures of the soil at this station. This is doubtless the first undertaking of this kind in the State, and so far as our knowledge goes, the first with a complete set of soil thermometers in the Northwest. This kind of experimental work has been performed at several experiment stations in Eastern states, but not in anything like a thorough manner in the upper Mississippi valley, where we have a characteristic intercontinental climate. A complete set of thermometers was ordered from Mr. Henry J. Greene, of New York, including those set at the following named depths: 1 inch, 3 inches, 6 inches, 9 inches, 12 inches, 2 feet, 3 feet, 4 feet, 5 feet and 6 feet deep. At H. and F. in the accompanying plate are represented the six and twelve inch thermometers. The thermometers are simply closed tubes with a long bulb at the bottom, and these are encased in a tubular piece of wood. Holes are bored through the wood at the bottom, thus putting the bulb in direct contact with the soil at the sides as well as at the bottom. Above the surface of the ground (*g*) half of the wooden tube is cut away, and behind the glass tube the wood is painted black, enabling the observer to the more easily read the thermometer scale, which is marked on the glass tube (*t*). These thermometers are designed to be set permanently for the season in the soil and to be read by the observer kneeling down, as the part of the tube bearing the scale reaches from near the surface of the ground to a foot or more high. The deep thermometers are made long simply by lengthening the tube between the scale and the bulb, and they are corrected and the scale so made, that even the deepest ones are reasonably accurate.

These thermometers were not designed for winter records in a climate so cold as this, but they were placed in the ground January 1st, and the winter being mild they registered low enough in all but a few instances. In these cases the mercury shrank to such an extent that it did not stand as high as the recording scale (*t*), and blanks are left in the table showing these instances. Owing to the snow which usually in this climate piles just where you wish it to blow away, these thermometers could not ordinarily be read in winter if placed in the ground in the manner designed by the inventor, Dr. Sturtevant. To make it possible for the observer to make the records during winter, two-inch gas-pipes were set in the ground at the various depths, and the thermometers were dropped into these, as shown at A. A string attached to the upper end was sustained within reach at the top of the pipe by means of a wad of cotton through which the string passed. A cap on the top of the pipe is quickly unscrewed and by means of the string the thermometer is lifted so that the scale can be seen above the top of the tube, which extends three feet above the surface of the ground. A wad of cotton around the thermometer near its bottom serves to prevent much circulation of air by convection. There is, of course, a source of error arising from the conduction of heat by the iron pipe. It is designed to take the thermometers out of these iron pipes during the summer and plant them in the soil, as was the plan of their inventor. The entire number of thermometers are shown in the engraving, also the frame of wood which served to keep them in place. An air thermometer enclosed by an upright box (D) is fastened to the frame at C, and from this is recorded the temperature of the air five feet above the soil.

Freezing and Thawing Out of Soil. The surface of the soil responds rather quickly to the temperature of the air. In very cold weather it is nearly as cold as the air. When the air becomes warmed by the action of the sun, or from warmer winds, the soil in winter remains colder than the air, and if below freezing, it does not so rapidly warm, on account of the great quantity of heat which must be turned into latent heat by the melting of ice in the soil. After once entirely thawed out the soil more rapidly responds to the warming influences of sun, winds, rains and chemical action of manures, etc. The soil at this station, which is gravel and sand with a good admixture of clay, froze to a depth of more than four feet, though the winter was unusually mild. The surface was fully exposed to the N. W. winds and but little snow lodged around the tubes containing the thermometers during the entire winter. The tabular statements, with averages at the bottom, show all the facts. The long period at which those thermometers, with their bulbs at one, two and three feet deep, registered 31° to 33° F. shows the time during which the soil stood at the melting point of ice, while thawing out.


6 FT
5 FT
4 FT
3 FT
2 FT
1 FT
9 IN
6 IN
3 IN
1 IN
C
A
F
H
D
T
g
E

RECORD OF SOIL TEMPERATURES

AT THE

MINNESOTA EXPERIMENT STATION

FOR JANUARY 1889.

2 P. M.

Jan.	Air	1 in.	3 in.	6 in.	9 in.	12 in.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.
1	*36	37	31	31	27	27	30	35	38	39	41
2	34	35	30	30	27	26	30	34	37	39	41
3	37	40	32	30	28	28	30	34	37	40	41
4	38	41	33	30	29	29	31	34	37	40	41
5	31	32	31	30	30	30	31	34	37	39	40
6	30	32	31	30	30	30	31	34	37	39	40
7	33	33	31	30	30	30	31	34	37	39	40
8	30	31	31	30	30	30	31	34	37	39	40
9	18	21	25	27	28	29	30	34	36	38	40
10	18	29	24	23	25	26	31	34	37	38	40
11	16	22	21	20	22	24	30	34	36	38	40
12	22	38	26	25	25	30	31	35	37	38	40
13	21	36	25	24	24	27	31	35	37	38	40
14	22½	34	23	21	22	23	29	33	37	38	39
15	34	30	26	25	25	25	29	33	36	38	39
16	30	30	26	25	25	26	29	33	36	38	39
17	10	25	22	25	25	27	30	33	36	38	39
18	24	7	16	15	17	20	29	33	35	37	39
19	18½	21	19	17	18	19	26	32	35	37	39
20	16	24	20	19	21	21	28	32	35	37	39
21	12½	22	15	13	16	18	27	32	35	37	39
22	19	25	19	15	17	19	27	32	35	37	39
23	*28	28	23	17	19	21	28	32	35	37	39
24	*32	33	26	20	22	23	28	32	35	37	38
25	37½	36	31	29	26	26	28	32	35	37	38
26	15	20	20	20	22	24	28	31	34	36	38
27	15	22	19	18	20	20	26	32	34	36	38
28	19	24	21	19	18	19	24	31	34	36	38
29	26	32	25	23	21	21	25	31	34	36	38
30	29	30	32	26	25	24	26	31	34	36	38
31	31½	25	21	19	21	22	26	31	34	36	37
Av	25	29	25	23	24	25	29	33	36	38	39

RECORD OF SOIL TEMPERATURES

AT THE

MINNESOTA EXPERIMENT STATION

FOR FEBRUARY, 1889.

2 P. M.

Feb.	Air	1 in.	3 in.	6 in.	9 in.	12 in.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.
1	35	38	29	27	23	22	26	31	34	36	37
2	35	36	30	28	26	25	27	31	32	36	37
3	28	35	30	29	27	27	28	31	34	36	37
4	30	25	26	26	27	27	28	31	34	35	37
5	–3	12	8	..	..	..	26	28	33	35	37
6	2	18	10	..	..	..	24	30	33	35	37
7	*14	22	17	20	20	23	24	30	33	37	37
8	22	26	24	22	21	20	24	30	33	35	37
9	22	28	26	23	21	21	24	30	33	35	36
10	22	28	23	21	21	21	24	29	33	35	36
11	15	28	21	20	19	20	25	29	33	35	36
12	11	23	16	14	15	..	24	29	32	34	36
13	15	17	15	14	17	..	23	29	32	34	36
14	20	*21	19	17	17	..	23	29	32	34	36
15	26	26	21	20	21	21	24	28	32	34	36
16	28	25	22	20	21	21	24	28	32	34	36
17	8	20	18	18	20	20	25	29	32	34	36
18	4	16	13	14	18	..	24	28	32	34	36
19	4	19	10	..	16	..	22	28	32	34	35
20	12	18	14	..	17	..	22	28	32	34	35
21	12	19	18	18	19	18	22	27	31	34	35
22	16	2	6	..	..	..	21	27	31	33	35
23	12	4	..	..	..	..	19	26	31	33	35
24	5	11	8	..	..	..	..	26	31	33	35
25	15	18	10	..	..	..	18	26	31	33	35
26	28	25	17	17	17	20	20	25	30	33	35
27	31	34	30	15	22	21	22	26	30	33	35
28	46	45	32	30	26	25	24	26	30	33	34
Av	17	23	19	21	21	22	24	29	32	34	36

RECORD OF SOIL TEMPERATURES

AT THE

MINNESOTA EXPERIMENT STATION

FOR MARCH 1889.

2 P. M.

Mar.	Air.	1 in.	3 in.	6 in.	9 in.	12 in.	2 ft.	3 ft.	4 ft.	5 ft	6 ft.
1	38	*40	30	30	28	26	25	26	30	33	34
2	50	*54	40	33	30	28	26	27	30	33	34
3	48	55	39	34	31	30	28	28	30	33	34
4	40	43	35	33	31	30	28	29	30	33	34
5	44	51	41	37	30	29	28	31	32	32	34
6	51	54	45	39	32	31	28	29	31	32	34
7	35	38	35	43	32	31	29	30	31	33	34
8	..	39	30	31	31	30	29	30	31	32	34
9	36	42	35	32	30	30	29	30	31	32	34
10	41	50	37	33	30	30	30	30	31	33	34
11	51	56	42	37	32	30	30	31	31	33	34
12	40	47	39	35	32	31	30	31	31	33	34
13	14	22	21	29	30	30	30	30	31	33	34
14	36	34	32	31	30	30	30	30	31	33	34
15	33	33	32	31	31	30	30	30	31	33	34
16	35	36	33	32	31	31	30	31	31	33	34
17	36	36	34	32	31	31	30	31	31	33	34
18	37	52	42	36	32	31	31	31	32	33	34
19	56	65	51	42	33	31	31	31	32	33	34
20	54	63	53	46	36	32	31	31	32	33	44
21	57	65	53	47	38	34	31	31	32	33	34
22	61	69	57	52	42	35	31	31	32	33	34
23	62	70	58	51	42	36	31	31	32	33	34
24	60	69	57	52	42	36	31	31	32	33	34
25	50	60	56	51	43	36	31	31	32	33	34
26	62	69	59	54	45	39	32	31	32	33	34
27	36	47	39	37	37	34	31	31	32	33	34
28	50	55	45	41	36	34	32	31	32	33	34
29	34	45	36	35	33	33	32	31	32	33	34
30	30	31	32	32	32	32	32	31	32	33	34
31	45	56	44	38	34	32	32	32	32	33	34
Av	44	49	41	38	34	32	30	30	31	33	34

RECORD OF SOIL TEMPERATURES

AT THE

MINNESOTA EXPERIMENT STATION

FOR APRIL, 1889.

2 P. M.

Apr.	Air	1 in.	3 in.	6 in.	9 in.	12 in.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.
1	58	63	53	48	40	35	32	32	32	33	34
2	42	52	47	46	40	35	32	32	32	33	34
3	43	54	47	44	39	36	32	32	33	33	34
4	53	58	51	46	39	36	32	32	32	33	34
5	43	58	52	47	41	37	33	32	32	33	34
6	55	63	53	47	40	36	33	32	32	33	34
7	49	49	46	43	40	38	34	32	32	33	34
8	60	62	57	52	45	40	34	32	33	33	34
9	66	76	66	58	49	43	36	33	33	34	34
10	56	56	53	50	46	43	37	33	33	34	34
11	50	58	55	51	47	43	37	34	33	34	34
12	57	67	60	54	48	44	38	35	33	34	34
13	58	73	63	56	49	43	38	35	34	34	34
14	60	69	62	57	50	43	38	36	34	35	35
15	57	73	65	59	52	44	39	36	35	35	35
16	55	57	54	52	49	45	40	37	35	35	35
17	61	70	55	63	51	46	41	38	36	35	35
18	59	58	54	52	49	46	42	39	36	36	36
19	64	75	66	60	54	47	42	39	37	36	36
20	60	62	65	60	54	47	42	39	37	36	36
21	58	74	65	60	54	48	44	40	38	37	36
22	57	57	55	53	53	47	45	41	38	37	37
23	59	64	62	55	55	48	43	40	38	37	37
24	68	68	63	59	55	50	42	39	38	38	37
25	68	73	63	59	53	46	44	42	40	38	38
26	68	75	66	62	55	48	45	42	40	39	38
27	57	60	60	58	54	47	45	42	40	39	38
28	45	56	53	51	48	45	44	43	41	40	39
29	51	60	58	55	50	46	44	43	41	40	39
30	56	69	61	56	50	45	44	43	41	40	39
Av	56	64	58	54	48	43	39	37	36	36	36

BEST VARIETIES OF CORN FOR ENSILAGE.

The comparative tests of varieties of corn for ensilage which were begun in 1887 (see Bulletin No. 2 and Annual Report for 1888, page 90) were continued in 1888. In field No. 4, were planted one hundred and fifty rows of corn and sorghum. There were five rows of some varieties, three of others, and only one row of a few kinds. The rows were each one hundred feet long and three feet apart, running north and south, on land well manured. At the east end of this field, where the numbers of the plots began, were eight varieties of white Dent corn, next to these were seven kinds of yellow Dents; plots 9 to 15. West of these was one variety of white Flint, No. 16, and ten kinds of red and yellow Flints. Following these was a plot of Brazilian flour corn and one of sorghum. At the west end were seventeen plots of Sweet varieties.

The different varieties were planted June 9th and 11th, by dropping three grains to each foot in furrows marked out with a single "shovel plow", and covered with a hoe.

Most varieties came up well, producing the average number of stalks to the foot shown in the table, and grew rapidly throughout the entire summer. A wind storm early in August bent most of the large varieties down quite badly, and thus slightly reduced their yields. Most varieties, especially the larger kinds, grew too thick to produce good ears, though they bore a fair crop. Once a week notes were taken of the height, stage of growth and general appearance. When the early varieties were at that stage commonly known as "glazed" the stalks were cut and weighed green and this weight is reduced to tons per acre in of the table. Some of the later, larger varieties were not yet at the stage of "glazing" when harvested, but their degree of development is shown in the tabular statement.

All varieties were cultivated alike, and otherwise similarly treated. The rainfall was ample for the growth of corn, and all had a good chance for producing a crop, excepting those kinds

TABLE SHOWING GROWTH OF STALKS, TIME OF BLOSSOMING, RIPENING, YIELD PER ACRE, DISTANCE APART OF STALKS IN THE ROW, ETC.

Tasseling is abbreviated, T.; blossoming, B.; silking, S.; past blooming, P. B.; out of bloom, O. B.; early milk, E. M.; late milk, L. M.; dough state, Do., and mature for ensilage, Ens. Each was harvested on or near the date on which the last abbreviation is given in the table.

Varieties.	Source of Seed.	Came up June—		July 9.	July 16.	July 23.	July 30.	August 6.	August 13.	August 20.	August 27.	September 3.	September 10.	September 17.	September 24.
White Dent—															
1. Southern White	......	16	Height In...	17	33	50	70	80	90	100	112	125	......	......	......
			Development	....	....	....	......	......	......	T.	T. B.	B.	......	E. M.	L. M.
2. White Giant Normandy	Dept. Agl. Washington	16	Height	19	36	54	85	95	100	110	120	125	......	......	......
			Development	....	....	....	......	T.	T.	T. B.	B. S.	O. B.	E. M.	E. M.	E. M.
3. Sheep Tooth Ensilage	Sibley	17	Height	18	34	50	70	80	90	100	105	120	......	......	......
			Development	....	....	....	......	......	......	T.	B.	P. B.	O. B.	E. M.	E. M.
4. Hickory King	N. B. & Co.	18	Height	17	30	46	65	75	90	96	105	110	......	......	......
			Development	....	....	....	......	......	......	T.	B.	P. B.	O. B.	E. M.	E. M.
5. Rustler	N. B. & Co.	16	Height	20	38	55	72	78	88	95	95	......	......	......	......
			Development	....	....	....	T.	B.	B. S.	O. B.	E. M.	M.	L. M.	Do.	Ens.
6. Giant	N. B. & Co.	17	Height	19	35	53	70	80	95	110	112	......	......	......	......
			Development	....		....	......	......	......	T.	B.	P. B.	O. B.	E. M.	E. M.
7. Breck's Boston Market	Department Agriculture	17	Height	19	35	55	70	80	95	110	115	......	......	......	......
			Development	....	....	....	......	T.	T.	B.	B. S.	P. B.	O. B.	E. M.	E. M.
8. Rose Dent	Grown here	16	Height	22	38	58	80	84	88	......	......	......	......	......	......
			Development	....	....	T.	B.	B. S.	P. B.	O. B.	E. M.	M.	Ens.	M.	
Yellow Dent—															
9. Golden Beauty	N. B. & Co.	17	Height	22	35	58	70	80	85	108	114	......	......	......	......
			Development	....	....	....	......	......	......	T.	B. S.	O. B.	E. M.	M.	L. M.
10. Golden Dent	N. B. & Co.	17	Height	22	36	58	70	78	84	105	111	......	......	......	......
			Development	....	....	....	......	......	T.	T.	B. S.	E. M.	M.	L. M.	E. Do
11. Smedley	Sibley	17	Height	19	31	50	60	72	90	108	112	......	......	......	......
			Development	....	....	....	......	......	T. B.	B. S	O. B.	E. M.	M.	L. M.	E. Do
12. Improved Leaming	N. B. & Co.	16	Height	20	34	50	65	72	88	108	112	......	......	......	......
			Development	....	....	....	......	......	T.	B. S.	O. B.	E. M.	M.	L. M	E. Do
13. Pride of the North	N. B. & Co.	16	Height	21	36	52	65	72	80	85	90	......	......	......	......
			Development	....	....	....	T.	B. S.	B. S.	P. B.	M.	Do.	Ens.		
14. Australian "No. 3"	Prairie Farmer	16	Height	21	36	55	68	72	82	95	100	......	......	......	......
			Development	....	....	....	......	T.	B.	B. S.	O. B.	E. M.	L. M.	Do.	Ens.
15. Australian "No 4"	Prairie Farmer	16	Height	22	36	52	60	84	90	102	120	......	......	......	......
			Development	....	....	....	......	......	......	T.	B.	P. B.	E. M	M.	L. M.
White Flint—															
16. White Canadian	Central Exp. Farm, Canada	17	Height	19	33	45	65	72	75	......	......	......	......	......	......
			Development	....	....	T.	B.	B. S.	E. M	L. M.	E. Do	Ens.			
Yellow Flint—															
17. Waushakum	N. B. & Co.	16	Height	20	35	46	60	80	80	85	90	......	......	......	......
			Development	....	....	....	T.	B. S.	B. S.	P. B.	E. M.	M.	Ens.		
18. Longfellow	N. B. & Co.	17	Height	20	35	46	60	75	80	88	90	......	......	......	......
			Development	....	....	....	T.	B.	B. S.	P. B.	E. M.	M.	E. M.		
19. Mercer	N. B. & Co.	18	Height	19	33	46	65	84	84	......	......	......	......	......	......
			Development	....	....	....	B.	B. S.	P. B.	O. B.	M.	Do.	Ens.		
20. Compton's Early	N. B. & Co.	18	Height	20	32	48	60	80	85	......	......	......	......	......	......
			Development	....	....	....	T.	B. S.	P. B.	O. B.	E. M.	L. M.	Ens.		
21. Smut Nose	Sibley	17	Height	21	33	50	60	80	85	......	......	......	......	......	......
			Development	....	....	....	B.	B. S.	P. B.	O. B.	M.	Do.	Ens.		
22. Squaw Corn	......	16	Height	21	35	46	60	65	65	......	......	......	......	......	......
			Development	....	....	....	T.	B. S.	O. B.	E. M.	M.	Ens.			
23. Angel of Midnight	......	16	Height	21	36	46	60	75	85	90	......	......	......	......	......
			Development	....	....	....	T	B. S.	B. S.	P. B.	E. M.	M.	Ens.		
24. Early Canada	......	17	Height	20	35	46	65	80	90	......	......	......	......	......	......
			Development	....	....	....	B.	B. S.	P. B.	O. B.	M.	Do.	Ens.		
25. Self Husking	......	17	Height	20	35	42	60	80	90	......	......	......	......	......	......
			Development	....	....	....	T.	B. S.	P. B.	O. B.	M.	Do.	Ens.		
26. Top over Flint	......	...	Height	14	24	30	42	69	65	75	......	......	......	......	......
			Development	....	....	....	......	T	B. S	P. B.	E. M.	M.	L. M.	Do.	Ens.
27. Brazilian Flour Corn	......	17	Height	13	26	38	55	75	85	95	100	112	......	......	......
			Development	....	....	....	......	......	......	......	T.	B.	B. S.	O. B.	Ens
28. Early Amber Sorghum	......	...	Height	6	12	24	40	60	65	85	100	110	......	......	......
			Development	....	....	....	......	......	......	......	......	T.	B.	P. B.	E. M.
Sweet Corn—															
31. Early Naragansett	......	18	Height	....	15	26	38	54	60	60	......	......	......	......	......
			Development	....	....	....	......	B.	P. B.	E. M.	M.	Do.	Ens.		
32. Extra Early Des Moines	......	17	Height	....	12	26	38	54	60	65	......	......	......	......	......
			Development	....	....	....	......	T.	B. S.	B. S.	O. B.	M.	Do.	Ens.	
33. Hickox Improved	......	17	Height	....	16	27	40	54	65	78	90	......	......	......	......
			Development	....	....	....	......	......	T.	T. B.	B. S.	O. B.	E. M.	L. M.	Do.
34. Early Minnesota	......	17	Height	....	17	27	38	66	75	75	......	......	......	......	......
			Development	....	....	....	......	B.	B. S.	P. B.	S. M.	Do	Ens.		
35. Crosby's Early	......	17	Height	....	17	27	38	62	78	80	......	......	......	......	......
			Development	....	....	....	......	T	B. S.	B. S.	P. B.	M.	L. M.	Do.	Ens.
36. Shaker's Early	......	16	Height	....	17	29	40	65	68	70	......	......	......	......	......
			Development	....	....	....	......	T.	B. S.	B. S.	O. B.	M.	L. M.	Ens.	
37. Chicago Market	......	16	Height	....	20	30	42	68	75	75	......	......	......	......	......
			Development	....	....	....	......	T.	B. S.	B. S.	E. M.	M.	L. M.	Ens.	
38. Egyptian Sweet	......	15	Height	19	30	42	65	70	85	98	108	......	......	......	......
			Development	....	....	....	......	......	T.	B.	B. S.	O. B.	E. M.	M.	L. M.
39. Triumph Sweet	......	16	Height	21	32	44	68	80	85	95	100	......	......	......	......
			Development	....	....	....	......	T.	B. S.	P. B.	O. B.	E. M.	L. M.	Do.	Ens.
40. Early Marblehead	......	16	Height	18	29	39	60	65	......	......	......	......			
			Development	....	....	T.	B. S.	O. B.	M.	L. M.	Do.	Ens.			
41. Moore's Early	......	16	Height	19	29	42	60	78	80	......	......	......	......		
			Development	....	....	....	T.	B.	B. S.	O. B.	E. M.	M.	Ens.		
43. Amber Cream	......	15	Height	18	32	42	56	75	80	85	......	......	......	......	......
			Development	....	....	....	......	T.	B. S.	P. B.	O. B.	E. M.	L. M.	Do.	
44. Perry's Hybrid	......	15	Height	21	35	45	70	78	78	......	......	......	......	......	......
			Development	....	....	T.	B.	B. S.	P. B.	E. M.	M.	L. M.	Ens.		
45. Longer Sweet	......	15	Height	17	32	43	70	80	85	94	......	......	......	......	......
			Development	....	....	....	T.	B.	B.	B. S.	O. B.	E. M.	L. M.	Do.	Ens.
46. Black Mexican	......	15	Height	18	30	38	60	72	75	80	......	......	......	......	......
			Development	....	....	....	T.	B.	S.	P. B.	O. B.	M.	L. M.	Do.	Ens.
47. Mammoth Sweet	......	16	Height	18	30	38	60	75	80	90	......	......	......	......	......
			Development	....	....	....	......	T.	B.	B. S	P. B.	Ens.	M.	L. M.	Do.
*Southern Corn for Ensilage	......	14	Height	12	38	58	60	85	90	110	115	......	......	......	......
			Development	....	....	....	......	......	......	......	T.	......	B.	......	E. M.
*Flint Corn for Ensilage	......	14	Height	12	33	46	60	80	85	......	......	......	......	......	......
			Development	....	....	....	T.	S.	P. B.	M.	L. M.	Do.	Ens.		

Varieties.	Yield in tons, per acre.	Distance apart of stalks in the row, in inches.	Laboratory number.	In the Green Substance, as Received: Water (H. 2 O.)	Total dry matter.	Crude ash.	Ether extract, or fat.	Crude fibre.	Crude protien.	Carbhydrates, by difference.	In the Dry Substance: Crude ash.	Ether extract, or fat.	Crude fibre.	Crude protein.	Carbhydrates.	Dry matter per acre.
				pr.ct.	pr.ct.	pr.ct.	pr.ct.	pr.ct.	pr.ct.	pr.ct.	pr.ct.	pr.ct.	pr.ct.	pr.ct.	pr.ct.	t'ns
1. Southern White	28.4	9½	87	......	......	......	......	......	......	......	6.71	......	24.72	......	......	....
2. White Giant Normandy	27.2	9½														
3. Sheep Tooth Ensilage	25.9	10	88	......	......	......	......	......	......	......	7.37	......	24.57	......	......	....
4. Hickory King	22.5	16½	72	83.07	16.93	1.08	......	3.80	......	......	6.36	......	22.47	......	......	3.7
5. Rustler	20.	8														
6. Giant	27.2	8	74	82.07	17.93	1.20	.56	4.81	......	......	6.64	3.10	26.63	......	......	4.9
7. Breck's Boston Market	25.7	11														
8. Rose Dent	23.	6½	37	78.50	21.50	1.53	.78	3.51	1.67	......	7.14	3.64	16.34	7.79	......	5.
9. Golden Beauty	28.6	8														
10. Golden Dent	28.8	7½														
11. Smedley	23.2	9														
12. Improved Leaming	25.2	7½														
13. Pride of the North	14.9	8	38	79.94	20.26	1.26	.82	3.95	......	......	6.24	4.03	19.53	......	......	3.
14. Australian "No. 3"	23.3	6½														
15. Australian "No 4"	30.3	9½														
16. White Canadian	16.2	15	27	82.63	17.37	1.25	1.00	2.92	1.75	......	7.14	5.84	16.78	10.05	60.19	2.8
17. Waushakum	23.8	10	39	83.05	16.95	1.37	.66	2.93	1.64	......	8.11	3.88	17.30	9.66	......	4.
18. Longfellow	26.8	8½	40	84.64	15.36	1.13	.51	3.16	1.51	......	7.36	3.31	20.56	9.84	......	4.1
19. Mercer	17.7	12	41	79.34	20.66	1.30	.84	4.08	1.76	......	6.30	4.06	19.78	8.52	......	3.7
20. Compton's Early	24.7	10	42	84.95	15.05	1.12	.56	3.04	1.40	......	7.45	3.80	20.14	9.32	......	3.8
21. Smut Nose	22.5	7½	43	83.72	16.28	1.34	.79	2.76	1.45	......	7.75	4.57	16.04	8.40	......	3.7
22. Squaw Corn	13.3	7½	30	77.16	22.84	1.25	1.09	3.57	2.07	......	5.47	4.76	15.62	9.06	......	3.
23. Angel of Midnight	27.8	7	44	83.54	16.46	1.00	.65	2.99	1.52	......	6.00	3.97	17.97	9.11	......	4.6
24. Early Canada	21.	7½	45	78.33	21.67	1.55	.76	4.23	2.06	......	7.13	3.48	19.52	9.51	......	4.6
25. Self Husking	19.5	6½														
26. Top over Flint	17.2	26	63	85.42	14.58	.93	.46	2.54	......	......	6.39	3.17	17.51	......	......	2.5
27. Brazilian Flour Corn	23.6	6½														
28. Early Amber Sorghum	19.9	8														
31. Early Naragansett	18.4	8½	28	85.36	14.64	1.23	.79	2.50	1.49	......	8.43	5.39	17.17	10.20	......	2.7
32. Extra Early Des Moines	13.1	13	46	84.87	15.13	1.10	.52	3.14	1.47	......	7.20	3.42	20.56	9.67	......	2.1
33. Hickox Improved	15.	10	65	84.22	15.78	1.01	1.14	2.50	......	......	6.37	7.21	15.83	......	......	2.7
34. Early Minnesota	20.3	10	35	84.42	15.58	1.09	1.06	2.60	1.42	......	6.97	6.78	16.70	9.10	......	3.2
35. Crosby's Early	23.6	10														
36. Shaker's Early	24.6	10	47	87.27	12.73	.93	.70	2.61	......	......	7.30	5.49	20.67	......	......	3.1
37. Chicago Market	24.9	11	48	82.94	17.06	1.14	.80	3.34	......	......	6.68	4.68	19.57	......	......	4.4
38. Egyptian Sweet	38.6	'8														
39. Triumph Sweet	28.9	8	67	87.42	12.58	1.05	.39	2.62	......	......	8.32	3.12	20.86	......	......	3.6
40. Early Marblehead	13.5	15	26	81.83	18.17	1.31	1.09	2.78	1.44	11.55	7.19	5.44	15.30	7.94	64.13	2.4
41. Moore's Early	25.6	12	50	85.56	14.44	1.06	.43	3.05	......	......	7.32	2.94	21.06	......	......	3.7
43. Amber Cream	29.	9	68	87.92	12.08	.92	.49	2.34	......	......	7.65	4.09	19.41	......	......	3.5
44. Perry's Hybrid	21.6	7	51	83.01	16.99	1.32	.87	3.06	......	......	7.80	5.17	18.69	......	......	3.7
45. Longer Sweet	25.9	7½	69	86.42	13.58	1.05	.50	2.82	......	......	7.73	3.70	20.79	......	......	3.5
46. Black Mexican	23.2	9	70	81.41	18.59	1.21	......	3.51	......	......	6.54	......	18.84	......	......	4.3
47. Mammoth Sweet	30.3	9	71	86.59	13.41	1.03	......	2.89	......	......	7.71	3.82	21.56	......	......	4.1
*Southern Corn for Ensilage	26.8	8		77.												
*Flint Corn for Ensilage	13.	8	....	66.02	33.98	2.41	1.40	7.26	......	......	7.11	4.27	20.28	......	......	4.4

*These two varieties were raised in large quantities, siloed, and fed in the experiment subsequently discussed.

† Average of three analyses in as many parts of the silo when put in.

for which the season was too short. Samples were also taken at the time of cutting each, and these were given to Prof. Harper for chemical analysis; the results of which are given on subsequent pages.

The wide differences in the yields per acre are partly attributable to the difference in the thickness of the stand as shown by the the figures in the table. The tabular statement of growth, blossoming, etc., is given to show the different habits of the various kinds of corn. The yield of green fodder per acre, together with the average distance apart of the stalks in the rows, is interesting. Owing to a fire, in the chemical laboratory at the University, many of the samples taken for analysis were lost; hence the incompleteness of that side of the table.

As shown by the table, the Southern corn planted in an adjoining field and siloed, produced over six tons of "water free" substance, or dry matter, which is larger than is shown by any other kind; and the Flint corn planted in the same field yielded four tons "water free" substance, which is nearly as large as any variety of Flint corn analyzed. These two kinds, then, are each the best representatives of their classes of corn for ensilage, when value is judged by the amount of dry matter they produce per acre, and they were especially well suited to the purposes of the feeding experiments hereinafter discussed. The Dent varieties gave the largest yields of fodder as a rule, and those of which the analysis is given also show a greater yield of dry matter than do either the Flint or the Sweet varieties. The larger Sweet varieties yielded more green fodder per acre than did the Flint corn, and one kind, Egyptian Sweet gave the enormous yield of 38.6 tons per acre, or considerably more than any of the large Dent kinds. (See discussion of best corn for ensilage in conclusion after notes on feeding experiment.)

SOUTHERN VS. FLINT CORN FOR ENSILAGE.

In 1888, we planted four acres to two kinds of corn for ensilage, intending to compare them in a feeding test. One half the field was planted with a large variety of Southern white corn and the other half to one of the most prolific varieties of Flint corn—Mercer. The last two kinds of corn in the table of notes on a previous page gives the growth, maturity, yield, etc., of both of these varieties as compared with other varieties grown under similar conditions. The Flint corn, maturing first, was placed in the bottom of our east silo and the Southern corn was put in above it. The temperature of the silo did not go above 100° F. The ensilage was rather sour when fed.

The milk cows at the Station were not in condition for a feeding experiment during the winter. Late in January, however, two of our mature Holstein-Fresian cows had calves, and a few weeks later these with two other H. F. cows were placed in the experiment feeding rooms. Six native and grade cows and heifers which we desired to fatten and sell were also placed in the stanchions in the experiment stable. While most of these fatting cattle were not the kind of animals to make a fine show of gains, yet "feeding them off" was thought to be just as practical a question to the dairyman who is "weeding out" his herd as is feeding steers to the man who manages a beef farm. To compare the two kinds of ensilage, it was fed in combination with enough rich grain to make what is called a "standard" or a nearly "balanced ration," both to the four milk cows and the six fatting cattle. A very small amount of timothy hay was also added to the ration for the milk cows.

All these cattle had been accustomed to ensilage with hay and dry corn fodder during the few months previous to their selection for the experiment, and to some of them bran and beets had been fed. The following table shows all the facts regarding the cattle, also their division into groups as mentioned later on in connection with a comparison of warm and cold water.

Nos. 16 and 42 had received daily 6 lbs. bran, 2 lbs. flaxseed meal, 6 lbs. oats, together with 54 lbs. of the below named "rough mixture." Nos. 15 and 44 had received daily 6 lbs. bran, 10 lbs. roots and 54 lbs. "rough mixture."

Nos. 92, 60, 76, 52 and 35 had been receiving daily for some time prior to their selection for this experiment six pounds of bran and 54 pounds of the following mixture: 70 lbs. ensilage, 20 lbs. timothy hay and 10 lbs. corn fodder, all cut and mixed together. No. 32 had been receiving little else than the mixture of "rough" feeds mentioned.

TABLE I.

Six Cows for Fatting.

Group	Number of Animal.	Weight.	lbs. Daily Milk yield prior to selection.	Last time bred.	Dropped last Calf.	Born.
Group 1.	35	1065	Heifer.	Oct. 11, '88.	Heifer.	October 27th, 1886.
	76	962	16½	Jan. 4, '89.	Sept. 14, '88.	Spring of 1883.
	52	865	12	Nov. 22, '88.	Aug. 6, '88.	May, 1886.
Group 2.	32	925	Heifer.	Nov. 30, '88.	Heifer.	December 30th, 1886.
	92	888	10	Dec. 30, '88.	Aug. 9, '88.	Spring of 1885.
	60	1055	10	Jan. 15, '88.	Aborted June 17.	Spring of 1882.

Four Cows Giving Milk.

Group	Number of Animal.	Weight.	lbs. Daily Milk yield prior to selection.	Last time bred.	Dropped last Calf.	Born.
Group 1.	44	1130	17	Sept. 24. '88.	July 9, '89.	February 7th, 1884.
	16	1290	51	Not bred.	Jan. 8, '89.	April 3d, 1884.
Group 2.	15	1200	16½	Jan. 9, '89.	Sept. 21, '88.	February 14th, 1886.
	42	1105	40	Not bred.	Jan. 10, '89.	March, 1883.

After placing them in the experiment rooms, all these cattle were fed on Flint corn ensilage together with grain, as in Tables IV. and VI., for about two weeks, to get them thoroughly accustomed to the comparatively rich ration. The same ration was then continued through twelve days, during which time records were kept of feed eaten, water drank, milk given, gain in weight, etc. The summaries of the data of the first period concerning the milk cows, are found in Table VIII., and those concerning the fatting cattle are found in Table XII. Upon the completion of the first period, the Flint corn ensilage in the rations was replaced with enough Southern corn ensilage to equal in dry matter that in the 35 pounds of Flint corn used daily per one hundred pounds of live weight in the first period. The Southern corn ensilage was somewhat dried in the field, thus giving ensilage made of it a greater per cent. of dry matter than is usual with this kind of ensilage. A preliminary feeding of four or five days was allowed, and the records of the second period were begun. It was assumed upon starting the experiment, that there would be no very great difference in the feeding value of the dry matter of the two kinds of corn ensilage. It was further assumed that, since the general character, and succulency, of the two kinds of ensilage differed but little, there would be no danger from having the interim or preliminary feeding before each period two or three days shorter than is generally considered allowable. The shortness of the time given to each period was controlled mainly by the condition of the animals we were by circumstances compelled to use; but this also was believed to be allowable when so little change was made in the rations from one period to another. The outcome of the experiment proves that too much reliance was placed upon these assumptions.

The Flint corn was siloed when in the "glazing" stage of maturity and the Southern corn ensilage when in the early milk stage. This corn was thickly drilled in rows thirty-two inches apart and was carefully thinned. Accurate counting showed an average of eight inches between the stalks in both parts of the field. The Southern corn yielded 26.8 tons of green fodder as actually weighed when hauled to the silo after having been allowed to dry a few hours, or 6.2 tons of dry matter per acre. The Flint corn yield thirteen tons of green fodder, and 4.4 tons dry matter per acre. The experiment in feeding was really to determine the relative value of a ton of the dry matter of each of these two kinds of corn.

The Flint corn had well developed ears, estimated at forty bushels per acre. The Southern corn was only in the milk stage and the ears were poorly developed, though better than is usually shown by Southern corn growing so thickly as was this. February 21st, 1889, the figures in table No. II were taken as a basis for calculating the rations for the four milk cows and the six fattening cows then in the experiment feeding stable.

The dry matter of the Flint corn (Mercer) was assumed to have the same qualitative analysis as the average of the four varities of Flint corn given on page ten of Bulletin No. 2. In the four kinds of flint there mentioned, the percentage of dry matter is 34.25 or only twenty-five hundreths per cent. higher than the dry matter in this silo as shown in three determinations by

Prof. Harper. The average of those four analysis was therefore here taken throughout in this preliminary calculation.

The dry matter of the Southern corn ensilage was assumed to have the same quantitave analysis as the average of tops, butts and middles of the same variety of corn grown in 1887, see lower line of table on page eleven of Bulletin No. 2.

To secure a similar statement of the analysis of the Southern corn ensilage its several ingredients were multiplied by $\frac{8}{7}$ to reduce the dry weight from the basis of only 20.3 per cent. dry matter of the crop of 1887, to twenty-three per cent. dry matter of the crop then in hand.

TABLE NO. II.

	Water per cent.	Dry matter per cent.	Albu-min-oids.	Starch.	Crude fibre.	Fat.
Southern Corn Ensilage..........	77	.23	1.77	14.31	5.03	.28
Flint corn ensilage...............	66	.34	2.96	24.67	4.58	.79

AMOUNT OF DIGESTIBLE CONSTITUENTS IN THE SEVERAL FOODS AND RATIONS USED; ALSO THE NUTRITIVE RATIO.

In making up rations for the several groups of cows in the different experimental periods the average coefficients of digestibility given in Stewart's Cattle Feeding were used, as were also the average composition of all feeds except the ensilage. The tables herewith are given to enable those interested to more carefully follow the experiment, and also to serve as an illustration to farmers of the practical application of so-called "feeding tables" to the construction of rational feeding rations. It is the intention of the writer to discuss in a future bulletin the principle features of feeding tables and their use.

TABLE NO. III.

Per cent. of Dry Matter Digestible Nutrients and Nutritive Ratio.

	Dry Matter.	Albumi-noids.	Carbohy-drates.	Fat.	Nutritive Ratio.
Southern Corn Ensilage.	23.	1.2.	11.6.	.12.	1:9.9.
Flint Corn Ensilage.	34.	2.0.	17.5.	.35.	1:9.2.
Stewart's Cattle Feeding.					
Timothy..................	86.5	7.3	49.5	2.7	1:7.1
Corn Meal................	85.4	8.4	60.6	4.8	1:8.6
Bran......................	88.6	10.0	48.5	3.1	1:5.6
Oil Cake, old process.......	91.9	27.6	27.0	10.4	1:2

Concerning the many questions which it was necessary to take into consideration in making out rations suited to the objects of this experiment space does not permit a discussion here. And it must be said that the figures in the table above, as well as in the four succeeding ones, excepting those of the weights of feeds, are averages. Here as elsewhere, chemical analysis in feeding is only a guide to practice. And without that expertness which is gained practically only by "staying by the individual animal" it amounts to but little. Science and practice very closely united form a value in feeding not attained by either of these singly.

TABLE IV.

Ration Fed Four Milk Cows During the First and Third Periods—Calculated to One Thousand Pounds Live Weight.

	Feeds in the ration, Pounds	Dry matter, Pounds	Digestible Nutrients. Albu-min'ids Pounds	Car-bohy-drates, Pounds	Fat, Pounds	Nutri-tive Ratio.
Flint Corn Ensilage	35	11.90	.70	6.12	1.22	
Timothy Hay	3	2.60	.22	1.49	.08	
Bran	8	7.09	.80	3.88	.25	
Oil Cake, O. P	2	1.84	.54	.54	.21	
		23.43	2.26	12. 3	.66	1:6

By substituting 52 pounds of Southern corn ensilage for the 35 pounds of Flint corn ensilage in the above, we had the following:

TABLE V.

Ration Fed the Four Milk Cows During the Second Period.—Calculated to One Thousand Pounds Live Weight.

	Feeds in the Ration, Pounds	Dry Matter. Pounds	Digestible Nutrients. Albu-min-noids. Pounds	Car-bohy-drates. Pounds	Fat. Pounds	Nutri-tive Ratio.
Southern Corn Ensilage	52	11.96	.62	6.03	.06	
Timothy	3	2.60	.22	1.49	.08	
Bran	8	7.09	.80	3.88	.25	
Oil Cake, O. P	2	1.84	.54	.54	.21	
		23.49	2.18	11.94	.60	1:6.1

TABLE VI.

Rations Fed Six Fattening Cows During the First and Third Periods, Calculated to One Thousand Pounds Live Weight.

	Feeds in the Ration, Pounds	Dry Matter, Pounds	Digestible Nutrients. Albu-min-oids. Pounds	Car-bohy-drates. Pounds	Fat. Pounds	Nutri-tive Ratio.
Flint Corn Ensilage.............	35	11.90	.70	6.12	.12	......
Bran	6	5.32	.60	2.91	.19	......
Corn Meal......................	6	5.12	.50	3.64	.28	......
Oil Cake, O. P..................	2	1.84	.55	.54	.21	......
		24.18	2.35	13.21	.80	1:6.4

By substituting 52 pounds Southern corn ensilage for the 35 pounds Flint corn, we have the following:

TABLE VII.

Ration Fed Six Fattening Cows During the Second Period, Calculated to One Thousand Pounds Live Weight.

	Feeds in the Ration. Pounds	Dry Matter. Pounds	Digestible Nutrients. Albu-min-oids. Pounds	Car-bohy-drates. Pounds	Fa Pounds	Nutri-tive Ratio.
South'rn Corn Ensilage.........	52	11.96	.62	6.03	.06	
Bran	6	5.32	.60	2.91	.19	
Corn Meal......................	6	5.12	.50	3.64	.28	
Oil Cake, O. P..................	2	1.84	.55	.54	.21	
		24.24	2.27	13.12	.74	1:6.6

RESULTS OF THE FEEDING.

The rations for one day for each group of cattle were carefully weighed out, the grain and ensilage mixed together in a large mixing box and the three feeds of each animal in the group were then weighed out from this mixture. The feeding, watering, milking, churning, making records, etc., were performed in much the same manner as described in bulletin No. 4, page 7 *et seq.* and annual report, page 108 *et seq.* The cattle were constantly attended to by Mr. Chas. Shultis, who did the work faithfully and well; he also did most of the work in connection with the care of the milk and the manufacture of the butter.

With the exception of slight indisposition on the part of Nos. 60 and 92 during a few days in the first period and of No. 35 during the last few days of the first period, when she was removed from the records for the time being, all the cattle were in good health and doing as well as could be expected of each of these individual cattle.

In changing from one period to another the amount or feed was so apportioned that the amount of grain and the dry matter of the ensilage would nearly or quite equal that fed during the last days of the period just before. In changing from the less bulky Flint corn ensilage to the Southern corn ensilage the cattle did not eat quite as much grain and dry material of ensilage but by the end of the preliminary feeding the normal amount was again taken.

The plan of the feeding was to give each animal nearly all it would eat, or as much as could be safely fed and not have the animals occasionally "off their feed."

In tables VIII, IX and X, the results of feeding the four milk cows are summarized and in table XI these results are collected showing the relative value under these conditions of the two kinds of corn ensilage used, also of warm and cold water, for milk cows. Tables XII, XIII and XIV in a like manner show the results of the three periods with the fatting cattle and table XV the collected results of the relative value under these conditions of the two kinds of ensilage and of warm and cold water. Results are given in pounds.

TABLE VIII.

First Period, March 9 to 20, Twelve Days, Showing Summary of Results in Feeding the Four Milk Cows.—Flint Corn ensil- with Grain.

		Weight.		Gain or Loss.	Water drank.	Feed eaten.	Dry matter of ensilage eaten.	Grain eaten.	Milk given lbs.	Butter produc'd	Lbs combn'd grain and dry matter of ensilage to one lb. of milk.
		begin'g	ending.								
Warm water group.	15	1170	1178	*8	937	628	....	....	187	....	....
	42	1330	1350	*20	1385	967	....	....	278	....	....
Cold water group	44	1140	1170	*30	1094	634	......	....	174	....	....
	16	1180	1195	*15	1309	686	......	....	444	....	....
Warm water group		2500	2528	*28	2322	1595	395	432	465	lbs oz 14.10	1.8
Cold water group		2320	2365	*45	2403	1320	327	357	618	11.4½	1.1
Totals.		4820	4893	*73	4725	2915	722	789	1083	25:4½	1.4

* Gain.

TABLE IX.

Second Period, March 25 to April 5, Twelve Days, Showing Summary of Results in Feeding the Four Milk Cows Southern Corn Ensilage with Grain.

		Weight.		Gain or Loss.	Water drank.	Feed eaten.	Dry matter of ensilage eaten.	Grain eaten.	Milk given lbs.	Butter produc'd	Lbs combn'd grain and dry matter of ensilage to one lb. of Milk.
		begin'g	ending.								
Warm water group	15	1200	1190	-10	680	714	....	....	190	....	
	42	1370	1335	-35	1149	1054	....	....	341	....	
Cold water group	44	1160	1160	-5	702	730	134	146	137	....	
	16	1190	1185		880	934	172	187	426	....	
Warm water group		2570	2525	-45	1829	1768	325	354	531	lb oz 15-5½	1.3
Cold water group		2350	2355	-5	1582	1664	306	333	563	11-5	1.1
Totals...		4920	4880	-40	3411	3432	631	687	1094	2610½	1.2

—Loss.

TABLE X.

Third Period, April 10th to 17th, Eight Days, Showing Results in Feeding the Four Milk Cows.—Flint Corn Ensilage with Grain.

		Weight.		Gain or Loss.	Water Drank	Feed Eaten.	Dry Matter of Ensilage Eaten.	Grain Eaten	Milk given lbs.	Butter produc'd	Lbs comb'nd grain and dry matter of ensilage to one lb. of milk.
		begin'g	ending.								
Warm water group	15	1180	1198	*18	662	406	....	......	132	......	....
	42	1350	1370	*20	883	526	....	......	247	......	....
Cold water group	44	1198	1188	-10	634	397	....	......	79	......	....
	16	1220	1175	-45	842	513	....	......	277	......	....
Warm water group		2530	2568	*38	1545	932	231	252	379	lbs oz 10.6	1.28
Cold water group		2418	2363	-55	1476	910	226	247	356	7	1.33
Totals.		4948	4931	-17	3021	1842	457	499	735	17.6	1.3

TABLE XI.

Combined Results of Feeding Four Milk Cows for all Three Periods.

	Period.	Feed Eaten.	Dry Matter of Ensilage Eaten	Grain Eaten.	Water Drank.	Gain or Loss.	Milk Given.	Butter Produced.	Lbs. combined Grain and Dry Matter of Ensilage to one lb. of Milk.
								lbs. oz.	
Warm water Group.	I.	1595	395	432	2322	*28	465	14 10	1.8
	II.	1768	325	354	1829	—45	531	15 5½	1.3
	III.	932	231	252	1545	*38	379	10 6	1.3
Cold water Group.	I.	1320	327	357	2403	*45	618	11 4½	1.1
	II.	1664	306	333	1582	* 5	563	11 5	1.1
	III.	910	226	247	1476	-55	356	7	1.3
Warm water Group	Totals	4295	951	1038	5696	*21	1374	40 5½	1.4
Cold water Group	Totals	3894	859	937	5461	- 5	1537	30 9½	1.2
Total of all cattle in periods I. and III.		4757	1179	1288	7746	*56	1718	43 4½	1.4
Total of all cattle in Period II.		3432	631	687	3021	-40	1094	26 10½	1.2

The table shows slightly better results when ice cold water was given than when warmed to 70° F., so far as milk is concerned. During period II, when Southern corn ensilage was fed with grain, it took slightly less of the combined grain and dry matter of the ensilage to the pound of milk than during periods I. and III. when Flint corn ensilage was given.

TABLE XII.

First Period, March 9 to 20, Twelve Days, Showing Results in Feeding the Six Fattening Cattle.—Flint Corn Ensilage with Grain.

	Weight.		Gain	Feed Eaten.	Water Drank.	Pounds Feed to 1 lb. Gain.	Dry Matter of Ensilage Eaten.	Grain Eaten.
	Beginning.	Ending						
35.................	1085	1090	5	332	603	66.00	......	......
76.................	990	1055	65	602	804	9.29	......	......
52.................	895	950	55	506	790	9.2	......	......
60.................	1045	1075	30	506	790	16.90	......	......
92.................	865	945	80	506	705	6.33	......	......
32.................	955	990	35	506	749	14.46	......	......
Warm water group..	2970	3095	125	1440	2197	11.52	357	390
Cold water group....	2865	3010	145	1518	2244	10.47	376	411
Totals.............	5835	6105	270	2958	4441	10.95	733	801

Gain.

TABLE XIII.

Second Period, March 25 to April 5, Twelve Days, Results in Feeding Six Fattening Cattle—Southern Corn Ensilage with Grain.

	Weight.		Gain	Feed Eaten.	Water Drank.	Dry Matter of Ensilage. Eaten.	Grain Eaten.
	Beginning	Ending					
35	1100	1120	20	628	564	......	......
76	1045	1072	27	748	499	......	......
52	965	965	00	628	746	......	......
60	1065	1090	25	672	525	......	......
92	940	952	12	644	445	......	......
32	970	980	10	646	579	......	......
Group 1	3110	3157	47	2004	1809	369	401
Group 2	2975	3022	47	1962	1549	361	3926
Totals	6085	6179	94	3966	3358	730	7936

TABLE XIV.

Third Period, April 10 to 17, Eight Days, Results in Feeding Six Fattening Cattle.—Flint Corn Ensilage with Grain.

		Weights.		Gain	Feed Eaten.	Water Drank.	Dry Matter Ensilage Eaten.	Grain Eaten.
		egining.	Ending					
*Warm Water	35	1125	1150	25	346	516	......	......
	76	1068	1105	37	389	394	......	......
	52	968	1000	32	346	584	......	......
†Cold Water	60	1115	1150	35	399	544	......	......
	92	970	980	10	335	410	......	......
	32	1025	1050	25	346	492	......	......
*Group 1		3057	3255	94	1081	1494	268	293.
†Group 2		3110	3180	70	1080	1446	268	292.6
Totals		6161	6435	164	2161	2940	526	585.6

TABLE XV.

Combined Results of Feeding Six Fattening Cattle for all Three Periods.

	Period.	Feed Eaten.	Dry Matter of Ensilage Eaten.	Grain Eaten.	Water Drank.	Gain.	Pounds combined grain and dry matter of Ensilage to one pound of gain.
Warm water group	I.	1440	357	390	2197	125	6.
	II.	2004	369	400.8	1809	47	16.4
	III.	1081	268	292.7	1494	94	6.
Cold water group	I.	1518	376	411	2244	145	5.4
	II.	1962	361	392.4	1549	47	16.
	III.	1080	268	292.4	1446	70	8.
Wm.wtr.group	Totals	4525	994	1083	5500	266	7.8
C'ld wtr. group	Totals	4560	1005	1095	5239	262	8.
Total of all cattle in periods	I & III	5119	1269	1386	7381	434	6.2
Total in period	II.	3966	730	793	3358	94	16.2

This table shows but little difference in effect from warming or cooling the water given to fattening animals in springtime. Water at the ordinary temperature of wells, say 50° F., would doubtless be better than either water warmed to 70° or cooled to 32°. A remarkable difference is shown in the value of the dry matter of the Flint ensilage over the dry matter of the Southern corn ensilage in both groups, between both the first and third periods as compared with the second; and between the sums of the first and third periods and the second period.

THE TIME TO CUT CORN FOR ENSILAGE.

Several samples each of No. 5, Rustler, a medium sized white Dent variety, and No. 38 Egyptian Sweet, a large, late, Sweet variety, were taken at different periods of growth for chemical analysis. Part of these were lost in a fire and the remainder, five of each, are given in the table below. These samples show a history of the changes of chemical composition for the period of twenty days, September 4th to September 24th, (see notes in the table). During this time the dent variety passed from the milk stage to the stage commonly called glazing, and it was cut for ensilage at the end of this time. Egyptian Sweet, No. 38 passed during this time from the very late blooming stage nearly to the dough stage, or to the time when the "chit" or embryo in the kernel is about half grown.

During this time the Dent corn increased its dry matter in a given weight from 11.68 per cent. to 19.66 per cent. and the weight of green fodder per acre probably increased also up to this time. The Egyptian Sweet increased its content of dry matter from 9.14 per cent. to 13.31 per cent. and the weight of green fodder per acre must also have increased very rapidly at this period.

	Date of Cutting.	Laboratory Number.	Water.	Total Dry Matter.	Crude Ash.	Ether Extract or Fat.	Crude Fiber.	Crude Protein.	Crude Ash.	Crude Fiber.	Crude Protein.	Carbohydrates.
Rustler No. 5.	Sept. 4	29	88.32	11.68	.99	.42	2.87	.95	8.51	3.62	24.59	8.18
	8	33	85.86	14.14	1.25	.47	3.23	1.13	8.83	3.32	22.82	7.94
	13	36	79.89	20.11	1.40	.68	3.76	1.49	6.97	3.36	18.68	7.41
	21	62	81.64	18.36	1.57	......	3.77	......	8.53	......	19.94	......
	24	73	80.34	19.66	1.37	.76	4.19	......	6.96	3.83	21.26	......
Egyptian Sweet. No. 38.	4	31	90.86	9.14	.71	.42	1.92	.79	7.78	4.57	21.08	8.68
	8	32	87.57	12.43	.88	.46	2.90	1.07	7.04	3.70	22.15	8.63
	13	49	86.22	13.78	1.05	.35	3.29	......	7.61	2.55	23.87	......
	21	66	86.81	13.19	.89	.63	3.30	......	6.75	4.78	24.98	......
	24	64	86.69	13.31	.77	.55	2.67	......	5.78	4.17	20.11	......

GENERAL CONCLUSIONS.

1. *For Fattening Cattle.* Our feeding experiment shows that we received more value per acre from the Flint corn ensilage than from the Southern corn ensilage.

2. *For Milk.* The large Southern corn produced one third more of dry matter per acre and this proved nearly equal in value pound for pound to the dry matter of the Flint corn.

3. The difference in effect on the weight of the cows giving milk from feeding the two kinds of ensilage is marked. The Flint corn causing an increase, while they decreased in weight when fed Southern corn ensilage. Flint corn was the best for fattening owing to thel arge amount of well ripened ears.

4. *The Warm vs. Cold Water Experiment.* Gave results very similar to those obtained in a like experiment a year ago. There was practically no difference in effect from the warming of water to 70° or cooling it to 32° or ice cold, when given to cattle which were comfortably warm all the time. Doubtless water at the ordinary temperature of well water, about 50°, would have been more

acceptable to the animals and possibly better for practical results. Warming water pays only in very cold weather; animals that are much exposed being most benefited.

5. These feeding trials certainly indicate that it pays better to put ears of corn into the silo than to husk them and then handle the stalks as dry fodder.

6. The position taken a year since by this Station, that those varieties of Dent corn which will mature in a given locality are best for ensilage in that locality, and that they should be cut up "ears and all", for the silo, is confirmed by our later investigations. Stating it a little differently we now say: Grow those kinds of Dent corn which are slightly too large to ripen but will become mature enough for ensilage, or will reach the "glazing" stage. Far northward the largest Flint varieties that will reach this stage can be used for ensilage, thus pushing the corn belt far beyond its present northern limit.

7. As stated in Bulletin No. 2, corn ensilage combined with clover hay makes a most excellent mixture of rough fodders for cattle. These with bran, shorts, corn meal, etc. in proper proportions form the most economical feeds for young cattle, and for both beef and milk stock in winter in Minnesota.

8. The great danger in feeding corn ensilage in a practical way, is in feeding too great a proportion of this, and not enough dry rough fodder and grain. Corn ensilage should never be fed alone.

9. A siloed crop certainly has as much available nutriment as the same crop dry-cured, and its succulency gives it an additional value, since this quality gives to the animal the ability to use more of the nutriment in the dry feeds given in the ration with the ensilage.

10. Where twenty, or even fewer, cattle are kept it pays to preserve enough fodder in the form of ensilage to furnish all with one third of the dry matter of their feed during winter.

11. Our own experiments, and those reported by other stations, indicate that corn produces the most digestible feed if cut in the glazing stage, or when the ends of the grains are beginning to harden.

IMPROVING CORN BY CROSS FERTILIZATION AND BY SELECTION.

WILLET M. HAYS, ASSISTANT IN AGRICULTURE.

While the breeding of live stock has become a science and most wonderful things have been attained by florists and horticulturists in improving their flowers, fruits and vegetables by systematic cross fertilizing, comparatively little has been accomplished or even undertaken by this means to produce better varieties of our staple grains, grasses and clovers.

Mere selection from fields fertilized in the natural way has alone been resorted to except in rare cases, and while much has been accomplished by this means, results of far greater importance may be hoped for from systematic cross-fertilizing followed up with rigorous selection.

Though the small size of the reproductive organs of some of these plants make the matter of cross-fertilizing very difficult; yet this simple operation can be accomplished in all grains, clovers and grasses bearing larger flowers. Red top, Kentucky blue grass, and other grasses having very small flowers could be artificially cross-fertilized only with very great difficulty.

The Fertilization of Corn, or the method of union of male and female "germs," is simple. Each ovary containing the ovule sends its silk or stile out of the husks. These silks are cylindrical or hair-like organs six to sixteen inches long bearing very small hairs along their sides. At a certain time, usually a few days after it appears in the open air, each silk excretes upon the surface a mucilaginous or waxy substance. These minute side hairs and the sticky material both serve to collect and hold the grains of the pollen which come in great profusion through the air from the anthers (little sacks) on the tassels of stalks in the vicinity. The mucilaginous substance furnishes moisture for the small seed–like pollen grain and it germinates and sends out a very fine hair-like "sprout" which enters the tissues of the silk and decends through it to the ovule in the grain on the cob, here the two unite and the result is a fertilized kernel of corn. Two or several grains of pollen may stick to a single silk, grow into it, and descend toward the ovary, but only one causes fertilization of the ovule, the others, also the silk, die as soon as fertilization of the grain has been effected.

Our varieties of field corn, especially those classed as dents, are not true to any type. The grains are rarely, if ever, fertilized by pollen from the same stalk bearing them; this is shown by the absence of grains on the cobs of stalks of corn standing alone and not near other growing corn. Every kernel represents a cross between the stalk bearing it and one of the various surrounding plants bearing the pollen.

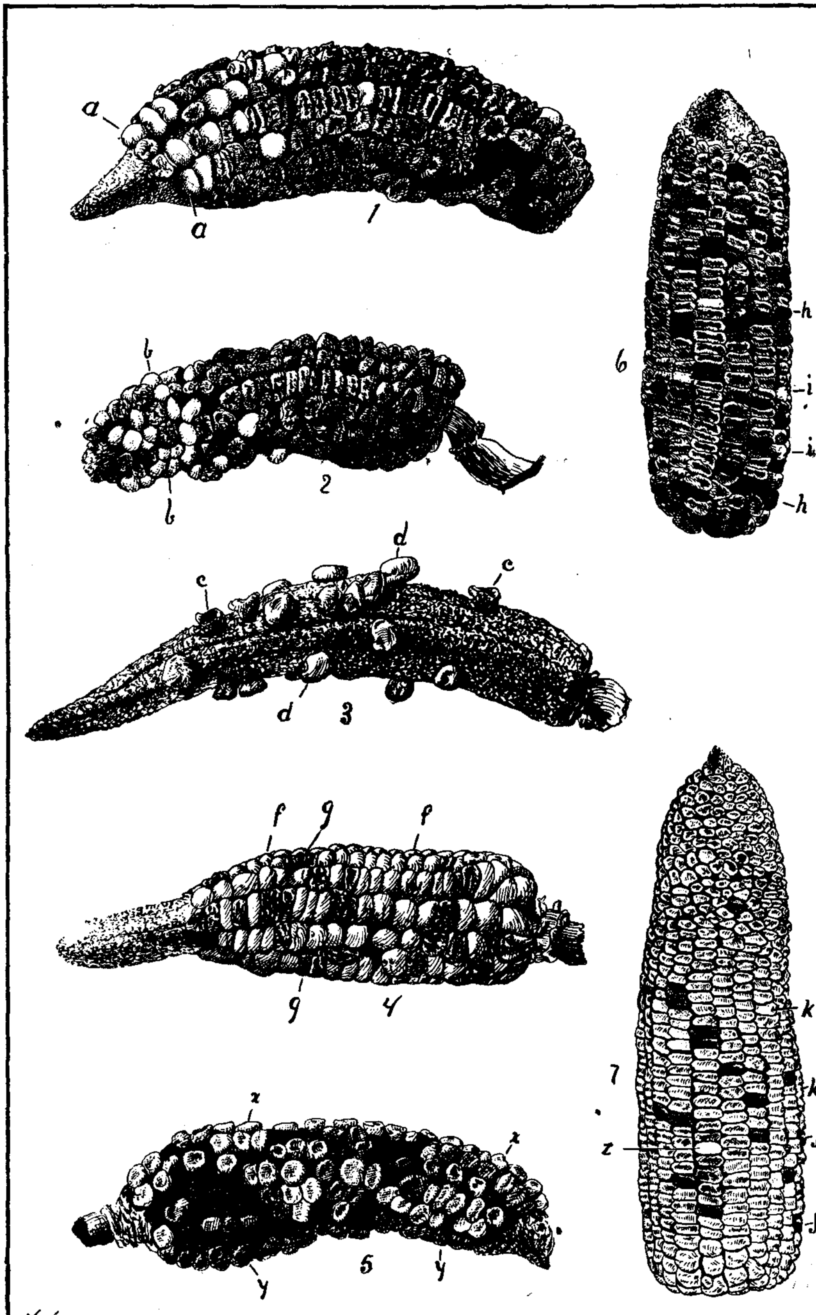
These varieties of corn have constantly been changed from one climate and soil to others, the different sorts intermixed, cultivated differently, and the seeds selected with different points in view for many years. All this has tended to break up the quality, which, in animals, we call "thoroughbred" or "line bred." The stockman would say "it is not true to type," "its blood is not strong." A basket of well selected seed ears of our best varieties of dent corn shows variations in every ear. Sometimes color has become a "thoroughbred" quality, again using the term of the stockman. I think we have nowhere else in the animal or vegetable kingdom, to use the language of another, such a "commingling of the blood of many races in a common stream," as in the Dent varieties of corn, except it may be in the mixtures of races, nationalties and families of our American people. Since this whole class of corn is in such an unstable state, so far as many of its inherited qualities are concerned, it seems reasonable to assume that it can be easily modified by judicious cross-fertilization and selection.

In numerous cases a white, yellow, or even a red Dent variety of corn has been grown on one farm, or in one neighborhood, and the seed selected with one type in view, and probably by one person, for several years or even for a few decades, thus reducing it by mere selection to nearly one type. This is a comparatively slow process, since individual grains, females, are not selected for the cross, but the group of grains on an entire ear, or on many ears. These grains have not all been fertilized by pollen from a single plant; but the tassels, male organs, of many surrounding individuals have showered their pollen upon the silks of the ears chosen.

Since pollen must come to the grain from another stalk, we can not take a single grain and develop a variety of corn from it. If we can so "breed" corn that the parentage on both sides can be controlled, we can more easily improve this crop by systematic crosses than any other of our field crops, on account of the great mixture of inherited qualities, making the varieties easily modified. Many sports can be thus developed, some of which will have the qualities most desired. These can be preserved by continued selection and "close breeding."

This locality is north of the section of country in which the Dent varieties of corn reach their greatest development. We have the best kinds of soil for corn, and in most sections or seasons, enough moisture for this plant; and we have sufficient warmth for the few summer months, but the warm weather does not last long enough. Early frosts are liable to cut short the crop of Dent corn, and far to the north in the state the Flint varieties will often be killed by early frosts. In a vain endeavor to find seed of a distinct variety of Dent corn suited in size and earliness, together with symmetry of ear, etc., I discovered that so little attention is usually paid to the selection of seed corn in this locality that the varieties (they are not worthy the name varieties) are much mixed. The ears are poorly formed, not uniform, not well filled out at the ends, grains short and loose on the cob. This corn shows that much less care has been used to improve it by selecting uniform and well developed ears than in those sections farther south where "corn is king." Our farmers need to pay much more attention to improving their seed corn by rigidly selecting the best typical ears from those fields yielding the most grain per acre. So few farmers are careful to develop good corn that more who already have superior varieties and good land to grow it upon could profitably, to themselves and to their neighbors as well, grow corn especially for seed. It is to show how to improve corn by selection and by systematic cross-fertilization that I have begun experiments in this line.

During the past season the writer studied the matter of cross-


a
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N. Hays

fertilizing corn. The numerous varieties of white and yellow Dent, white and yellow Flint and white and black Sweet corn, mentioned on pages 12 to 26 of this bulletin, were utilized and 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. From not getting the pollen on at the right time, or other causes, some of these ears produced no grains, others were only partially filled, and none were as well filled out as those ears similarly situated which were not covered. Silks from ovaries which failed to become fertilized grew a week or two after those from fertilized grains were dead and they grew to much greater length.

Both cloth and paper bags were used, but the former was much the best. Many of the ears which were covered with bags, and cross fertilized, showed unmistakable signs of crosses being produced in the natural way by third varieties. For example, numerous Mammoth White Sweet ears were covered with bags, and dusted with pollen from other varieties, but they nearly all had some black grains, showing that the pollen from the adjacent plot of Black Mexican Sweet had reached the silks, either when the bags were removed for dusting the desired pollen upon them, or by adhering to the silks before the bags were slipped over the ears, and later coming in contact with the silks as they grew out.

OBSERVED EFFECTS OF CROSSES.

The plate on the opposite page shows five ears, Nos. 1, 2, 3, 4 and 5, which were covered with bags, and two, 6 and 7 which were allowed to become fertilized in the natural way. Figure 1 represents an ear grown upon a stalk of Mammoth Sweet corn. It was cross-fertilized with pollen from a stalk of large yellow Dent corn, from seed grown in Australia, formerly taken there from Illinois. The kernels shown to be of light color (*a, a,*) are light yellow and as smooth as grains of Flint corn. There are only fifteen of these grains on the ear, and only one or two show clearly the dent form. These grains vary in color from nearly the deep yellow of the male parent to the light straw color of the female. A few kernels show that Black Mexican pollen from the adjoining plot reached the silks of this ear. All other grains on the ear appear like the grains of Mammoth Sweet corn.

Figure 2 is a cross between a large white Dent, White Giant Normandy, and Crosby's Early Sweet. The kernels figured light colored are pure white, nearly as smooth as grains of Flint corn, only showing a slight folding of the outer covering, and are hardly as large as the other kernels on the ear, all of which appear like grains of pure Triumph Sweet corn (*b*).

Number 3 was produced on a stalk of Triumph Sweet white, and was cross-fertilized by Smedley yellow Dent. Nine of the twenty-two kernels on this ear appear to be unmixed kernels of Sweet corn, (*c, c,*) while the other thirteen (*d, d,*) all show signs of the cross. Some of these are nearly smooth, but most of them are more or less wrinkled.

Number 4 grew on a stalk of Crosby's Early Sweet, white, and was fertilized by pollen from a Flint variety, Squaw Corn. Two-thirds of the kernels (*f, f,*) are light colored, only slightly dented, and appear much more like Flint than like Sweet corn. The other one-third (*g, g,*) are wrinkled like kernels of Sweet Corn, with no gradation between the two.

Number 5. Represents an ear which grew on a stalk of Mammoth Sweet corn, white, and the grains were artifically fertilized with pollen from Black Mexican Sweet. Some kernels (*x, x,*) on this ear are as light in color as those on ears of unmixed Mammoth Sweet corn, others (*y, y,*) are nearly or quite as dark as any on ears of unmixed Black Mexican Sweet, and there are all gradations of color between these two extremes.

Number 6. Grown on a stalk of Longe's Early, No. 45, which stood but a few yards from the plot of Black Mexican, and was left uncovered. About one-third of the grains (*h, h,*) show the Black Mexican cross in all shades of the mixture of the two colors. The other two-thirds show no Black Mexican cross but a few nearly white grains (*i, i,*) indicate that pollen from another white variety had some influence.

Number 7. Was also produced by a stalk of Longe's Early and was also uncovered. Besides various grains (*j, j,*) showing the Black Mexican cross and others showing a cross with a whiter variety of sweet corn, there is a grain at *z* which is a typical yellow Dent grain and must have been produced by pollen of a yellow Dent variety at least 10 rods to the eastward.

In a field of Flint corn north of this field, and separated from it by a field planted to root crops we found several ears with black grains, indicating that pollen from Black Mexican, which flowered at the same time as the flint corn, had been carried by the wind, or insects, to the distance of thirty rods or more. A dozen or more ears were dusted with pollen from the same stalk as that bearing the cob but in no instance was any grain produced.

Many other interesting crosses were produced, some of which will be propogated and tested as to their value.

Very many interesting and numerous practical facts are being developed in these experiments with "breeding" corn, and it is hoped that they will lead to the more careful improvement of varieties of corn, both for grain and for fodder and ensilage, also for table use. Methods of originating varieties of corn and of keeping them pure and improving them; also actually originating kinds suited to each part of the State is not a small undertaking but is certainly one which should be hopefully attempted. I especially request parties who have kinds of corn considered well adapted to their respective parts of the State to save and forward to the Station half a dozen ears, not shelled, that those kinds best suited to the various localities may be used in crosses here on this farm. Please send with these, statements of methods used in improving corn, by selection, etc.

WASHING AND SALTING BUTTER.

W. M. HAYS AND D. N. HARPER.

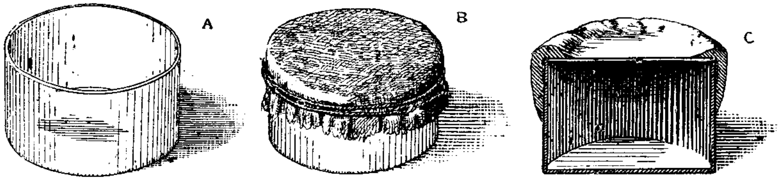
In the following pages is given the introduction to an inquiry into the methods used in the manufacture of butter, which was begun a year ago by Mr. Hays.

In no line of agricultural work has practice crystalized itself more clearly about the few essential principles governing the production of uniform results than in the manufacture of our better grades of butter. The few absolutely essential principles involved are readily understood and the way is easily made clear to the production of fine goods. Under normal conditions the cow furnishes only good butter fats, and these need only to be handled in a way to not do them any injury, in order to make a choice, well flavored product. And the great quantities of poor butter which are annually sold at "grease prices," or but little higher, are injured on account of a lack of attention to details, poorly formed habits and ignorance of improved processes on the part of farmers; also, a lack of proper appliances, together with carelessness in shipping and storing on the part of dealers. We do not hope to discover improvements in the art of butter making so as to radically modify the methods now used by our best butter makers. There are, however, many minor points which need to be made plain to those who are now expert, and especially to those who do not as yet fully appreciate the leading principles governing the art. Milk is a very unstable mixture of organic chemical compounds, and the few essential rules regarding its care *must be intelligently and scrupulously observed.* While the few main facts concerning making fine butter can be told in a few hundred words, so much of artistic skill, gained only by practice, is required that teaching butter making cannot be done alone on paper.

A study of washing and salting butter, to compare the several methods of getting the milk or curd out and the salt in, and at the same time loose nothing of the flavors, has been prosecuted. Part of the facts gathered are here given. Others only partially developed as yet will be given in a future report.

SALT WILL NOT DIFFUSE THROUGH BUTTER.

To determine some of the relations of salt to butter, while working it into the butter, the following experiment was performed: Several glass cups (A, Fig. 1) were covered with muslin, tied on as at B. The cups were then filled with clear, fresh well water, and the cloth covers were coated with unsalted butter (C). On some of these the diaphragm of butter was one-fourth of an inch thick, and was plastered down around the sides of the cups so as to seal them. The cups were then immersed in strong brine in such a manner that the clear water



inside was separated from the brine on the outside merely by the cloth and butter. Contrary to the guesses of many butter makers, no saltiness could be detected in the water in the cups, even after they had remained in this position an entire week. Other cups were then similarly prepared, excepting that the butter diaphragm was rubbed down to a mere film over the center of the muslin, by means of the warm finger. This film, which, of course, was melted by the warmth of the finger, also stood as a perfect barrier to the salt. Though it was so thin on the muslin as to render it transparent, the finger nail being easily seen through it, no salt could be detected in the water in the cup at the end of a week. Lard was tried in the same way, and it also was a perfect barrier to the diffusion of the salt. This clearly illustrates that the fats of butter are not only impenetrable to water, but to salt also; since, if the salt could diffuse through the butter, the latter, when used as a thin diaphram, would allow the salt to pass by endosmosis from the brine on the outside of the cups to the fresh water inside.

This simple but decisive experiment certainly shows that the mixing of salt into butter is not a matter of diffusion into or through the fats. In other words, the salt does not "strike into" the butter quite as it does into meat, or as into the tissues of cooked vegetables. This is also shown by placing rolls of unsalted butter into brine, in which case the butter does not become salty, and if the roll is rinsed or soaked a moment in clear water the salt is removed from its surface. It is also shown by placing rolls of butter containing crystals of undissolved salt in it, into clear water. The crystals will not travel to the water and be dissolved, nor can the water go to the crystals and there dissolve them.

In order to determine how loosely granular butter must be "massed" together to allow salt to diffuse through it, numerous other cups were prepared as before and granular butter was placed upon the muslin covers. On some of these was placed well drained butter, which had been firmly pressed together when very cold, as in a butter mould, without really working it, so that it retained its granular structure. The outer and inner surfaces of the diaphragm were not made smooth by cutting or rubbing, but were broken so as to allow the brine and the water to be in contact with the granules. It was found that salt would not diffuse through a layer of this butter one-fourth of an inch thick, unless the granules laid together so loosely that the spaces between them were plainly discernable by the unaided eye. When the churn was stopped while the granules were the size of wheat grains, or smaller, and the butter washed in the churn in ice-cold water and allowed to remain there until about forty degrees Fahr., and then pressed, not too heavily, the salt did diffuse through the mass. In this case the salt doubtless passed through water in continuous channels or interstices among the granules. Where the soft granules are pressed so as to mash them down against each other, water cannot drain out nor salt "strike in." The water must be "worked out" and the salt must be "worked in." The addition of salt to partially worked butter aids in working the water out, since the water, by dissolving the salt, increases in density and runs off more readily.

SALTING BUTTER WITH BRINE.

Water will dissolve, at ordinary temperatures, nearly 40 pounds of salt to the 100 pounds of water. Average butter contains about 12 per cent. of water. If more salt is placed in the butter than the water can dissolve it remains in crystals, since the butter fats do not dissolve the salt. If this water contains all the salt it can hold in solution, a pound of butter will contain .77 of an ounce of salt. Few butter markets demand more than this amount of salt. Most butter makers add an ounce to an ounce and one-half of salt to partially worked butter, and in completing the working out of the water a part of this salt is carried out by the water, leaving on an average three-fourths of an ounce of salt to the pound of butter. Butter makers try to leave in the butter only as much salt as will dissolve, and finding grains of salt is counted against the quality of the butter. The belief has been entertained by many, that salting could be done as well with brine as by the ordinary method, and the injurious working thus avoided. The theory seemed to be correct, but practice has not borne it out, since uniform results are not obtained. Since either the theory or the practice is defective, it was thought advisable to make a few tests which might throw light upon this subject.

A brine was made by placing fine dairy salt in water containing ice. This was allowed to stand for half an hour, or while the butter was being churned. This brine was then carefully strained to remove all undissolved salt, and a small bag of salt was placed in it to further saturate it, or, as was thought at the time, to replace whatever of salt was necessary to saturate the brine and buttermilk after the granular butter, with the small amount of buttermilk contained, was added. Granular butter was placed in this water and allowed to remain there for thirty minutes or more. Four samples were taken, two of which were worked about as butter is ordinarily worked; one was worked "dry," while another was merely pressed. These were analyzed with the following results:

No.	How Worked.	Salt, per cent.	Water, per cent.
1	Worked Dry........................	.29	....
2	Worked Medium....................	.25	....
3	Merely Pressed......................	.29	7.96
4	Worked Medium......................	.28	6.52

The very small amount of salt incorporated into the butter by this method was a surprise and could be explained only by the relative "weakness" of the brine.

Numerous other analysis made in connection with experiments to determine the amount of caesine left in butter, with different methods of washing, etc., and to be published later, showed a similarly small amount of salt gotten into the butter by brine washing.

The six samples below were prepared as follows: Nos. 5, 6 and 7 were removed from the churn when the granules would average less in size than raddish seeds, while Nos. 8, 9 and 10 were taken from the churn when the granules were larger than grains of wheat. These were placed in brine, in which fine salt had been stirred for an hour, then all undissolved salt strained out, and were gently stirred to enable the brine to surround all particles. Nos. 5 and 8 were removed in one minute, Nos. 6 and 9 in five minutes, and Nos. 7 and 10 in thirty minutes, and each sample immediately worked as nearly free of water as possible.

	No.	Time in Brine.	Salt, per cent.	Water, per cent.	Fraction of oz. Salt to pound Butter.	Ounces Water per pound Butter.
Small Granules.	5	One minute	0.22	10.99	.0325	1.7584
	6	Five minutes...	0.28	10.73	.0448	1.7168
	7	Thirty minutes .	0.31	10.40	.0496	1.6640
Large Granules.	8	One minute	.13	8.39	.0208	1.3424
	9	Five minutes...	.18	7.46	.0288	1.1926
	10	Thirty minutes.	.23	7.12	.0368	1.1392

The butter was thoroughly stirred so as to bring the water in contact with the granules. More salt was left in the butter when it remained in the brine for some time, and about one-half more was incorporated in the butter taken from the churn in very small granules than where granules were allowed to become larger, but this was mainly due to the larger percentage of water contained in the butter washed when in smaller granules.

Saturated Brine.—In order to determine the amount of salt that could be incorporated into granular butter with saturated brine, some water containing a large surplus of salt was boiled until flakes of salt crystals covered the surface of the brine. Duplicate analysis were made of the water and of the butter, salted with it, with the following tabulated results:

I. Laboratory Number.	II.	III. Water, per cent.	IV. Salt, per cent.	V. Lbs. Salt to 100 pounds Water.	VI. Ounce of Salt to the pound of Butter.
348	Butter..	12.20	4.15	34	.67
349	Butter..	8.81	2.63	30	.42
350 and 351	Brine...	....	....	32.	....

Column V in the table shows the amount of salt per 100 parts of water in the brine and also in the butter. The average in the two samples of butter is the same as in the brine used. This is conclusive evidence that if saturated brine be used the water in the butter can be nearly saturated by washing when the butter is still in the granular state. In other words, the full amount of dissolved salt can be incorporated with the butter by this means.

Other samples were analyzed for water and salt.

Laboratory Number.	Minutes in the Brine.		Water, per cent.	Salt, per cent.	Part of oz. of Salt to the pound of Butter.
100	1	Worked dry....	12.13	.64	.10
102	5	Worked dry....	11.54	....	....
104	30	Worked dry....	16.38	.94	.15
109	30	Merely pressed.	40.37	3.69	.59
101	1	Worked dry,...	11.55	.23	.04
103	5	Worked dry....	11.43	.55	.09
105	30	Worked dry....	11.05	.43	.07
111	30	Merely pressed.	11.10	1.94	.31

The figures in the above table show that more salt can be incorporated into the butter if left in the brine for ten minutes or more than if taken out sooner than this. It also shows that if the churn is stopped when the granules are very small, brine salting may be more easily accomplished than if the butter is collected into granules larger than wheat grains.

This table also shows that it is more difficult to work the water out of butter churned only until the granules are large enough to float, than from butter churned until the grains are larger. The amount of both salt and water retained in the butter merely pressed but not worked, is much the greater in case of that churned only until very small granules had been formed.

THE OBJECT OF WASHING BUTTER.

Samples of butter of the same churning were taken when the granules had only attained a size sufficient to render them able to float—without throwing salt into the churn, to increase the density of the solution so as to draw off the butter milk. Two samples were taken from the churn and not washed, one of these was worked so as to press out as nearly as possible all of the water, and another sample was merely well pressed with very little working. Two other samples were taken from the churn and placed in a vessel containing an ample supply of fresh well water, and were thoroughly "washed." One of these was worked dry while the other was merely pressed. Still other two samples were taken and similarly treated, excepting that a rather weak brine was used for washing the butter.

The churn was then revolved until the butter had collected into much larger granules, being on the average somewhat larger than grains of wheat. Duplicates of the samples mentioned above were then taken. All were then analyzed with the results as appended.

Contrary to the opinion generally held, these results would seem to indicate that washing butter either with clear well water or with brine, does not remove nearly all the curd of the butter milk.

The average of those samples taken from the churn and washed when the butter was yet in very small granules, shows that the water remaining in the butter contains less cheesy matter than that taken out after the butter had been "gathered" into larger granules. This certainly goes to prove that there is water or butter milk enclosed in the larger granules which could not be washed out. Sufficiently large amounts of wash water were used and the granular butter in both cases was left in the water and occasionally stirred for twenty minutes. Larger granules are mere collections of smaller ones, and these

THE TABLE GIVES THE ANALYSIS SHOWING THE PER CENT. OF WATER, CURD, AND ASH LEFT IN EACH SAMPLE. THE CURD CALCULATED TO THE WATER—FREE BASIS—ALSO IS GIVEN IN COLUMN EIGHT. IN COLUMN NINE IS GIVEN THE PER CENT. OF CURD IN THE WATER LEFT IN THE BUTTER.

I	II	III	IV	V	VI	VII	VIII	IX
Size of butter granules when the churning was stopped.	Laboratory number.	Washing and Working.	Water, per cent.	Curd, per cent.	Ash, per cent.	Salt, per cent.	Curd, calculated to water — free basis — per cent.	Curd in water in the butter—per cent.
Granules Diameter of lead in common lead pencil.	112	Not washed, worked dry............	12.73	.64	.04	....	.73	.50
	113	Not washed, merely pressed.........	16.90	.86	.046	....	1.03	.51
	114	Washed in clear water, worked dry..	13.23	.81	.81		....	....
	115	Washed in clear water, merely pres'd	17.45	.50	.02	....	.60	.29
	116	Washed in weak brine, worked dry..	11.58	.46	.03	.22	.52	.40
	117	Washed in weak brine, merely pres'd	17.81	.45	.027	1.19	.54	.25
Granules slightly larger than grains of wheat.	118	Not washed, worked dry............	12.49	.67	.05	....	.76	.54
	119	Not washed, merely pressed.........	12.24	1.17	.044	....	1.33	.94
	121	Washed in fresh water, worked dry..	8.09	.57	....	....	.62	.70
	120	Washed in fresh water, merely pres'd	12.63	.49	....	....	.56	.40
	123	Washed in brine, worked dry.......	8.16	.71	.017	.23	.77	.87
	122	Washed in brine, merely pressed....	12.33	.60	.024	4.77	.68	.49

in turn are collections or aggregations of the fat globules of the milk. The interstices among the smaller or larger cohering masses of butter, are filled with water. The caseous matter, even if it is soluble, cannot escape from these into the clear wash water outside of the granules, because the fats do not allow substances like these to diffuse through them.

The amount of ash remaining in the butter was very much reduced by washing when in the granular form. The curd, however, is not readily dissolved and must be carried out mechanically by the water, while the soluble materials can be as easily removed without much agitation. Considerable stirring, as by revolving the churn, materially assists the water in carrying off the particles of curd.

DIVISION OF HORTICULTURE.

SAMUEL B. GREEN.

GREENHOUSE WALLS.

RELATIVE PROTECTIVE VALUES OF DIFFERENT METHODS OF CONSTRUCTION.

The manner of constructing the sides of buildings has been an important subject for discussion, since the time when men first made the rudest huts to protect themselves from the weather, to the present day. To know how to build a wall that is of low cost and that is tight and durable is not enough. A wall to be perfect, or even sufficient for many purposes, must have the quality of keeping out the greatest practical degree the effect of the cold air which may come against its exterior surface. The "cold" as we commonly term the general effect of low temperature in the air, must enter a building either as cold air or by conduction. When a room is cold by reason of cold air entering it, there must be some opening through its covering which will allow the warm air inside to pass out and its place to be filled by the heavier cold air. But a room may be cold and yet have no opening whatever in its covering. In such a case the low temperature is caused by the cooling of the air in the room by its contact with its sides, floor and ceiling. This latter coldness, or coldness resulting from conduction, may to a great extent be limited and controlled by methods of building.

There is a wide spread and well grounded faith in having a complete dead air space in the walls of buildings, and its benefits will be apparent to any close observer from the effect it may have in protecting his body. There are many ways of putting an air space into walls and while it is of some value to have a general estimate of the kinds of walls in use, it is of much greater importance to know their relative values by a careful trial and to know just how much better one may be than another. Before undertaking this experiment I looked the ground over carefully but was not able to find any exact data as to the relative amount of conductive capacity, of walls built in different ways. I met many persons who had very strong opinions and impressions as to the results of certain forms of wall building, but they could not substantiate their statements by any sure experiment.

In the following article I have obtained the results given from an experiment with various different walls of a green house but the record is just as reliable when applied to the structure of walls of other buildings. During the past season a new greenhouse was erected on the station grounds and I had a part of one of the east side walls divided into seven different sections, forming as many kinds of walls. These sections were each two feet wide and five feet high and were isolated from each other by two thicknesses of one inch board with an air space between them. Against the inside of each section was placed a shallow box (size 24x15x4 inches) without any back where it went against the wall. In the front of the box was a door which was kept shut except at such times as the reading of the thermometer in side was recorded. The cracks between the boxes and the sections were filled with cement.

The experiment walls were made as follows:

Section 1. Is made the same as the general walls of the greenhouse, viz: Two four-inch walls of brick, with a three-inch hollow tile between, and so laid that there is an air space of one inch on each side of the hollow tile, between it and the brick covering, making this wall thirteen inches thick when finished and with three dead air spaces. Fig. I., Plate I.

Section 2. Is a solid brick wall thirteen inches thick. Fig. II., Plate II.

Section 3. Is a brick wall thirteen inches thick, having a five-inch air space inside. Fig. III., Plate IV.

Section 4. Two four-inch courses of brick are laid on each side of a three-inch box, which is as high and wide as the section. In other words, it is a three-inch hollow wooden wall with a brick veneer on each side. Fig. IV., Plate IV.

Section 5. Is made of a four-inch studding covered with matched boards, building paper and clapboards on the outside only. Fig. V., Plate II.

Section 6. This was made the same as number five, but was, in addition, boarded up inside, and so was left a four-inch dead-air space. Fig, VI., Plate II.

Section 7. This was made the same as number six, only it was filled with dry pine saw dust. Fig. VII., Plate II.

All of the above mentioned sections are so tight that there is no circulation of air in them, and no water can get inside.

The readings of the thermometers in the boxes against every section, and those recording the temperature of the greenhouse, and the outside air, were taken at 7 a. m., 10 a. m. and at 6 p. m.

In the following table will be found the readings of the thermometers from January 24th, to March 1st, which period included the coldest weather of the winter.

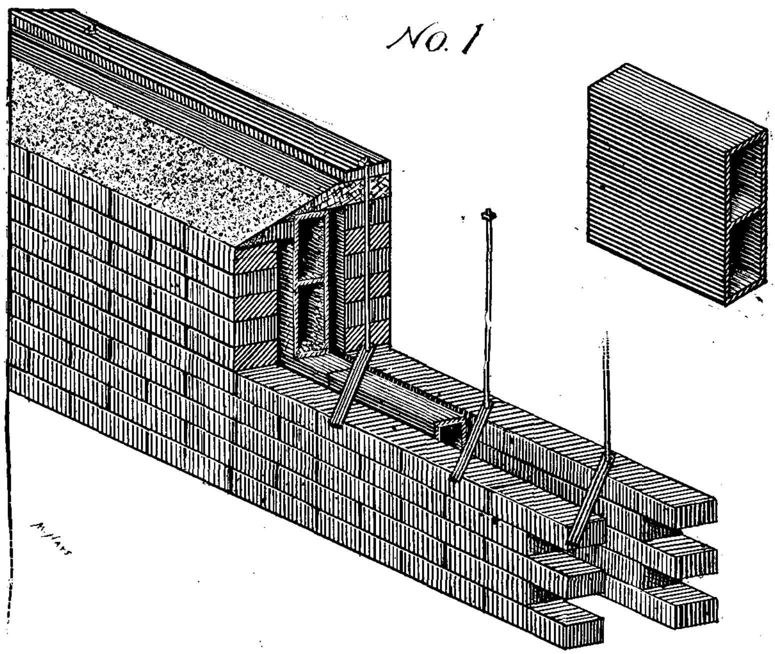


PLATE I.

GREENHOUSE WALL MADE OF BRICK AND HOLLOW TILE.

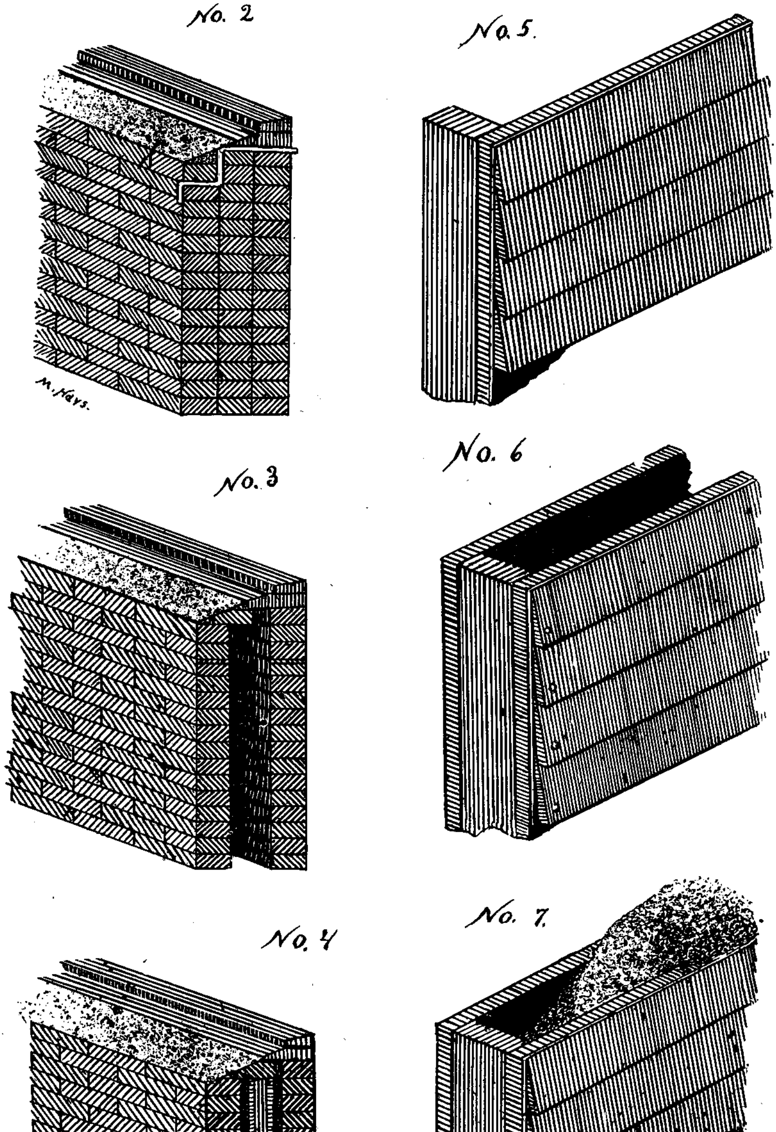


PLATE II.

CROSS SECTION OF EXPERIMENT GREENHOUSE WALLS.

TABLE SHOWING THE TEMPERATURES OF VARIOUS GREENHOUSE WALLS FOR PART OF THE MONTH OF JANUARY, 1889. (Fahrenheit.)

Day of the Month.	Thermometer Reading at 7 A. M.								
	Brick and hollow tile.	Solid brick wall.	Hollow brick wall.	Wood, with brick veneer.	Single wooden wall.	Hollow wooden wall.	Wooden wall filled with saw-dust.	Temperature inside of greenhouse.	Temperature outside.
24	63	57	57	61	40	54	57	60	12
25	65	61	60	65	46	58	61	60	22
26	64	63	59	64	34	55	57	52	6
27	62	59	59	62	36	54	57	57	2
28	60	54	54	57	31	47	52	45	-6
29	63	56	56	63	40	55	57	57	6
30	67	61	61	67	88	60	62	53	19
31	60	55	58	60	33	48	53	48	3
Averages	63	58.5	58	62.7	37.5	55.1	57	54	8

Day of the Month.	Thermometer Reading at 10 A. M.								
	Brick and hollow tile.	Solid brick wall.	Hollow brick wall.	Wood, with brick veneer.	Single wooden wall.	Hollow wooden wall.	Wooden wall filled with saw-dust.	Temperature inside of greenhouse.	Temperature outside.
24	61	56	54	59	46	52	55	60	22
25	62	60	58	62	50	56	57	74	30
26	61	57	55	61	33	49	54	58	6
27	60	57	55	60	33	55	55	55	5
28	56	52	47	56	31	46	48	64	7
29	57	52	52	57	42	50	51	65	13
30	61	57	55	51	45	53	57	65	25
31	58	54	52	57	38	47	51	69	6
Averages	59.5	55.5	53 5	59.5	39.7	51	53.5	63.4	14.2

Day of the Month.	Thermometer Reading at 6 P. M.								
	Brick and hollow tile.	Hollow brick wall.	Solid brick wall.	Wood, with brick veneer.	Single wooden wall.	Hollow wooden wall.	Wooden wall filled with saw-dust.	Temperature inside of greenhouse.	Temperature outside.
24	57	53	54	56	48	56	56	61	29
25	61	66	68	60	50	59	60	61	30
26	55	50	52	55	55	46	49	52	6
27	56	55	53	56	34	49	51	55	10
28	52	47	47	52	34	45	47	46	12
29	53	48	50	53	37	50	50	49	21
30	54	48	52	54	42	50	50	51	24
31	53	47	49	53	35	45	48	41	9
Averages	55.1	51.7	53.1	54.8	38.1	50	51.7	52	17.6

TABLE SHOWING THE TEMPERATURE OF THE VARIOUS GREENHOUSE WAL MONTH OF FEBRUARY, 1889.

Day of the Month.	Thermometer Reading at 7 A. M. Brick and hollow e.	Solid brick wall.	Hollow brick wall.	Wood with brick veneer.	Single wooden wall.	Hollow wooden wall.	Wall filled with saw-dust.	Temperature inside of greenhouse.	Temperature out-side.
1	55	50	48	54	32	47	47	52	13
2	49	46	45	49	32	42	45	34	12
3	64	60	58	63	47	60	62	64	21
4	61	57	56	60	47	53	56	50	28
5	57	52	50	56	20	39	42	29	-22
6	57	50	48	56	25	45	51	47	-21
7	60	54	52	59	33	48	53	46	2
8	64	58	57	63	43	56	60	65	12
9	51	57	55	59	36	49	54	54	5
10	63	59	57	62	39	53	51	57	10
11	63	59	57	61	35	50	55	57	-1
12	66	61	60	65	45	57	59	61	-5
13	67	61	59	6[illegible]	48	56	60	60	5
14	64	58	56	62	36	54	58	61	13
15	66	61	59	65	50	57	60	60	20
16	69	64	63	67	45	51	62	74	24
17	66	61	60	64	32	50	56	55	-10
18	58	53	51	56	29	44	50	52	-15
19	60	53	51	58	30	46	51	47	-16
20	61	52	51	57	30	46	52	54	-20
21	60	52	54	60	41	53	55	59	15
22	60	51	50	57	29	43	50	52	-20
23	57	48	48	55	25	40	48	56	-30
24	52	42	43	53	26	37	44	34	-10
25	54	44	45	54	30	40	46	51	-11
26	59	53	4	59	44	52	55	61	13
27	61	52	53	61	49	55	56	59	20
28	64	57	56	62	48	59	60	65	22
Averages	60.7	54.4	53.3	5 .	36.6	49.6	53.5	54.1	2.07

Day of the Month.	Thermometer Reading at 10 A. M. Brick and hollow tile.	Solid brick wall.	Hollow brick wall.	Wood, with brick veneer.	Single wooden wall.	Hollow wooden wall.	Wall filled with saw-dust.	Temperature inside of greenhouse.	Temperature out-side.
1	53	48	47	52	37	44	46	55	24
2	59	45	44	58	37	43	45	71	23
3	64	60	58	63	50	58	60	75	26
4	57	56	55	58	42	52	54	56	24
5	51	47	42	52	25	34	41	59	-15
6	55	50	47	54	31	45	48	74	-11
7	57	50	47	56	32	44	49	57	3
8	62	57	56	61	43	53	57	73	12
9	55	49	47	54	32	46	49	69	18
10	60	42	41	57	32	41	46	71	22
11	66	61	59	63	41	57	61	75	4
12	65	60	57	64	35	52	56	70	-3
13	63	58	56	63	37	52	56	56	9
14	62	56	55	61	37	52	56	66	6
15	63	57	56	62	42	52	56	57	23
16	56	53	51	56	40	48	50	52	26
17	62	57	65	61	33	48	52	57	-2
18	58	52	50	57	31	47	52	55	-6
19	52	46	44	52	29	38	45	60	-7
20	56	48	48	55	34	44	48	69	-5
21	59	52	54	60	42	53	55	76	24
22	56	49	46	55	31	43	47	72	-18
23	58	47	47	57	33	45	49	85	-21
24	52	43	43	52	33	42	45	57	-1
25	56	46	49	56	40	49	51	73	4
26	59	49	51	60	45	51	54	65	22
27	60	52	52	60	52	50	57	80	27
28	65	58	57	63	59	63	63	87	35
Averages	58.5	51.7	50.8	57.8	37.7	48.1	51.7	66.8	8.07

Day of the Month.	Thermometer Reading at 6 P. M. Brick and hollow tile.	Solid brick wall.	Hollow brick wall.	Wood, with brick veneer.	Single wooden wall.	Hollow wooden wall.	Wall filled with saw-dust.	Temperature inside of greenhouse.	Temperature out-side.
1	48	45	44	48	40	45	47	58	29
2	54	50	50	54	47	55	55	58	30
3	60	56	55	60	45	46	56	56	24
4	53	51	50	52	37	47	51	45	10
5	52	47	46	51	32	46	50	53	-8
6	55	49	48	54	34	49	51	63	-2
7	54	52	51	54	42	48	53	51	17
8	59	55	53	58	44	53	56	61	19
9	61	57	55	60	44	55	58	59	12
10	63	57	57	62	46	57	60	71	21
11	61	56	56	61	41	54	·9	55	8
12	59	55	54	60	38	51	56	52	7
13	56	52	51	56	37	47	51	52	13
14	57	52	51	57	39	48	52	54	17
15	60	57	55	59	42	52	55	57	15
16	67	63	61	66	50	62	66	58	15
17	60	55	55	59	35	52	57	58	5
18	50	46	46	50	35	44	47	45	2
19	47	43	42	47	33	39	44	53	8
20	50	40	45	52	39	46	49	52	19
21	55	49	51	56	40	48	52	32	-3
22	51	45	44	52	28	39	47	49	18
23	52	43	45	52	30	43	49	53	14
24	55	45	47	55	32	46	49	50	3
25	51	43	46	52	36	45	47	44	11
26	58	48	50	59	45	52	55	57	23
27	58	52	51	57	50	54	55	65	32
28	62	58	57	61	58	54	63	72	42
Averages	56	50.8	51.1	55.8	39.2	49.1	53.3	54.7	12

CONCLUSIONS.

1st. Where more than one air space is put in the brick wall (Nos. 1 and 4) it is much warmer than the lined board wall filled with saw-dust; but the lined board wall with a saw-dust filling is as warm as the brick wall with one dead air space.

2nd. Of the brick walls, the warmest is that made of brick and hollow tile, leaving three air spaces.—(Fig. 1, plate III.)

3rd. The wooden wall with a brick veneer (Fig. No. 4) is warmer than the hollow-brick wall—(Fig. No. 3).

4th. The hollow-brick wall with a five inch air space, was nearly, though not quite so warm as a thirteen inch solid wall.

5th. Of the walls made of wood the warmest is that made with an interior lining and filled with four inches of dry saw-dust. (Fig. 7.) This wall was warmer than the wall made with a hollow air space of four inches and not filled with saw-dust. (Fig. 6). This difference was most apparent in the severest weather.

6th. There is a very great difference between the walls built of a single, well-made wooden covering, even though having tarred paper under the clapboards and inside, (Fig. 5, plate IV.) and the same wall when well sheathed up inside. This difference is so great that for stables as well as for greenhouses and dwelling houses, it will well repay the owner to sheath up inside and even to fill the air space with some dry, non-conducting material. In this experiment the temperature of the simple wooden wall (Fig. 5) in severe weather was frequently from five to ten degrees below the freezing point while none of the other kinds reach nearly so low a temperature.

REMARKS.

Probably the cheapest warm wall for general farm purposes is one made of wood with a four inch air space which is filled with dry saw-dust or some other good non-conducting material.

When a hollow wall is to be filled with saw-dust or similar material, it is all important that the material should be dry when put in and then be so protected that it cannot get wet either from water coming in at the top or the sides.

In making a dead air space the sides of the wall should be tight both inside and out, in order to prevent any circulation of air and to have it a true *dead air space.* Dead air is the best of non-conductors, but its efficiency depends to a great extent upon the number of times it is broken up and multiplied.

While dry saw-dust gave very excellent results as a filling for walls in this case, it is probable that dry chaff, cut straw or hay would answer nearly as well for the same purpose.

EXPERIMENT WITH POTATOES.

COMPARATIVE MERITS OF DIFFERENT VARIETIES.

Most of the potatoes which have been tried, and whose record is given in the following detailed experiment, have been grown on the Station lands for four seasons. They have each year been grown from the largest and best whole tubers of each kind for seed, and yet many varieties have shown a great tendency to deteriorate from year to year. Besides the varieties mentioned in table one, which are the best kinds grown at the station last season, I have this spring discarded over 150 varieties (table II) which had so deteriorated as to be worthless for future experiment purposes. These varieties (table II) consisted of potatoes, the most of which had never merited much attention in this country. Many of them were of foreign origin, and the rest, were, mostly, those which have been only cultivated successfully over small areas, and have had but a short lived local reputation, or else have had a wide reputation but seemed to have run out." Most of the stronger and better varieties after a few seasons have shown a much greater tendency to blight than new tubers of the same or some other kind when obtained from a distance.

The forty European kinds which have been cultivated, were originally imported from France and England and are varieties, which, in those countries are very highly esteemed, yet most of them have developed great weakness after the first season. Several of them have produced a fair crop some years but the tubers lacked in quality and have not been nearly equal to the better American kinds.

These facts would seem to show conclusively:—

1st. That it is impracticable if not impossible, to maintain continuously for many years most varieties of potatoes, in their pristine purity and excellence on such land, in such a climate as we have here.

2d. That it is very important to occasionally change our potatoes which are to be used for planting, and to obtain new stock from a distance even though not far distant.

3d. That we have no reason to expect to obtain from Europe varieties which are as good as the best kinds which have originated in this country.

NOTES ON THE TABLE.

The marks on blight in the following table are given on a scale from 0 to 10. Where 10 is given it means total blight at the time the observation was made.

I have not indicated the ripening period of the different kinds because of the prevalence of blight, but I have inserted, instead, a statement of the general period, of ripening of the most valuable varieties.

Each variety was tested in March by baking, and its quality is given in the table. The tubers were free from any signs of growth when this test was made.

All the varieties were planted May 30th, on a good open clay loam, which was rather wet at the time, For three years previous it had been cultivated in strawberries, and had formed a heavy sod which was turned under the autumn previous to planting.

The planting was done in rows three feet apart with the potatoes one foot apart in the rows. Whole potatoes were used for seed.

VARIETIES WORTHY OF SPECIAL MENTION.

Polaris.—This potato we have grown for two years, having originally obtained the stock from the U. S. Department of Agriculture. It is a very early variety of great productiveness and excellent quality. It varies from long to oblong in shape, with very few protruding eyes. The foliage is strong and vigorous. It has proven to be a good cooking potato for both early and late use. This spring, after having started sprouts six inches long, it cooked dry and mealy. I consider it the most promising potato we are now growing for general use.

St. Patrick.—This old variety has produced as many good potatoes to the hill as any of the varieties grown the past season It is oblong in form with white skin, an excellent cooking potato, and presents a nice, bright appearance.

Late Beauty of Hebron.—This gave one of the heaviest yields the past season, and was only exceeded in weight of crop by the St. Patrick. It is of good form and color, with a white skin and rather deep eyes. Quality not of the best, but it is a good table potato for a heavy cropper.

Vanquard.—One of the earliest varieties and a good cropper. Of good quality, with a pink skin. Tubers oblong, with shallow eyes.

Windsor No. 1.—Received from the Des Moines Seed Company. It is early and a good table potato. Tubers rather irregular in form, with a white skin. Productive and desirable.

Rural New Yorker No. 2.—Of good quality and productive. Vines healthy and strong. Tubers round in form and of good size. Skin white.

Charter Oak.—Tubers were obtained from Peter Henderson & Co. in 1888. It comes to us highly recommended. Has grown vigorously on our land the past season, but has proven to be a very light cropper and only of medium quality. Form irregular oval. Skin and flesh white. Eyes shallow, and blossom light-blue in color.

Extra Early Vermont.—This is a desirable early potato of fair quality. Tubers pinkish-white and oblong, with shallow eyes. A very heavy cropper.

No. 1.—This stock was received in 1888 from J. J. H. Gregory fcr trial. Form long, with a few rather deep eyes. Quality good. Medium early in season, and a promising variety.

Chas. Downing.—Received from J. J. H. Gregory in 1888, who highly recommends it. It has also the highest endorsement of the Ohio Agricultural Experiment Station. I find it to be oval in form, of medium size, with shallow eyes; flesh white, and of good cooking quality. Productive.

Early Mayflower.—Of excellent quality and a good cropper. Eyes few and shallow. Skin and flesh white and attractive. A good potato for early use.

Early Oxford.—Received from J. J. H. Gregory for trial in 1888. It has much the shape and cooking qualities of the early rose, but is lighter in color. Of fair size and quite productive. A promising early kind.

Dakota Seedling.—A large potato with a red, smooth skin, and of good cooking quality. With us its chief objection is that it has shown a tendency to grow hollow, and we cannot recommend from our experience. Form long, with shallow eyes. Season late.

Dakota Red.—A large potato with white flesh and red skin. Of medium cooking quality. Very productive and a good keeper. Matures late.

Empire State.—This variety is a good cropper and an excellent table potato. Somewhat irregular in shape, inclining to oblong; desirable for the main crop. Season medium late.

Globe.—An excellent white-skinned potato of rather irregular form. A heavy cropper, and in some soils of excellent quality. With us of only fair quality.

Morning Star.—Stock received from ——————— in 1888. A very excellent potato, of good size and form. Skin and flesh white; eyes shallow. A heavy cropper, and very desirable if it continues to deport itself as well in the future as it has with us this year.

Belle.—A white-skinned, good cooking variety. Has given a uniformly heavy yield since its introduction. A well known and valuable variety.

Early Sunrise.—Tubers long and uniform in size. Very early and a heavy cropper. Also an excellent table potato.

TABLE I

SHOWING YIELD OF POTATOES IN POUNDS FROM TEN HILLS, THEIR QUALITY, &c.

NAMES.	Weight of seed when planted.	Height of Haulm taken June 16.	Height of Haulm taken July 17.	Blight on scale of 10.	Wgt. of potatoes from 10 hills, dug Sept. 20.	QUALITY.	When marketable.	COLOR AND SHAPE.
	lbs.	in.	in.		lbs.			
Acme	1¼	4	12	7	22	Good	Medium	White skin, round, small
Adirondack	1½	3	20	2	9	Fair		White skin, round, globular, eyes deep.
Agawam	1¼	5	22	0	22	Good	Medium	White skin, oblong, eyes rather shallow.
Alpha	1	3	12	8	5	Very good	Late	White skin, oblong, eyes shallow, very smooth.
American Giant	1¾	5	28	5	17	Good	Medium	White skin, oblong, eyes shallow.
Angola	½	6	14	3	7½	Fair		White skin, irregular, oblong, eyes shallow.
Badger	¾	5	18	2	16	Medium	Late	Light pink skin, oblong, eyes rather shallow.
Baldwin	2	5	16	9	12	Good	Late	White skin, ovate, eyes shallow.
Beauty of Hebron	2	6	20	1	22	Good	Early	White skin, flesh.
Beauty	1½	5	20	2	23	Good	Medium	White skin, long, eyes shallow.
Bellaire	½	3	20	6	15	Fair	Late	White skin, oblong, eyes rather deep.
Belle	2¼	4	26	2	22	Good	Medium	White skin, long, eyes deep, valuable and well known.
Berkshire	1½	3	22	0	23	Medium		Pink skin, irregular, oblong, eyes shallow.
Black Prince	1	5	14	1	11	Poor	Late	Purple skin, long, eyes shallow, smooth, nice.
Britanicum	1½	4	14	4	6	Poor	Medium	White skin, globular, eyes very deep.
Bonanza	1	5	22	0	6	Good		Light pink skin, oblong, shallow eyes.
Bradford Seedling	1¼	3	20	5	16	Medium		White skin, very irregular in form, rough.
Breese's Prolific	¾	0	14	0	8	Fair		White skin, oblong, eyes shallow, smooth.
Brunhall's	½	5	20	3	10	Good	Medium	White skin, long, eyes rather deep.
Brunhall's No. 4	2¾	5	26	3	9	Good	Medium	Light pink skin, oblong, eyes deep.
Brownell's Best	1¾	4	23	1	16	Fair		White skin, irregular, in shape, eyes shallow.
Brownell's Success	¼	2	20	0	6	Fair	Late	White skin, long, eyes shallow.

TABLE I (Continued)

NAMES.	Weight of seed When planted.	Height of Haulm taken June 16.	Height of Haulm taken July 17.	Blight on scale of 10.	Wgt. of potatoes from 10 hills dug Sept. 20.	Quality.	When marketable.	COLOR AND SHAPE.
	lbs.	in.	in.		lbs.			
Bucyrus.............	1¼	3	20.	3	17	Medium....	....	Light pink skin, oblong, eyes shollow.
Bulkeley's Seedling...	¾	4	12	8	4	Good.......	....	White skin, oblong, eyes rather deep.
Burbank.............	¾	3	14	5	10	Good.......	Late	White skin, long, eyes deep, well known.
Calico	½	2	12	9	7	Poor........	....	Purple, irregular in shape, eyes shallow.
California Purple.....	¾	5	18	7	5	Poor........	Late......	Dark purple, oblong, shallow eyes.
Cayuga	2½	5	14	1	24	Good.......	....	White skin, long, eyes deep.
Centennial............	1	0	10	4	3¼	Fair........	....	Pink skin, irregular, globe shape, eyes shallow.
Champion of America.	3	5	26	4	20	Poor........	Late......	Brownish white skin, oblong, eyes deep.
Charter Oak..........	1	8	32	0	10	Medium....	Medium ..	Irregular oval, white skin, eyes shallow.
Chas. Downing........	1	5	20	1	19	Good.......	Early	White skin, round, flat, eyes deep.
Chenery...............	1½	3	18	0	6	Very good..	....	White skin, irregular in shape, eyes shallow.
Chicago Market.......	1¼	6	19	5	8½	Fair........	Medium ..	Light pink skin, oblong, eyes deep.
Chili No. II..........	¾	2	14	5	6	Medium....	Early	Light pink skin, oblong, eyes rather shallow.
Clark's No. 1.........	1½	5	22	7	13	Good.......	Early	White skin, oblong, eyes shallow, rough.
Coldstream...........	2	5	20	7	14	Good.......	....	White skin, long, eyes rather deep.
Colebrook	¾	4	16	1	10	Fair........	....	Light pink skin, longish, eyes shallow.
Conner...............	2¼	1	20	0	10	Good.......	Late......	White skin, randish, eyes rather shallow.
Cornell's Kidney......	¾	4	16	.6	6	Good.......	....	White skin, long, eyes very shallow.
Cullock	1¾	3	18	2	14	Good.......	....	White skin, oblong, eyes rather deep, rough.
Cusco Seedling........	2½	5	20	9	11	Fair........	....	White skin oblong, eyes rather deep.
Dakota Red...........	3¼	4	30	0	21	Medium....	Late......	Red skinned, long in form, eyes deep.
Dakota Seedling......	¾	4	28	0	18	Good.......	Late......	Red skin, oblong, eyes shallow tubers often hollow.
Dover Seedling.......	1¾	2	18	7	8	Fair........	Medium ..	White skin, nearly round, eyes shallow.
Dr. White............	1	3	26	7	14	Very good..	Late......	White skin, long, eyes shallow.

Dunmore............	1¼	3	16	8	8	Good.......	....	White skin, oblong, eyes shallow.
Dykeman	2¾	5	18	4	18	Fair.......	....	White skin, roundish, eyes very deep.
Early Blue..........	½	2	20	3	4	Medium....	Early	Light pink skin, roundish.
Early Favorite........	½	4	16	8	13	Good.......	Early	White skin, oblong, eyes shallow.
Early June..........	2	4	16	9	14	Good.......	Early	White skin, oblong, eyes shallow.
Early Market.........	1¼	4	12	8	10	Very good..	Early	Light pink skin, eyes rather deep.
Early Mayflower......	1½	5	24	3	17	Very good..	Early	White skin, oblong, eyes shallow.
Early Oxford.........	1	5	26	2	18	Good.......	Early	White skin, oval, eyes exc'd'ngly shallow,(promising)
Early Queen.........	1¼	4	16	4	9	Fair.......	Early	White skin, oblong, eyes shallow.
Early Rose..........	1	5	20	5	25	Good.......	Early	Light pink skin, oblong, eyes rather deed.
Early Rose Seedling..	1	4	24	10	7	Fair.......	Early	White skin long, eyes shallow.
Early Scotch Cottage..	1½	3	19	3	18	Good.......	Early	White skin, oblong, eyes shallow.
Early Shaw..........	1	4	20	7	7	Poor.......	Early	Pinkish white skin, long, eyes deep, rough.
Early Sunrise.........	1¾	6	20	4	19	Fair.......	Early	Red skin, irreg. oblong, eyes deep, early & productive
Early Telephone......	1½	3	16	2	16	Fair.......	Early	Light yellow skin, oblong, eyes shallow.
El Paso..............	2¼	3	20	10	28	Good.......	....	White skin, long, eyes deep, poor.
Empire	1	3	18	9	4	Good.......	Medium ..	White skin, irregular in form, eyes shallow.
Empire State.........	1½	6	20	3	16	Fair.......	Medium ..	White skin, irregular, oblong, eyes deep.
Eureka	¾	4	20	1	14	Good.......	....	White skin, oblong, eyes rather shallow.
Extra Early Seedling..	¾	2	14	9	8	Poor.......	Early	White, oblong, eyes shallow, rough.
Extra Early Vermont..	1¾	5	24	1	25	Fair.......	Early	Pinkish white skin, oblong, eyes rather deep.
Field Crop...........	¾	3	18	1	10	Good.......	Medium ..	White skin, oblong, eyes shallow.
Findlay..............	1½	4	21	0	14	Medium....	....	Light pink skin, ovate, eyes rather deep.
Forfarshire Red......	⅛	3	9	5	3	Medium....	....	Light pink skin, gobular, eyes rather deep.
Foster's Late Rose....	¾	3	16	0	8	Fair.......	Late......	White skin, round eyes rather deep.
Fox Seedling.........	¼	3	10	5	5	Good.......	....	White skin, roundish, eyes shallow.
Garfield.............	1¼	3	22	4	8	Fair.......	....	White skin, oblong, eyes rather deep.
Garnet Chili.........	1¾	4	16	9	5	Poor.......	....	Red skin, oblong, eyes rather deep.
Gem	2¼	7	24	7	18	Good.......	....	White skin, oblong, eyes deep, small.
Giant...............	1¾	2	18	9	10	Good.......	....	White skin, oblong eyes shallow.
Gideon's Seedling.....	1	5	14	10	9½	Fair.......	Medium ..	Light pink skin, roundish, eyes shallow.
Gilman	1½	2	21	3	12	Poor.......	....	Yellow skin, oval, eyes verry shallow.
Globe................	1½	4	16	0	25	Fair.......	....	White skin, irregular in form, eyes rather shallow.
Gregory No. 1.........	1	6	21	0	20	Good.......	Medium ..	Light pink skin, long, eyes deep.
Hamilton	1	3	14	6	9	Fair.......	....	White skin, oblong, eyes shallow, very smooth.
Harrison.............	1½	3	22	1	16	Medium....	....	White skin, long, eyes deep.

TABLE I (Continued.)

NAMES.	Weight of seed when planted.	Height of Haulm taken June 16.	Height of Haulm taken July 17.	Blight on scale of 10.	Wgt. of potatoes from 10 hills dug Sept. 20.	Quality.	When marketable.	COLOR AND SHAPE.
	lbs.	in.	in.					
Harlequin	1¼	4	18	8	18	Medium	Early	Light pink skin, oblong, eyes shallow.
Hickory	¾	5	12	2	5	Poor.........	....	White skin, roundish, eyes rather deep.
Hyde's Seedling.......	1½	6	24	8	16	Poor.........	....	Light pink skin, ovate, eyes shallow.
Ice Cream.............	2¼	5	26	7	18	Fair.........	Medium ..	Light pink skin, oblong, eyes rather deep.
Improved Gem.......	1¼	5	18	9	6	Fair.........	....	Light pink skin, oblong, eyes shallow.
Irish American.......	¾	3	14	3	7	Fair.........	....	White skin, oblong, eyes rather deep.
James Vick...........	1	4	18	8	8	Medium....	....	White skin, roundish, eyes shallow.
Jersey Blue..........	2½	5	24	9	15	Good.......	Medium ..	White shin, long, eyes small and shallow.
John Bright..........	1¾	6	13	10	16	Poor.........	....	Light pink skin, long, eyes rather deep.
Jane's Seedling.......	1¾	3	18	8	5	Fair.........	....	Light pink skin, oblong, eyes small and shallow.
Jumbo.....	3½	5	24	0	25	Good.......	Medium ..	White skin, long, eyes shallow.
Kansas...............	1¼	4	20	1	13	Good.......	....	Light red skin, globular, eyes rather deep.
King of Potatoes......	2	5	20	10	15	Fair.........	Medium ..	Light pink skin, long, eyes shallow.
King of Jackson's.....	1½	5	21	9	11	Good.......	....	White skin, oblong, eyes shallow.
King of Sweden.......	2	3	20	6	10	Poor.........	....	Purple skin, roundish, eyes rather shallow.
King of the Earlies....	1	5	14	3	10	Medium....	Early	White skin, oblong, eyes rather deep.
Lackawanna..........	1¼	2	20	2	14	Medium....	....	Brownish skin, long, eyes shallow.
La Plume............	1½	3	20	6	9	Good.......	Medium ..	Light pink skin, oblong eyes shallow.
Late Beauty of Hebron	1	7	22	0	30	Medium....	Late......	White skin, irregular oblong, eyes rather deep.
Late Pink Eye.........	¼	6	10	6	4	Poor.........	Late......	White skin, pinkish, oblong.
Late Rose............	1½	5	21	7	8	Medium....	Late......	Pinkish white skin, long, eyes shallow.
Magnum Bonum......	1½	5	20	2	10	Good.......	Medium ..	White, long, eyes shallow.
Maiden's Blush.......	2½	4	20	9	13	Fair.........	....	White, oblong, eyes rather deep.
Massachusetts White..	1½	2	19	2	7	Medium....	....	White, irregular, eyes shallow,

Mammoth Pearl......	1¼	3	14	7	11	Good.......	Late......	White, roundish, eyes shallow.
Matchless............	1¼	2	14	5	10	Medium....	Late......	White, roundish, eyes shallow.
Menomonte	1¾	3	20	7	13	Good.......	....	White, irregular in shape, eyes deep, rough.
Minnesota Seedling...	1	4	20	8	8	Fair........	Medium ..	White, roundish, eyes shallow.
Missouri White	1¼	5	21	2	8	Medium....	....	White, irregular in shape, eyes shallow.
Marjolin Cetard......	¾	3	16	0	14	Fair........	Early	White, long, eyes shallow.
Model...............	1½	0	15	3	8	Good.......	Early	White skin, oblong, eyes shallow.
Motley....	1	5	18	7	6	Fair........	....	White skin, oblong, eyes shallow.
Morning Star.........	1	5	20	0	20	Very good..	Late......	White skin, ovate, eyes shallow, smooth.
Muldoon	1	6	20	7	10	Medium....	....	Pinkish white skin, eyes shallow.
Napoleon.............	1¼	4	18	2	10	Medium....	Early	White skin, long, eyes deep, rough.
Noblow	1¼	5	19	5	9	Fair........	....	White skin, oblong, eyes rather deep.
North River Beauty	1¼	2	13	9	5	Good.......	Medium ..	Pinkish white skin, oblong, eyes shallow.
Ohio Pinkeye.........	1	3	14	4	7	Fair........	....	Yellowish white skin, oblong, eyes shallow.
Ohio	1¼	5	20	3	17	Medium....	Early	Pinkish white skin, oval, eyes shallow.
Palmer....	1¼	4	18	10	15	Poor........	Medium ..	White skin, irregular in form, eyes shallow.
Palmer No. 2..........	3 oz.	3	14	0	12	Fair........	Medium ..	White skin, oblong, eyes rather deep.
Palmyra.............	½	5	16	8	6	Poor........	....	White skin, irregular in shape, eyes deep.
Paragon.............	1½	3	18	4	13	Poor........	....	White skin, irregular in shape, eyes deep, rough.
Patterson's Albert....	2½	6	20	0	26	Fair........	....	White skin, oblong, eyes shallow.
Patterson's Early White	½	2	10	6	2	Good.......	Early	White skin, oblong, eyes rather shallow, smooth.
Patoka	1¼	5	20	2	14	Fair........	....	Pinkish white skin, long, eyes deep.
Pecan........	½	3	18	4	10	Medium....	....	White skin, oblong, eyes shallow.
Pearl of Savoy.......	1½	....	....	....	20	Good.......	Early	Turbers, oblong, hard and vigorous.
Plymouth Rock.......	1¼	5	25	0	15	Medium....	....	White skinned, long, eyes shallow.
Pride of America.....	1¼	6	18	8	14	Fair........	....	Pinkish white skin, ovate, eyes rather deep.
Prince Edward........	¾	4	20	2	15	Medium....	Medium ..	White skin, irregular, eyes deep.
Porter's Excelsior.....	½	5	19	3	8	Fair........	....	White skin, irregular, eyes deep.
Prince of Wales Kidney	1½	3	18	0	14	Medium....	....	Yellowish white skin, oblong, eyes shallow.
Purple Peerless.......	1½	4	20	0	9	Poor........	....	Purple skin, long, eyes deep.
Polaris....	1¼	6	23	0	29	Very good..	Very Early	White skin, oblong, eyes shallow.
Pierce's Seedling......	2½	5	48	7	17	Fair........	....	Pinkish white skin, oblong, eyes rather deep, rough.
Queen of the Valley...	2½	5	20	9	10½	Medium....	Medium ..	White skin, oblong, eyes shallow.
Queen of the West....	1	5	10	8	4	Fair........	....	White skin, oval, eyes shallow.
Quinby's Seedling.....	¾	4	20	10	8½	Fair........	....	Pinkish white skin, oblong, eyes shallow.
Rand's Red...........	2	4	20	3	17	Fair........	....	Pinkish skin, round, eyes rather deep.

TABLE I (Continued.)

NAMES.	Weight of seed when planted.	Height of Haulm taken June 16.	Height of Haulm taken July 17.	Blight on scale of 10.	Wgt. of potatos from 10 hills dug Sept. 20.	Quality.	When marketable.	COLOR AND SHAPE.
	lbs.	in.	in.		lbs.			
Raspberry Leaf	1	3	16	6	4	Good	Medium	White skin, oblong, eyes shallow, smooth.
Red Climax	2	5	20	9	12	Poor		Light pink skin, oblong, eyes deep.
Rocky Mountain Rose	1½	6	24	2	15	Medium		Light pink skin, long, eyes rather deep.
Rose Bud	1¼	5	20	4	12	Fair	Medium	Light rose skin, long, eyes shallow.
Rosy Morn	1	4	12	6	7	Fair		Light pink skin, long, eyes shallow.
Rural New Yorker No. 2	6	2	14	0	15	Good	Medium	White skin, roundish, eyes deep.
Russian Early	1¼	4	18	5	9	Good		White oblong skin, eyes rather deep.
Rural Blush	2¼	4	20	1	15	Good		White skin, oblong, eyes deep.
Seedling No. 2	2	7	20	3	14	Good	Early	White skin, roundish, eyes very deep.
Seedling Prolific	1¼	4	20	2	9	Medium		White skin, oblong, eyes shallow.
Shaker's Fancy	2¾	3	22	2	8	Poor	Late	Pinkish skin, roundish, eyes very deep.
Silverskin	1	5	16	2	5	Medium		White skin, irregular, oblong, eyes very deep.
Six Weeks	1¾	4	22	2	18	Fair	Early	Pinkish skin, long, eyes rather deep.
Snapdragon	¾	2	16	8	4	Poor		Pinkish skin, long, eyes rather deep.
Snowball	1½	5	16	9	6	Medium	Medium	White skin, globular, eyes shallow.
Snowflake Early	1	5	16	7	14	Good	Early	White skin, oblong, eyes shallow.
South Bend	1	4	20	8	16	Good		White skin, long, eyes shallow.
St. Patrick	1	4	24	0	31	Good	Early	White skin, long, eyes rather shallow.
St. Helena	1¾	6	14	6	14	Fair		Light pink skin, oval, eyes shallow.
Starch	¼	2	12	2	5	Fair	Early	White skin, oval, eyes shallow.
Stonehouse	1	5	22	2	13	Good	Medium	White skin, oblong, eyes shallow.
Strawberry	¾	3	16	0	22	Good	Late	White skin, ovate, eyes shallow.
Sutton's Ex. Kidney	1	3	20	0	10	Fair	Late	White skin, oblong, eyes rather deep.
Telephone	1	4	16	2	16	Medium	Early	White skin, oblong, eyes rather deep.

Temple	1½	2	11	5	4	Poor		Purple skin, oblong, eyes deep, rough.
Titicaca	1½	3	20	4	7	Poor	Late	Purple skin, ovate, eyes deep.
Tyran Purple	¼	4	15	1	9	Poor		Purple skin, round, eyes deep.
Vanguard	1	5	24	0	26	Good	Early	Light pink skin, oblong, eyes rather shallow.
Western Chief	¾	3	18	9	5	Fair		Light pink skin, oblong, eyes shallow, small.
West Windsor	1	5	20	1	6	Good	Medium	White skin, long, eyes rather deep.
Whipple's Seedling	1	3	20	4	8	Fair	Late	Pinkish white skin, globular, eyes deep.
Windsor No. 1	1	5	20	1	22	Good	Early	White skin, irregular, eyes rather deep.
Wall's Orange	1¼	5	24	0	25	Fair		Light pink skin, round, eyes rather deep.
White	1½	4	20	9	15	Good	Early	White skin, long, eyes shallow.
White Lily	1½	4	16	7	25	Fair		Light pink skin, eyes rather deep.
White Star	½	5	24	0	10	Good	Medium	White skin, ovate, eyes rather deep.
Willard	1½	6	20	7	13	Fair		White skin, long, eyes very deep.
Wilson	1¼	5	20	4	24	Good		White skin, long, eyes very deep.
Yorkshire Hero	1¾	6	20	10	16	Fair	Medium	Light pink skin, oval, eyes deep.

TABLE II.—SHOWING THE VARIETIES DISCARDED FROM OUR LIST AS WORTHLESS.

Names.	Weight of seed when planted. (Lbs.)	Heighth of haulm, taken June 16. (Inches.)	Heighth of haulm, taken July 17. (Inches.)	Weight of potatoes from ten hills. (Lbs.)
Alaska Blue	½	0	14	5
Amazon	¾	2	13	4
Andes	½	2	12	2
Ash Leaf Fluke	¼	5	16	6
Ashleaf Kidney	¼	1	10	4
Ben Merritt	¾	4	19	7
Bidgefield's Seedling	½	3	8	2
Black Diamond	1	2	13	4
Black Mercer	6 oz.	3	16	4
Blue Kidney	½	0	8	1
Blue Neshannock	¾	3	12	4
Blue Western	1½	0	14	2
Breakfast	½	5	19	6
Brownell's Superior	1	2	13	2
Barrow's Perfection	½	3	14	4
Blanchard	1	2	18	6
Bussom's Late Prince	½	0	12	2
California	2 oz.	2	6	3 oz.
Callao	¾	0	12	4
Campbell's Late Rose	1	4	12	3
Climax	½	1	18	6
Colorado	½	5	8	1
Colorado II	1	4	19	6
Columbus	¾	3	8	3
Compton's Surprise	¼	4	9	1
Concord	1	3	10	3
Conn Blue	1	2	15	7
Conover	1¼	0	12	4
Cowhorn	¾	0	12	7
Davenport Seedling	¼	3	8	1
Davis Seedling	5	4	22	5
Duke of Cumberland	¾	2	12	6
Early Durham	1½	5	20	9
Early Golden	1½	2	14	3½
Early Harvest	1¼	5	14	6
Early Indiana	¼	3	15	1½
Early Kidney	¾	2	18	5
Early Lilac	1½	4	20	3
Early Manly	2	3	14	1½
Early Peachblow	½	3	16	9
Early Pinkeye	¾	2	10	2
Early Prince	¾	3	12	2
Early Racehorse	¼	3	12	1
Early Sovereing	2	3	20	6
Early White Mountain	2 oz.	1	12	0
East Branch	1¾	4	20	5
English White	1	4	13	1½
Essex	1	4	22	0

TABLE II.—SHOWING THE VARIETIES DISCARDED FROM OUR LIST AS WORTHLESS.—*Continued.*

NAMES.	Weight of seed when planted. (Lbs.)	Heighth of haulm, taken June 16. (Inches.)	Heighth of haulm, taken July 17. (Inches.)	Weight of potatoes from ten hills. (Lbs.)
Excelsior	1¼	1	12	6
Excelsior Kidney	½	0	10	1½
Finche's Seedling	¾	3	11	2
Fenn's Earley Market	¾	4	16	6
Fenn's Perfection	¼	0	12	1½
Fenn's White Kidney	½	0	10	5
Forest Rose	1	5	16	5
Forfarshire Red	2 oz.	3	9	2
General Grant	½	3	14	2
German Russet	¼	1	4	0
Gilbert's Seedling	1	3	16	4
Gray Russet	1½	4	14	6
Greenfield	1	2	14	4
Haye's Superb Kidney	¼	2	18	3
Hinman	¾	4	16	7
Huntington Seedling	¼	4	8	1½
Improved Ashleaf Kidney	¼	2	11	3
Jackson's White	1¼	3	12	4
Jordan's Prolific	2¼	1	12	1
Karl's Household	1	3	14	4
Lapstone Kidney	½	3	8	1½
Mahopac Seedling	1	5	10	3
Merino	¼	0	2	0
Marceau	3 oz.	10	6	1
Neshannock	¼	2	4	0
Niggerhead	½	3	18	1½
Niggertoe	2 oz.	3	6	0
Ohio Beauty	....	....	....	....
Ohio Kidney	¾	2	15	3
Old Flesh Colored	½	0	8	1½
Old Kidney	¾	2	15	3
Old Pinkeye	1	3	10	5
Old White	....	....	....	....
Oneida	1¼	3	18	4
Orono	1	3	17	5
Patterson's Blue	¾	6	18	4
Patterson's Golden Don	....	....	....	....
Patterson's Regent	½	6	14	7
Peachblossom	½	2	14	3
Pigeon Eye	1	3	14	2
Prince of Wales	¼	3	14	4
Prince Arthur	¼	0	10	3
Prince Teck	¼	0	14	4
Philbrick's Early	½	5	20	6
Patterson's the Queen	1	2	18	5
Patterson's Victoria	¾	0	0	0
Porter's Seedling	½	0	0	0
President	¼	0	10	6

TABLE II.—SHOWING THE VARIETIES DISCARDED FROM OUR LIST AS WORTHLESS.—*Continued.*

NAMES.	Weight of seed when planted. (Lbs.)	Heighth of haulm, taken June 16. (Inches.)	Heighth of haulm, taken July 17. (Inches.)	Weight of potatoes from ten hills. (Lbs.)
Purple Blush	3 oz.	½	9	4
Purple Mercer	½	4	16	5
Pink Eye Best	¾	5	12	3
Quarantaine Violette	¼	3	12	0
Rand's New Peachblow	½	3	6	2
Red Gem	¾	4	18	6
Red Jacket	½	3	9	½
Red Kidney	2	3	19	11
Red Orange	5	2	5	1
Red Peachblow	1½	2	12	7
Red Emperor	½	6	14	3
Red Fluke	¼	4	16	0
Rector of Woodstock	2 oz.	0	6	½
Rochester Seedling	½	3	14	5
Rose of Erin	1	5	14	5
Rose of the West	½	4	18	6
Rough and Ready	3 oz.	3	8	2
Rosebury	½	2	9	½
Ruby	½	4	12	2
Samaritan	¾	3	18	4
Scotch Blue	½	4	6	1½
Scotch White	½	0	9	2
Seedling Peachblow	1¼	2	19	5
Skerry Blue	¼	2	12	3
Sedila	½	3	8	2
Startler	1½	6	8	0
Tioga	½	3	11	3
Tucker	2½	5	20	0
Utica Pinkeye	¾	4	20	2
Vandeveer	1	0	11	2
Vermont Seedling	1¼	3	12	4
Wideawake	1	0	18	2
Wonderful Red Kidney	½	4	12	2
White Apple	¾	4	21	4
White Cowhorn	½	3	9	1
White Eye Peachblow	¼	2	14	2
White Elephant	2	5	15	6
White Market	¼	2	9	2
White Rock	1½	4	12	2
White Rose	1	2	13	6
Red Sprouts	1¼	4	19	6
Wm. R. Prince	1¼	3	14	4
Worcester	¾	3	18	5

DIVISION OF CHEMISTRY.

D. N. HARPER

ON THE CHEMISTRY OF WHEAT.*

To the heavy frosts of August of last year, 1888, is generally attributed the disastrous failure of the wheat crop over large sections of this State and Dakota. It is the opinion of many, however, that the rust is chiefly responsible for the damage done. I do not think the data at hand is sufficient to warrant a positive statement as regards the harmful effects produced by either separately ; since, so far as is known, rust prevailed in all those sections visited by frost, and no samples of wheat only "rusted," or only "frosted," have been obtained. When I undertook to analyze the samples of wheat, the results of which follow, I laid great stress upon the desirability and the necessity of having samples which were affected only by the rust or only by the frost. No such samples have I been able to obtain. It is impossible, therefore, to attempt now to determine which was the more harmful. †

I.

I desire to give in the following pages a preliminary report of the work done by me touching the chemical aspect of this subject. Unfortunately there is no literature, so far as I have been able to ascertain, on the suject of "rusted" or "frosted" wheat. We shall, therefore, be obliged to rest our view wholly upon the comparatively few analyses given here, and we shall need to be guarded in making any generalizations.

*This report I had hoped to publish in the February Bulletin. Frequent interruptions, together with the freezing and bursting of the water pipes in the laboratory, and failure in the water supply, rendered it impossible.

† To complete this work and state definitely what is the effect of "rust" and what the effect of "frost," new samples are needed. Any persons having samples of wheat injured by one or the other only will confer a favor by sending some of the same to me at our expense.

For the benefit of those who may be unfamiliar with the terms employed, I here make the following explanatory statements:

Water is found as a constituent of all vegetable and animal substances, and is driven off by heat. To determine its amount here a weighed portion of the substance, in a finely divided state, was subjected for an uninterrupted length of time—five hours or more—to a heat at which water boils—indicated by 212 degrees on a thermometer having a Fahrenheit scale or 100 degrees if marked with Centigrade scale. To prevent any change in the constitution of the residue the drying took place in an atmosphere of perfectly dry hydrogen gas. When the substance obtained a weight which remained constant on repetition of the heating, the loss of weight sustained indicated the amount of water there was present.

*Ash** is that part of the grain which is not combustible, and which remains after subjecting it to a low red heat, where all that will burn away has done so.

Oil includes many different bodies—fatty substances and coloring matters—which can be dissolved out of the perfectly dry substance by means of ether, carbon bi-sulphide, etc. To determine the amount present, the substance freed from all traces of water, was digested with ether for eight or more hours, and the matter thus extracted, after driving off the ether, was weighed.

Fiber is the woody frame work of the grain—the skeleton holding the various other parts as starch, gluten, etc., in place. To determine its amount an empirical method was used. The dry substance, from which the fat had been extracted, was boiled for a certain length of time in a weak acid solution of definite strength, filtered quickly and washed with boiling water. This was then boiled for the same length of time in a correspondingly weak solution of caustic soda (lye), filtered quickly,

*The ash of wheat contains. [Blyth.]

	WINTER WHEAT. Per Cent.	SPRING WHEAT. Per Cent.
Potash	31.16	29.99
Soda	2.25	1.93
Lime	3.34	2.93
Magnesia	11.97	12 09
Ferric Ori e	1.31	.51
Phosphoric Acid	46.98	48.63
Sulphuric Acid	.37	1.52
Silica	2.11	1.64
Chlorine	.22	.48

washed thoroughly with hot water, and then with alcohol, and, finally, with ether. The weight of the perfectly dry substance, after deducting the ash present, is the amount of fiber. Cotton and linen are pure fiber.

Protein includes many different substances, containing introgen. The constitution of some of these is not clearly understood. Numerous determinations show that most of these bodies contain 16 per cent. of their weight of nitrogen. Therefore, $6\frac{1}{4}$ times the amount of nitrogen is taken as crude protein. The determination of nitrogen involves certain chemical reactions, which it will not be possible to state here.

Albuminoid Nitrogen is the amount of nitrogen contained in those bodies not soluble in hot water, but coagulated by boiling, and precipitated by copper hydrate.

Carbohydrates-(Nitrogen-Free-Extract)-are general terms, including a variety of substances, starch, sugar, gum, etc. The amount is determined by difference.

Gluten is that substance which gives to wheat its unique value. As here used it includes many different nitrogenous compounds of complex and not well understood constitution, as well as variable quantities of fatty and mineral substances, etc. Its distinctive characteristic of forming a tenacious, insoluble mass by kneading with water gives to wheat flour its great advantage for bread-making. Other vegetable products, contain large quantities of protein, but when kneaded with water, either form no dough, or only slight quantities. The quality of gluten is judged from many stand-points as to color, tenacity, &c. To determine its amount I have made use of the following method: All the samples of wheat were ground as fine as possible in a coffee-mill. Some were then further powdered in a mortar, care being taken to break up the hull or bran as little as possible. These latter were then sifted by means of a fine copper sieve and sieves of bolting cloth, very kindly loaned for the purpose by Mr. J. T. Bradley, chemist of the Pillsbury Company. By this means I had hoped to obtain quickly and with tolerable accuracy, all the bran separated from the starchy and albuminous bodies, thus making a mechanical analysis. Only a few of the samples were treated in this way. Although the results were in the main satisfactory, I soon became aware that to make a separation thus would require more time than I

TABLE I.—NAMES, GRADES, SOURCES, ETC., OF THE WHEATS.

A. Graded Wheat.

Laboratory Number.	Collection Number.	Name of Wheat.	Grown near	Received from	Grade.
304	7	Not given..........	Hereford.........	Minn. & North. El.	No. 2 North.—2 lbs. off
305	8	"	Alexandria........	" "	No. 1 " —2½ off...
306	9	"	Argyle.............	" "	No Grade.............
307	10	"	Neche	" "	No. 3—1 off ....
308	11	"	Cleremont	" "	No. 1 Hard—2 off .....
309	12	"	St. Thomas........	" "	No Grade—2 off ....
310	13	"	Argusville.........	" "	No. 3—2 off ....
311	14	"	Brandon	" "	No. 1 Northern—2 off..
312	15	"	Crasy..............	" "	No Grade.............
313	16	"	Nelson	" "	No. 1 Northern—1½ off
314	17	"	Edenburg, D. T...	" "	No. 1 " —2 off..
315	18	"	Emerado	" "	No. 3—1½ off..........

B. Not Graded Wheat.

316	19	Scotch Fyfe.	Fergus Falls	W. Benzman......	Shrunken from rust and heat.
317	20	Blue Stem.........	Pelican Rapids....	F. H. Miller	Supposed frosted .....
318	21	Saskatchew'n Fyfe	Crookston.........	Mrs. Kimmelbach.	Rusted and frosted....
319	22	" "	"	" "	" " ....
320	23	" "	"	" "	" " ....
321	24	Scotch "	"	" "	" " ....
322	25	" "	"	S. Merriam........	" " ....
323	26	" "	"	" "	" " ....
324	27	Mammoth Spring.	"	" "	" " ....
325	28	Blue Stem.........	"	S. L. Collins......	" " ....
326	29	" "	"	M. & N. Elev. Co.	" " ....
327	30	Saskatchew'n Fyfe	Hallock	Kelso Farm	" " ....
328	31	" "	"	" "	" " ....

TABLE I.—NAMES, GRADES, SOURCES, ETC., OF THE WHEATS.

A. Graded Wheat.

Laboratory Number.	Collection Number.	Name of Wheat.	Grown near	Received from	Grade.
304	7	Not given..........	Hereford.........	Minn. & North. El.	No. 2 North.—2 lbs. off
305	8	"	Alexandria.........	" "	No. 1 " —2½ off...
306	9	"	Argyle.............	" "	No Grade..............
307	10	"	Neche	" "	No. 3—1 off ....
308	11	"	Cleremont	" "	No. 1 Hard—2 off .....
309	12	"	St. Thomas........	" "	No Grade—2 off ....
310	13	"	Argusville.........	" "	No. 3—2 off ....
311	14	"	Brandon	" "	No. 1 Northern—2 off..
312	15	"	Crasy.............	" "	No Grade.............
313	16	"	Nelson	" "	No. 1 Northern—1½ off
314	17	"	Edenburg, D. T...	" "	No. 1 " —2 off..
315	18	"	Emerado	" "	No. 3—1½ off..........

B. Not Graded Wheat.

316	19	Scotch Fyfe......	Fergus Falls	W. Benzman......	Shrunken from rust and heat.
317	20	Blue Stem.........	Pelican Rapids....	F. H. Miller	Supposed frosted .....
318	21	Saskatchew'n Fyfe	Crookston.........	Mrs. Kimmelbach.	Rusted and frosted....
319	22	" "	"	" "	" " ....
320	23	" "	"	" "	" " ....
321	24	Scotch "	"	" "	" " ....
322	25	" "	"	S. Merriam........	" " ....
323	26	" "	"	" "	" " ....
324	27	Mammoth Spring.	"	" "	" " ....
325	28	Blue Stem.........	"	S. L. Collins......	" " ....
326	29	" "	"	M. & N. Elev. Co.	" " ....
327	30	Saskatchew'n Fyfe	Hallock	Kelso Farm	" " ....
328	31	" "	"	" "	" " ....

TABLE II.—PHYSICAL CHARACTERISTICS, ETC., OF THE WHEATS.

A. Graded Wheat.

COLOR.	HARDNESS.	Am't of Wheat of Specific Gravity. 1.+	1.—	Weight of 100 Grains. Sp. Gr. 1.+	Sp. Gr. 1.—	REMARKS.
		Pr. Ct.	Pr. Ct.	Grams.	Grams.	
Amber, discolored	Hard to not so hard.	100.	....	1.6595	....	Many shrivelled grains.
" not uniform	Very hard to hard ...	100.	....	1.9692	....	A few shrivelled grains.
" pinkish and dark	Much varied	96.9	3.1	1.7427	1.0067	Most of the grains shrivelled
" uniform, brightest...	Uniform hardest....	100.	....	2.3766	....	An occasional shriv'd grain.
" " bright......	V. H., uniform......	100.	....	2.3259	....	....
" discolored	V. H., H., not so H.	99.4	.6	2.1440	Calculat'd 1.0826	For most part well filled.
" dull and discolored.	" " "	100.	....	1.6820	....	Many shrivelled grains.
" uniform..............	Very hard, uniform .	100.	....	2.1137	....	Some grains under size and shrivelled.
" pink, dark, etc.......	Most not so hard....	87.2	12.8	1.8525	.9800	Majority of grains shrivelled Nutty taste.
" uniform..............	Very hard to hard...	100.	....	2.0008	....	Some shrivelled grains.
" uniform, bright......	" " " ...	100.	....	2.2352	....	....
" some discolored	Not so hard	100.	....	1.8954	....	Good sized shrivelled grains

B. Not Graded Wheat.

Dull and discolored.......	Very varied..........	100.	....	1.5774	....	Majority small and shriveled.
Somewhat discolored	" "	100.	....	1.7468	....	Shrivelled.
Dull yellow, "	Soft and tough......	61.6	38.4	1.2862	1.2017	Good sized, but shrivelled. Nutty taste—sweetish.
Dull, "	" "	61.2	38.8	1.2240	1.2222	Good sized, but shrivelled. Nutty taste—sweetish.
" "	" "	84.8	15.2	1.4735	1.1892	Good sized, but shrivelled. Nutty taste—sweetish.
" "	" "	85.8	14.2	1.5018	1 2238	Good sized, but shrivelled. Nutty taste—sweetish.
" "	" "	74.8	25.2	1.3209	1.0572	Good sized, but shrivelled. Nutty taste—sweetish.
" "	" "	94.5	5.5	1.3270	.7848	....
" "	" "	90.4	9.6	2.1279	1.5464	Grains of better size. Sweetish—slightly nutty taste.
" "	" "	90.9	9.1	1.7414	1.1684	Grains of better size. Sweetish—slightly nutty taste.
" "	Hard to soft & tough	96.3	3.7	1.7340	1.1284	Better than above.
" "	Few hard, rest soft and tough.	94.8	5.2	1.6779	.9972	Shrivelled, with nutty taste —sweetish.
" "	Few hard, rest soft and tough.	88.1	11.9	1.6343	1.1143	Shrivelled. Taste not so marked.

TABLE III.—CHEMICAL ANALYSIS OF THE VARIOUS WHEATS.

A. Graded Wheat.

Laboratory number.	Collection number.	Water.	Ash.	Oil.	Fiber.	Carbohydrates.	Protein.	Nitrogen.			Gluten.			
								Total.	Albuminoid	Ratio.	Fresh.	Dry.	Ratio.	Quality.
		p ct.	p ct	p ct	p ct	p ct.	p ct.	p ct	p ct		p ct.	p ct		
304	7	9.52	1.06	2.16	2.90	69.8	14.56	2.33	2.07	1.1	29.2	11.3	2.5	Good.
305	8	9.71	1.50	2.13	2.02	71.26	13.38	2.14	1.98	1.1-	33.9	14.4	2.3	Best.
306	9	8.82	1.75	2.36	1.86	71.46	13.75	2.20	2.06	1.1-	25.4	10.6	2.4	Good.
307	10	9.76	1.75	2.25	1.91	69.45	14.88	2.38	....	....	25.2	10.4	2.4	Good.
308	11	10.30	2.14	2.08	3.20	67.40	14.88	2.38	2.36	1.	34.2	13.7	2.5	Very good.
309	12	10.05	1.63	2.18	1.10	70.79	14.25	2.28	2.09	1.1-	23.1	9.6	2.4	Good.
310	13	11.57	1.62	2.75	1.08	69.85	13.13	2.10	....	....	25.3	10.5	2.4	Good.
311	14	......	....	....	....	......	......	....	....	....	23.1	9.6	2.4	Fair.
312	....	......	....	....	....	......	16.56	2.65						
b.	15	9.11	1.71	2.87	1.67	70.01	14.63	2.34	1.92	1.2	21.8	8.8	2.5	Fair.
313	16	......	....	....	....	......	......	....	....	-	25.5	10.3	2.5	Good.
314	17	11.16	1.72	1.99	1.49	70.08	13.56	2.17	2.11	1.	27.	10.3	2.6	Good.
315	18	1[illegible].78	1.33	2.25	2.23	68.72	13 69	2.29	1.87	1.2	27.2	11.1	2.5	Good.

B. Wheat not Graded.

316	19	......	....	....	....	......	......	....	....	....	34.4	14.5	2.4	Good.
317	20	......	....	....	....	......	......	....	....	....	21.3	8.7	2.5	Poor.
318	21	9.89	2.80	3.93	3.36	62.08	17.94	2.87	2.24	1.3	*none			
b.	....	8.76	2.03	4.89	....	......	17.39	2.78	2 56	1.1				
319	22	8.53	2.00	3.73	3.85	63.33	18.56	2.97	2.36	1.3	*none			
b.	....	8.42	2.13	5.28	5.08	61.46	17.63	2.82	2.54	1.1				
320	23	10.29	1.54	3.49	3 20	63.85	17.63	2.82	2.48	1.1	6.6	2.7	2.5	Extremely poor.
b.	....	......	....	....	....	......	20.19	3.30	2.71	1.2				
321	24	9.92	1.72	3.74	3.09	64.97	16.56	2.65	....	....	18.9	7.1	2.6	Very weak.
b.	....	......	....	....	....	......	19.00	3.04	2.57	1.2				
322	25	8.91	1.80	3.81	3.98	64.32	17.38	2.78	2.43	1.1	16.5	5.9	2.8	Very weak.
b.	....	......	....	....	....	......	19.81	3.17	2.88	1.1				
323	26	8.94	1.64	3.15	2.61	68.85	16.81	2.69	2.39	1.1	17.4	6.7	2.6	Very poor.
b.	....	......	....	....	....	......	17.81	2.85	2.71	1.1-				
324	27	11.22	1.82	3.03	2.05	65.63	14.25	2.28	2.13	1.1-	12.4	4.7	2.6	Very poor.
b.	....	......	...	....	....	......	18.69	2.99	2.78	1.1-				
325	28	8.79	1.62	2.82	4.67	67.35	14.75	2.36	....	....	21.3	8.5	2.5	Poor.
b.	....	......	....	....	....	......	19.88	3.19						
326	29	......	....	....	....	......	......	....	....	....	30.9	12.9	2.4	Good.
327	30	......	....	....	....	......	......	....	...	....	13.6	5.4	2.5	Very poor.
328	31	9.00	1.89	2.93	2.16	69.46	14.56	2.33	....	....	16.7	7.1	2.4	Very poor.
b.	....	......	....	....	....	......	16.38	2.62						

*Gluten seemed to have lost all cohesiveness. Was present, but too weak to "wash out.'

*AVERAGE COMPOSITION OF AMERICAN WHEAT.

Locality.	Number of analyses.	Weight of 100 grains.	Water.	Ash.	Undetermined.†	Albuminoids.	Weight of 00 Grains. Highest.	Weight of 00 Grains. Lowest.	Albuminoids. Highest.	Albuminoids. Lowest.
		grams	per ct.	per ct.	per ct	per ct.	grams	grams	per ct.	per ct.
U. S. and British America..	407	3.644	10.16	1.92	75.77	12.15	5.924	1.830	18.03	7.70
......	......	......	......	......	......	......	......	......	......	......
Atlantic and Gulf States....	117	3.489	10.34	1.77	76.54	11.35	5.079	1.830	15.58	9.43
Middle States..............	91	3.537	10.61	1.85	75 04	12.50	5.800	2.138	16.63	10.15
Western States..............	177	3.763	9.83	2.06	75.37	12.74	5.924	2.561	18.03	8.93
Pacific States..............	20	4.091	10.25	1.87	78.15	9.73	5.745	2.584	12.78	7.70
Canada.....................	6	3.325	9.74	1.56	77.83	10.87	3.686	2.964	14.70	9.45
......	......	......	......	......	......	......	......	......	......	......
Pennsylvania..............	33	3.373	10.73	1.70	76.13	11.44	4.658	2.035	15.58	9.45
Maryland..................	9	3.597	10.52	1.75	76.08	11.65	5.079	2.075	14.53	9.80
Virginia..................	15	3.433	9.98	1.84	76 08	12.10	4.283	1.830	14.00	10.15
West Virginia.............	2	3.392	8.55	2.07	78.44	10.94	......	......	11.03	10.85
North Carolina............	22	3.776	10.03	1.59	77.95	10.43	4.628	2.780	12.43	8.93
Georgia...................	7	3.579	10.00	1.96	76.26	11.78	4.627	2.834	14.00	9.45
Alabama...................	19	3.424	10.82	1.96	75.93	11.29	4.647	2.011	13.65	9.80
Ohio......................	44	3.476	10.68	1.94	74.55	12.83	5.800	2.663	16.10	10.68
Tennessee.................	15	3.150	10.24	1.92	75.34	12.50	3.990	2.138	16.63	10.15
Kentucky..................	8	3.454	10.83	1.75	74.27	13.15	3.666	3.146	14.53	11.90
Michigan..................	22	3.969	10.71	1.64	75 98	11.67	4.902	3.402	15.23	10.50
Missouri..................	12	3.502	9.80	1.92	76.72	11.56	3.867	3.098	14.00	10.50
Arkansas..................	1	......	9.56	2.52	74.97	12.95	......	......	......	......
Minnesota.................	13	3.245	9.96	1.77	75.08	13.19	3.867	2.720	17.15	10.85
Dakota....................	12	3.149	8.84	1.95	74.25	14.95	3.700	2.771	18.03	12.43
Manitoba..................	2	3.288	8.35	1.63	75.49	14.53	......	......	......	......
Kansas....................	10	3.204	11.80	1.64	75.41	11.15	3.424	2.881	12.25	10.50
Texas.....................	19	2.847	10.03	1.81	75.02	13.14	3.937	2.561	15.23	10.68
Colorado..................	106	4.214	9.73	2.21	75.33	12.73	5.924	2.716	15.94	8.93
Utah......................	2	3.893	9.17	2.23	78.45	10.15	4.084	3.703	10.50	9.80
New Mexico................	2	3.572	9.30	1.98	78.22	10.50	3 956	3.188	11.73	9.28
California................	10	3.892	10.73	1.86	76.47	10.94	5.184	3.095	12.78	9.10
Oregon....................	8	5.044	9.74	1.84	79.82	8.60	5.745	4 253	9.47	8.05
Washington T'y............	2	3.655	9.89	1.98	79.90	8.23	4.726	2.584	8.75	7.70

*Department of Agriculture, report 1884, page 77. †Fiber, carbhydrates and fat.

was willing to allot, considering the value of the results. An apparatus which I devised to overcome all these difficulties, I found would cost more than our financial condition could stand. A weighed amount of the flour thus obtained, or of the finely ground whole wheat, was mixed in a porcelain dish, with enough water to make a good dough. This was then placed in a linen bag and let stand in water for a few minutes until thoroughly wet. Then by a stream of water the starch was washed partially out. It was then removed from the bag to the hand where the bran and remaining starch was completely washed away, while holding the sample over a fine sieve, to arrest any small particles of gluten which might become disengaged from the mass. The gluten was then dried as well as possible between the fingers, and weighed. This is tabulated as "fresh," and after drying to expel all traces of water, it was again weighed and appears as "dry." I have given this process in considerable detail, as it will doubtless prove of value to farming people. On account of the ease of manipulation and the rapidity with which it may be done, any one can in a few minutes determine the value of any sample of wheat or flour. This determination can not lay claim to great accuracy, since many things come into play, the exact effects of which cannot easily be calculated. Therefore, I have carried the results to but one place of decimals.

The *Specific Gravity** was approximately taken by shaking the sample in distilled water and quickly separating the part which floated from that which sunk. The former had a specific gravity less than 1. (1.—). The latter of more than 1. (1.+). Both were air-dried and weighed, and the per cent. of each calculated. Since there is on the exterior of the wheat grain a waxy coating, which for some time withsands the action of water, no loss of weight by solution occurred. A slight decrease was apparent by reason of dust and dirt washed off. Where sufficient quantity of grain of specific gravity 1.— was obtained complete analyses have been made. These analyses are marked "*b*". Some of the samples were composed in large part of cockle, etc. All were picked clean by hand, so that all the analyses have been made of perfectly clean wheat.

*The weight of the grain, as compared with the weight of the water which the grain displaces—assuming that volume of water to weigh one.

TABLES 1, 2 AND 3.

In these tables I have tabulated all the information obtainable regarding the names, sources, physical characteristics, etc., of the wheat received and the results of the analyses. The *grade* given is that which was marked on the sample when received, and has the authority of the State grain inspection department. The *color* is purely relative; No. 307, the brightest and most uniformly colored, is taken as the basis for all comparisons. The *hardness* is also determined relatively to No. 307, which was the hardest of all. I have taken five grades of hardness and made the comparative tests by biting a certain number of the grains representing an average of the sample. The grades run from "very hard," "hard," "not so hard" to "soft" and "tough." *One hundred grains* from that portion of the original sample of 1.+ specific gravity, as also that portion of 1.− specific gravity, were taken and accurately weighed and the percentage of each noted.

GRADED WHEATS.

An examination of tables 1 and 2 would lead us to pronounce even the best wheat very poor. As regards physical characteristics, the graded wheats of last year's crop are far inferior to those of former years,* if the weight of one hundred grains, uniformity of color and hardness, can be taken as a fair basis of comparison. On the other hand, table 3 shows the crop last year to be of more uniform quality, and of better quality, than of those previously recorded. All the grades show a large amount of protein, and "wash out" very well. This is best seen by comparing Richardson's analyses with my own, the averages of which follow. In making up the average I have excluded No. 314, as it was received from Dakota.

*This statement is given very guardedly, as there are few recorded analyses of Minnesota wheat, and from the sources I have been able to cull those all the information desired could not be had.

AVERAGES OF ANALYSES OF MINNESOTA WHEAT.

ANALYST.	Number of Samples.	Weight of 100 Grains.	Water.	Ash.	Oil.	Fiber.	Albuminoids (Protein.)	Heaviest 100 Grains.	Lightest 100 Grains.	Highest Albuminoids	Lowest Albuminoids
		Grams	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Grams	Grams	Per Ct.	Pr Ct.
*Richardson	9	3.354	10.60	1.71	2.03	2.04	12.66	3.828	3.116	17.15	10.85
Harper	9	1.9609	10.07	1.61	2.34	2.11	14.13	2.3766	1.6595	14.88	13.13
†Harper	6	2.0029	10.44	1.57	2.27	2.22	14.09	2.3766	1.6595	14.88	13.13

*Department of Agriculture, Report 1883, page

†Same as on line above, but excluding "no grade" wheats.

The only remarkable differences here are in the weights per 100 grains and the percentages of protein. In Richardson's analyses in no case did the weight of 100 grains fall so low as the highest weight observed by me. The highest percentage of protein obtained by him is more than two per cent. greater than the same obtained by me; his lowest percentage is more than two per cent. less than mine. Between the highest and lowest percentages of protein there is a difference, in his analyses, of 6.30 per cent.; in mine, of but 1.75 per cent. The average percentage of protein in last year's wheat is about 1.5 per cent. greater than in the crop Richardson analyzed (1882).

Other things being equal, upon the amount of albuminoids depends the value of wheat, and I have already stated the quality of last year's crop judged by that is good. There is no exceptionally large percentage of albuminoids noted, but the average is above that of former observations. To determine how wide the variation might have been last year I endeavored to get more samples of well established grades, but was informed by the chief grain inspector, Hon. Mr. James, that it would be impossible to select samples.

The analyses of such samples as I had appear in table 5. To see how well the grading of the wheat will compare with chemical analyses I have arranged the *averages* in table 6. While discrepancies exist, I am inclined to think that with the present system of grading they are as slight as could reasonably be expected. The most remarkable discrepancies are in the contents of protein. While the average of "No. 1 Hard" is 14.88 per cent.—based on analysis of a single sample; "No grade" has an average of 14.21 per cent., as calculated from three analyses. These vary among themselves but slightly. It may be that the

Table No. V.—Analyses of Wheats According to Grade.

"No. 1 Hard."

Lab. No.	Coll. No.	Wt. of 100 Grains.	Water.	Ash.	Carbo-hydrates.	Fiber.	N. per Ex-tract.	Protein	Total Nitrogen.	B. Nitrogen	Gluten.	
											Fresh	Dry.
		grams.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	pr ct.	pr ct.	pr ct.	pr ct.
308	11	2.3259	10.30	2.14	2.08	3.20	67.40	14.88	2.38	2.36	34.15	13.65

"No. 1 Northern."

Lab. No.	Coll. No.	Wt. of 100 Grains.	Water.	Ash.	Carbo-hydrates.	Fiber.	N. per Ex-tract.	Protein	Total Nitrogen.	B. Nitrogen	Gluten Fresh	Gluten Dry.
305	8	1.9692	9.71	1.50	2.13	2.02	71.26	13.38	2.14	1.98	33.9	14.44
314	17	2.2352	11.16	1.72	1.99	1.49	70.08	13.56	2.17	2.11	27.	10.30
311	14	2.1137	....	....	....	....	....	....	......	......	23.1	9.63
313	16	2.0008	....	....	....	....	....	....	......	......	25.5	10.30

"No. 2 Northern."

Lab. No.	Coll. No.	Wt. of 100 Grains.	Water.	Ash.	Carbo-hydrates.	Fiber.	N. per Ex-tract.	Protein	Total Nitrogen.	B. Nitrogen	Gluten Fresh	Gluten Dry.
304	7	1.6595	9.52	1.06	2.16	2.90	69.80	14.56	2.33	2.07	29.15	11.25

"No. 3."

Lab. No.	Coll. No.	Wt. of 100 Grains.	Water.	Ash.	Carbo-hydrates.	Fiber.	N. per Ex-tract.	Protein	Total Nitrogen.	B. Nitrogen	Gluten Fresh	Gluten Dry.
307	10	2.3766	9.76	1.75	2.25	1.91	69.45	14.88	2.38	......	25.22	10.35
310	13	1.6820	11.57	1.62	2.75	1.08	69.85	13.13	2.10	......	25.31	10.48
315	18	1.8954	11.78	1.33	2.25	2.23	68.72	13.69	2.29	1.87	27.15	11.05

"No Grade."

Lab. No.	Coll. No.	Wt. of 100 Grains.	Water.	Ash.	Carbo-hydrates.	Fiber.	N. per Ex-tract.	Protein	Total Nitrogen.	B. Nitrogen	Gluten Fresh	Gluten Dry.
306	9	1.7427	8.82	1.75	2.36	1.86	71.46	13.75	2.20	2.06	25.4	10.55
309	12	2.1440	10.05	1.63	2.18	1.10	70.79	14.25	2.28	2.09	25.0	10.3
312	15	1.8525	9.11	1.71	2.87	1.67	70.01	14.63	2.34	1.92	21.8	8.77

Table No. VI.—Averages.

	No. of An-alyses.	Wt. of 100 Grains.	Water.	Ash.	Oil.	Fiber.	Carbo-hydrates.	Protein.	Gluten.	
									Fresh	Dry.
		grams	pr ct.	pr ct.	pr ct.	pr ct	pr ct.	pr ct	pr ct.	pr ct.
No. 1 Hard................	1	2.3259	10.30	2.14	2.08	3.20	67.40	14.88	34.15	13.65
No. 1 Northern............	2	*2.0798	10.44	1.61	2.06	1.76	70.67	13.47	24.9*	†11.2
No. 2 Northern............	1	1.6595	9.52	1.06	2.16	2.90	69.80	14.56	29.2	11.3
No. 3	3	1.4885	10.37	1.57	2.42	1.74	69.34	13.90	25.89	10.63
No Grade...................	3	1.9131	9 33	1.71	2.47	1.54	70.75	14.21	24.1	9.87

*Average. †Obtained on four samples.

Other Analyses of Graded Wheats of Minnesota.

Analyst.	Number of Samples.	Grade.	Wt. of 100 Grains.	Water.	Ash.	Protein.	Carbohydrates.	Fiber.	Year.
			gr'ns	pr ct.	pr ct.	pr ct	pr ct.	pr ct.	
Richardson..........	4	No 1 Hard..........	3.001	8.64	1.91	14.40	*75.05	......	1883
Noyes..............	1	Minnesota No 1.....	2.732	12.34	1.59	13.06	†70.98	2.03	1882
Noyes..............	1	Minnesota No. 2.....	2.109	11.31	1.92	13.00	†71.40	2.37	1882
Noyes..............	1	Minnesota No. 3.....	2.037	11.85	1.97	13.56	70.12	2.50	1882

*Undetermined. †Oil, starch, etc.

explanation of this high amount of protein in low grade wheat is found in the fact of there being present some grains of "rusted and frosted" wheat. This will be better appreciated by the discussion of that subject which follows. And this may explain why "No. 3" could have a higher percentage of protein than "No. 1 Northern." Excluding No. 307, which has an exceptionally high percentage, the average of "No. 3" still remains slightly in excess of that of "No. 1 Northern," and based on a like number of analyses. Quite remarkable, too, is a comparison of analyses of No. 307, graded "No. 3," and No. 308, graded "No. 1 Hard." A reference to tables 1 and 2 shows No. 307 to be the hardest, best colored, highest weight per 100 grains, while No. 308 stands second in physical characteristics. Each has exactly the same percentage of protein. No. 308 has an exceptionally high percentage of albuminoid nitrogen (2.36%), which, calculated to albuminoids, represents 14.75 per cent. of those coagulable bodies (see page 67). Unfortunately I am now unable to make that determination in case of No. 307. As regards the contents of gluten, No. 308 is far superior to No. 307, there being a difference of over three per cent. No. 305, "No. 1 Northern," "washes out" the most gluten and the best.

Comparing the average of the various grades with regard to the percentages and quality of gluten, with the single exception of No. 305, "No. 1 Northern," we find the results to be as we should expect them—a gradual failure in both in harmony with with the grading.

All these points are further brought out by a comparison of analyses in

TABLE NO. VII.

A. AMOUNT OF PROTEIN.

	No.	Grade.	Water.	Ash.	Oil.	Carbo-hydrates.	Protein.	Gluten. Fresh.	Gluten. Dry.	Fiber.
			pr ct.	pr ct.	pr ct.	pr ct.	pr ct.	pr ct.	pr ct.	pr ct.
Highest	307	No. 3	9.76	1.75	2.25	69.45	14.88	25.22	10.35	1.91
	308	No. 1 N..	10.30	2.14	2.08	67.40		34.15	13.65	3.20
Lowest	310	No. 3	11.57	1.62	2.75	69.85	13.13	25.31	10.48	1.08
Nearest Mean	309	No grade.	10.05	1.b3	2.18	70.79	14.25	25.	10.3	1.10

B. GLUTEN WASHED OUT—DRY.

	No.	Grade.	Water.	Ash.	Oil.	Fiber.	Carbo-hydrates.	Protein.	Gluten. Fresh.	Gluten. Dry.
			pr ct.	pr ct.	pr ct.	pr ct.	pr ct.	pr ct.	pr ct.	pr ct.
Highest*	305	No. 1 N..	9.71	1.50	2.13	2.02	71.26	13.38	33.9	14.4
Lowest	312	No grade.	9.11	1.71	2.87	1.67	70.01	14.63	21.8	8.8
Nearest Mean	315	No. 3.....	11.78	1.33	2.25	2.23	68.72	13.69	27.2	11.1

*No. 308—"No. 1 hard" a close second.

FROSTED AND RUSTED WHEATS.

By referring to tables 1, 3, 8 and 9, we can partially appreciate the effects of rust and frost on wheat. The physical characteristics are abnormal as well as the percentages of all the chemical constituents. This opens a new and quite interesting study—the chemical nature of the effects of rust and frost. If the rust be responsible for the bad effects produced, it would seem to be a parasite living on the carbohydrates. If the frost has induced these peculiar changes, then what is their nature? These are questions which I shall not attempt to answer in this article.

Most remarkable are the high percentages of protein and albuminoid nitrogen. The latter bears about the same ratio to total nitrogen in the damaged wheats that it does in the graded wheats. It is most singular that in the poorest wheat I had there appeared the highest percentages of protein and true albuminoids. In the table on page — we see that the greatest amount of protein there noted is 18.03 per cent.—a Dakota wheat. The second highest is 17.15 per cent.—a Minnesota

TABLE VIII.—ANALYSES OF "RUSTED AND FROSTED" WHEATS.

Laboratory number.	Collection number.	Wgt. of 100 grains.	Water.	Ash.	Oil.	Fiber.	Carbohydrates.	Nitrogen. Protein.	Nitrogen. Total.	Nitrogen. Albuminoid.	Nitrogen. Ratio.	Gluten. Fresh.	Gluten. Dry.	Gluten. Ratio.
		grams	p ct.	p ct.	p ct.	p ct.	p ct.	p ct.	p ct.	p ct.		p ct.	p ct.	
"Saskatchewan Fife."														
318	21	1.2862	9.89	2.80	3.93	3.36	62.08	17.94	2.87	2.24	1.3	none	none	....
b.	....	1.2017	8.76	2.03	4.89	....	.....	17.39	2.78	2.56	1.1	....	....	....
319	22	1.2240	8.53	2.00	3.73	3.85	63.33	18.56	2.97	2.36	1.3	none	none	....
b.	....	1.2222	8.42	2.13	5.28	5.08	61.46	17.63	2.82	2.54	1.1	....	....	....
320	23	1.4735	10.29	1.54	3.49	3.20	63.85	17.63	2.82	2.48	1.1	6.6	2.7	2.5
b.	....	1.1892	....	....	....	....	.....	20.19	3.30	2.71	1.2	....	....	....
327	30	1.6779	....	....	....	....	.....	.....	....	....	....	13.6	5.4	2.5
328	31	1.6343	9.00	1.89	2.93	2.16	69.46	14.56	2.33	....	....	16.7	7.1	2.4
b.	....	1.1142	....	....	....	....	.....	16.38	2.62	....	....	....	....	....
"Scotch Fife."														
321	24	1.5018	9.92	1.72	3.74	3.09	64.97	16.56	2.65	....	....	18.9	7.1	2.6
b.	....	1.2238	....	....	....	....	.....	19.00	3.04	2.57	1.2	....	....	....
322	25	1.3209	8.91	1.80	3.81	3.98	64.32	17.38	2.78	2.43	1.1	16.5	5.9	2.8
b.	....	1.0572	....	....	....	....	.....	19.81	3.17	2.88	1.1	....	....	....
323	26	1.3270	8.94	1.64	3.15	2.61	68.85	16.81	2.69	2.39	1.1	17.4	6.7	2.6
b.	....	.7848	....	....	....	....	.....	17.81	2.85	2.71	1.1-	....	....	....
"Blue Stem."														
317	20	1.7468	....	....	....	....	.....	.....	....	....	....	21.3	8.7	2.5
325	28	1.7414	8.79	1.62	2.82	4.67	67.35	14.75	2.36	....	....	21.3	8.5	2.5
b.	....	1.1684	....	....	....	....	.....	19.88	3.19	....	....	....	....	....
"Mammoth Spring."														
324	27	2.1279	11.22	1.82	3.03	2.05	65.63	14.25	2.28	2.13	1.1-	12.4	4.7	2.6
b.	....	1.5464	....	....	....	....	.....	18.69	2.99	2.78	1.1-	....	....	....

TABLE IX.—AVERAGES OF ANALYSES OF RUSTED AND FROSTED WHEAT.

KIND.	No. of analyses.	Weight of 100 grains.	Water.	Ash.	Oil.	Fiber.	Carbohydrates.	Protein.	GLUTEN.	
									Fresh.	Dry.
		grams.	pr ct.	p ct.	p ct.	p ct.	per ct.	per ct.		
Saskatchewan Fife.	4	*1 4592	9.43	2.06	3.52	3.14	64.68	17.05	*7.4	*3.
b................	4	*1.1449	8.59	2.08	5.09	....	......	17.90	......	....
Scotch Fife........	3	1.3832	9.26	1.72	3.57	3.23	66.05	17.92	17.6	6.0
b................	3	1.0219	.....	....	....	....	......	18.87	......	....
Blue Stem..........	1	†1.7441	8.79	1.62	2.82	4.67	67.35	14.75	†21.3	†8.6
b................	1	†1.1684	.....	....	....	...	......	19.88	......	....
Mammoth Spring .	1	2.1279	11.22	1 82	3.03	2.05	65.63	14.25	12.4	4.7
b................	1	1.5464	.....	....	..	....	......	18.69	......	....
Grand average‖	9	‡1.5519	9.43	1.87	3.40	3.20	65.54	16.49	‡13.2	‡5.2

*Average of 5 samples. †Average of 2 samples. ‡Average of 11 samples, not including Nos. 316 and 326. ‖Not including analyses marked "b."

wheat. I have observed no record of an American wheat having a higher percentage, but here we have many higher. In my analyses the lowest percentage of protein found in the "rusted and frosted" wheats is greater than the average for the graded wheats; and only three—Nos. 324, 325 and 328—contain as small an amount of protein as those "graded" wheats—Nos. 307 and 308—having the largest amount. The average percentage of protein for the "rusted and frosted" wheats is more than two per cent. greater than that for the "graded" wheats.

The two classes of wheat are not distinguishable alone by the difference in percentage of protein. The amounts of all the other constituents differ. The percentages of water and carbohydrates in the "rusted and frosted" wheats are less than in the "graded" wheats; while of the ash, oil, fiber and protein they are greater. The fact that the carbohydrates are decreased more than 5 per cent., while the oil is increased over 1½ per cent. and the protein over 2 per cent., would seem to indicate that either the rust causes the extraction of the starchy and saccharine matters, soluble in the juices of the plant; or that the frost changes those substances, so that the plant cannot utilize them for storing up food in the grain, or else it impairs the efficiency of the cells. No. 319*b*, table 8, where a high percentage of protein and the greatest amount of oil are associated with the lowest percentage of carbohydrates is very suggestive.

That the rust or frost has not done the milling and left us only the bran, is evident from a comparison of the averages of the composition of bran* and of "rusted and frosted" wheat given in the following tabular statement:

Authority.	Number of Analyses.	DRY MATTER.			PROTEIN.			FAT.			CARBOHYDRATES.			CRUDE FIBER.			ASH.
		Minimum.	Maximum.	Average.	Minimum.	Maximum	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum	Average.	Minimum.	Maximum	Average.	Average.
		per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.
A	......	83.50	92.40	87.00	10.10	17.00	14.50	1.70	6.60	3.50	28.50	61.50	53.60	4.10	34.60	9.40	6.00
B	2	85.82	91.35	87.98	7.81	16.89	14.54	2.39	5.84	3.66	50.41	58.93	55.16	7.24	16.64	8.67	5.83
C....	18	86.28	89.10	87.91	12.31	17.94	15.01	1.85	5.04	3.30	......	......	......	......	......	......	6.24
D	11	88.78	91.58	90.57	14.25	20.19	16.49	2.82	5.28	3.40	61.46	69.46	65.54	2.05	5.08	3.20	1.87

*Annual Report of the New Jersey Agricultural Experiment Station, 1888. On authority of *A*, Dr. Julius Kuhn, Halle. *B*. Dr. E. H. Jenkins, Connecticut Station. *C*. New Jersey Station. *D*. Average composition of "Rusted and Frosted" wheat.—*Harper*.

But the matter of most practical importance is the very soft character of the grain, and the small quantity and poor quality of the gluten contained. The amount of gluten varies from nothing in 318 and 319 to 8.7 per cent. in 317; all is of very poor quality. I find record of but one instance of wheat having been analysed where there was no gluten present. Ritthausen* copies Millon's tables where, amongst others, there appears the following analyses:

II. Wheat raised during the year 1852 and '53. in the neighborhood of Algier, and under the same latitude.

No.	LOCALITY, ETC.	WATER.	NITROGEN.	PROTEIN.†	DRY GLUTEN.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
11	Guyotville, weak white Wheat. Grains with mealy, very slightly horny fracture.........	12.23	1.588	9.92	4.8
12	Same. The weak grains separated from half-hard ones.............	....	....	....	0.0
13	Same. The hard grains separated from the weak ones............	....	....	....	11.8

†Calculated from the percentage of nitrogen.

The wheat of the next year's crop (1853), from the same locality, contained only 3.5 per cent. of dry gluten. No statement is made as to the conditions under which this wheat grew. From these analyses Millon† concludes that there can no longer be any doubt of the existence of wheat which contains no gluten. My own results do not warrant this statement, but rather that the gluten of wheat may be so injured, that by the process of "washing out," it cannot be separated. In fact the determination of gluten by "washing out," should not be considered so much a quantitative as a qualitative one. From wheat where the gluten is in good condition it can be separated in apparently its entire quantity, and in this wheat the tenacity is remarkable. Where the wheat has been damaged this function of the gluten

* "Die Eiweisskorper der Getreidearten," etc., Bonn, 1872, page 7.

† "*Der Weizen von Guyotville, der zwei Jahre hintereinander in einer durch ihren Getreidebau beruehm ten Gegend erbaut war, liess keinen Zweifel ueber die fortdauernde Existenz glutenfreien Weizen mehr uebrig.*" *Millon Journ. f. pract Chem., 61. 343. Ritthausen, Op. cit. 8.*

is more or less destroyed, and by mechanical means it is not possible to make an accurate quantitative determination. The method of "washing out," however, affords a good basis of comparison.

No cereal, for its proper development, is more dependent than wheat upon its environment and conditions of growth. A reference to the table on page 12, shows that there is a decided difference in wheats grown in various parts of this country. That grown on the Pacific coast has the highest weight per 100 grains, and the least amount of protein, while that grown in the Western States has the lowest weight per 100 grains and the most protein. Then the wheats grown in various localities of each section differ. Oregon produces the largest and heaviest berry and having the least amount of protein. Colorado wheat has a large, heavy berry with a large percentage of protein, while Minnesota and Dakota produce the wheat having the greatest amount of protein and least size and weight. These differences in the wheats of various localities remain nearly constant from year to year, so that it may said that for each section there is a standard for wheat. Prof. Blount's experience has been that for the climate and soil of Colorado, there is a standard more or less clearly defined. Wheat received from sections producing a poorer quality than Colorado, after a few season's growth, attained this standard; while wheat received from Minnesota and Dakota—where the best American wheats are grown—gradually reverted to the same standard.

I do not consider it to be proven that wheat grown from seed, such as 318 and 319 will fail to contain gluten. Nowhere in this country are the conditions for the successful raising of wheat better than in our own wheat growing sections, and I think it safe to assume that where germination and the first steps of growth can be accomplished, the wheat harvested will be better than the damaged seed sown. That the wheat produced will be as good as from thoroughly good seed cannot be expected. How great the depreciation will be we can tell only by experience. Where first-class seed could be obtained it would be very unwise to sow anything else, and our farmers have been wise to provide themselves with good seed and to sow it.

Basing our comparisons upon the amount of gluten, we see that the "Blue Stem" wheat has been least affected by the rust and frost, while the "Saskatchewan Fyfe" has been most affected. It will not be proper to draw very bold conclusions, but inasmuch as the various samples, were grown chiefly in one locality and under like conditions, it may be safe to say that the "Blue Stem" is the hardiest, and will best withstand the rust and frost. This matter of the best variety of wheat is one demanding careful attention. The best of our wheats are very good, but improvement is possible. To better control the selection of wheat for seed, and to see whether we cannot reach a still higher standard, I have started, in conjunction with some farmers in the wheat growing sections, a series of experiments, the results of which will be published from time to time.

The high percentage of protein in the damaged wheats indicates that they would be good for feeding purposes. That is the claim made by many who have used them. They have proven to be so for this purpose, as is well known by the readers of our agricultural press. I have thus far found it impossible to make certain experiments which I had planned in order to test their feeding value. When these can be made the results will be published.

DIVISION OF VETERINARY SCIENCE.

OLOF SCHWARTZKOPFF.

MODERN FEEDING OF PIGS, AND ITS INFLUENCE UPON THE FORMATION OF THE SKULL AND DENTITION.

During the past few years many objections have been raised, on the part of our practical breeders, to the correctness of the older rules for recognizing the age of our domestic animals. Several cases of an extraordinarily early development of the dentition have been observed in fat stock shows, and other exhibitions, and it has been alleged that modern feeding, with the tendency to produce early maturity, results also in an earlier shedding of the teeth. Not only in the United States have these doubts been heard, but also in England and Germany. In 1882 Prof. G. T. Brown published in the journal of the Royal Agricultural Society, of England, an article in which he comes to the conclusion that, as a general thing, the views of the breeders cannot be relied upon, and that the recognition of the age from the teeth is still the best and surest. In June, 1886, the executive committee of the fat stock show at Berlin, preferred similar complaints, and requested the Minister of Agriculture to introduce new experiments at the veterinary schools, and agricultural experiment stations in Germany, to ascertain whether the signs of age from dentition, sexual development and growth of horns, can appear at an earlier time in our precocious breeds, than hitherto believed. Accordingly, Prof. A. Nehring, of Berlin, published in the "Landwirtschaftliche Jahrbucher, of 1888," a series of new dentition tables for pigs, as a result of his studies and investigations, upon a collection of one hundred and thirty-one skulls of different kinds of pigs, at the museum of the Royal Agricultural School at Berlin.

Having seen and examined parts of this collection, I will undertake to demonstrate, with the guide of the above mentioned tables, together with my own experience and observation while practicing in breeding establishments, that our practical men have been quite right in many cases, and that the doubts to which reference has been made are not without foundation.

Before entering into the variations observed, I will briefly review what is accepted concerning the dentition of the pig.

This animal has two sets of teeth, a first called the temporary or milk teeth, which after a certain term of general development of the animal, are replaced by a second set, called the permanent teeth. In both, the temporary and permanent dentition, we distinguish three kinds of teeth, according to their form and purpose; these are called—first, the incisors, placed in the anterior portion of the jaw for taking up the food; second, the tusks or canine teeth, which are looked upon merely as a natural weapon; and, third, the grinding teeth, or molars, in the posterior part of the jaw for the mastication of food. The permanent molars are divided into premolars and molars. The rudimentary tooth, commonly known as wolf's tooth, being counted with premolars. The wolf's tooth and the three permanent molars come into place without being preceded by milk teeth.

Because of certain difficulties in describing the number of these different teeth, their disposition in the jaw and mode of succession, it has become a practical usage to represent these particulars in a dental formula. Such is a combination of letters and figures being very convenient for reading and writing. The following formula we will adopt for our purpose

I. TEMPORARY OR MILK DENTITION, COMPLETE.

6 upper. 6 lower.	incisors, *i.*
2 upper. 2 lower.	tusks or canine teeth, *c.*
6 upper. 6 lower,	molars, *m.*

Formula of Temporary Dentition for one side of the Jaw.		
INCISORS.	TUSKS.	MOLARS.
i 1, i 2, i 3,	*c*	*m 1, m 2 m, 3,*
i 1, i 2, i 3,	*c*	*m 1, m 2, m 3,*
14 on each side.		28 on both sides.

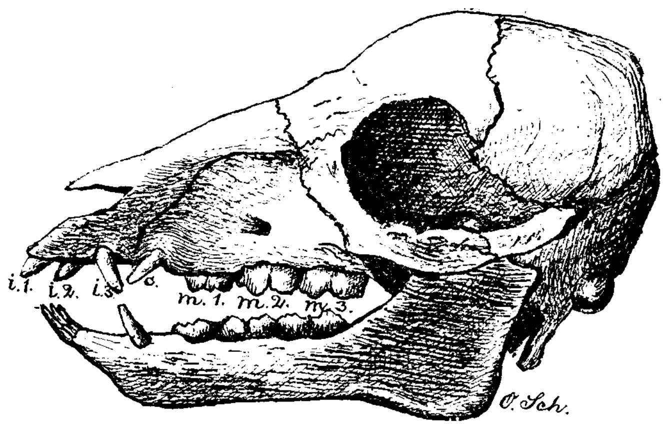


Fig. 1.
Skull of a three months old pig, with full Milk dentition. (Original.)

II. PERMANENT DENTITION, COMPLETE.

6 upper. 6 lower.	Incisors, *I.*
2 upper. 2 lower.	(Tusks.) Canine, *C.*
P 1, Wolf's tooth, if present.	
6 upper. 6 lower.	Premolars, *P.*
6 upper. 6 lower.	Molars, *M.*

Formula for Permanent Dentition for one side of the Jaw.			
INCISORS.	TUSKS.	PREMOLARS.	MOLARS.
I 1, I 2, I 3,	*C.*	*P 1, P 2, P 3, P 4,*	***M** 1, **M** 2, **M** 3,*
I 1, I 2, I 3,	*C.*	*P 1, P 2, P 3, P 4,*	***M** 1, **M** 2, **M** 3,*

22 on each side.
44 on both sides.

SEE FIG II NEXT PAGE.

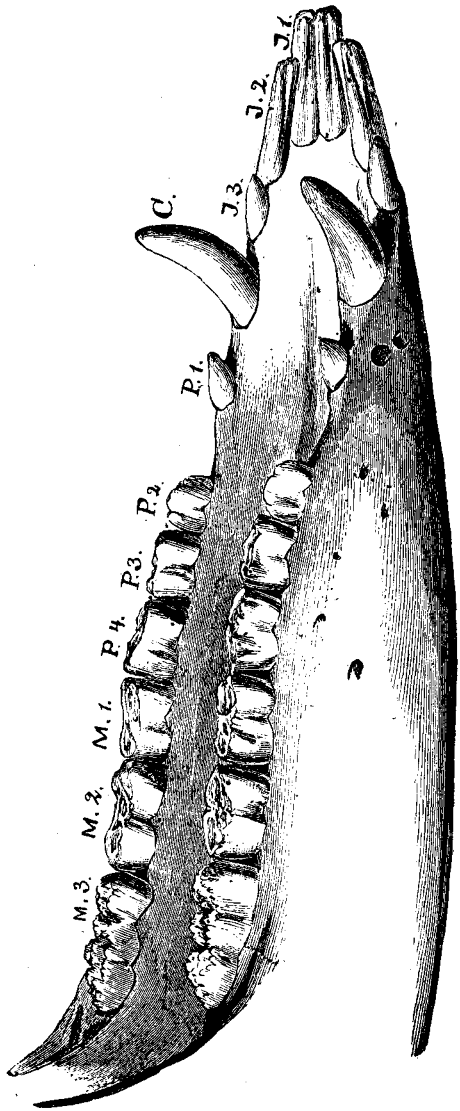


Fig. II.

Lower jaw, showing permanent dentition. (After Rhode).

Making use of these dental formulas, I will proceed to explain the development of the milk and the permanent dentition, comparing both the old observations and the new. This method will prove that there is a remarkable difference in the time occupied by the teeth in cutting their way through the gum and appearing on its surface, while the mode of succession remains unchanged. But it must be remembered that the dentition tables, still referred to in modern books for the practical pig breeder, are based upon observations made in times when the common pig was raised, or, perhaps, a breed more or less improved by English stock, and fed in the old fashioned style. Variations into early maturity were then described as abnormal; but as soon as the pure breeding of the favorites of our day commenced, Berkshire, Poland China, et al., and we applied to them scientific feeding, we forced the animals into entirely new and artificial conditions, revealing the hitherto unknown physiological laws of early maturity.

The young pig comes into the world with eight teeth, *i 3* and *c*, that is the corner incisors next to the tusk, and the tusk itself. These teeth look very much alike, and evidently have the purpose of assisting the tongue in sucking.

Between 4 and 14 days appear two milk molars, *m 2* upper and *m 3* lower jaw. From 2 to 5 weeks break through *m 2* lower and *m 3* upper jaw, and at about the same time *i 1* upper and *i 1* lower jaw. Between five weeks and three months appear *i 3* and *i* 2 lower jaw, followed shortly after by *i 2* upper. With this tooth the milk dentition is finished—the normal time being three months. The longer time mentioned in each case is the time at which the various teeth appear in the primitive hog and the shorter time is that at which these teeth may appear in our improved hogs.

The milk dentition is now resting for a time, seemingly to prepare for the growth of the permanent teeth. Between 2 and 6 months the first permanent molar *M 1* will appear, and together with it the wolf's tooth. The other teeth are replaced in the order in which they succeeded in the milk dentition. Thus we see *I 3* and *C*, at 7½ to 10 months, followed shortly by *M 2* upper and lower jaw. In about 12 months, *I 1* lower will appear, while *I 1* upper jaw, sometimes comes as late as 15 months. After changing the premolars, *I 1* and *M 3* appear in from 11 to 22 months. Between 16 and 17 months are replaced *I 2* upper and lower jaw. At almost the same time appears the last molar, *M 3*, in upper and lower jaw. Now we have a fully developed permanent dentition, which is illustrated in Figure II.

For the practical use of the swine-breeder, I will summarize what has been discussed above in the following

TABULAR VIEW OF THE DENTITION OF THE PIG.

	TEETH.	Precocious Pigs.	Normal time of Appearance.	Primitive Pigs.
Milk Dentition.	*i 3*, and *c*	Present at Birth.		....
	i 1	2 weeks.	3-4 weeks.	5 weeks.
	i 2, upper jaw	8 weeks.	12 weeks,	16 weeks.
	i 2, lower jaw	5 weeks.	8 weeks.	12 weeks.
	m 1, both	5 weeks.	7 weeks.	9 weeks.
	m 2, upper jaw	4 days.	8 days.	14 days.
	m 2, lower jaw	2 weeks.	3-4 weeks.	5 weeks.
	m 3, upper jaw	2 weeks.	3-4 weeks.	5 weeks.
	m 3, lower jaw	4 days.	8 days.	14 days.
Permanent Dentition.	*I 1*	11 months.	12 months.	14 months.
	I 2,	16 months.	18 months.	21 months.
	I 3	7½ to 8 mos.	9 months.	10 months.
	C	3½ months.	9 months.	10 months.
	P 1	2 to 3 mos.	5 months.	6 months.
	P 2	13 months.	14 to 15 mos.	16 months.
	P 3	12 months.	13 to 14 mos.	15 months.
	P 4	12 months.	13 to 14 mos.	15 months.
	M 1	2 months.	5 months.	6 months.
	M 2	7 to 8 mos.	9 to 10 mos.	12 to 14 mos.
	M 3	17 months.	18 to 19 mos.	21 to 22 mos.

7. The question now arises as to what may be regarded as the cause of this early dentition in modern pigs. We know that our present method of feeding causes a rapid development of the whole body, including, of course, the head. As the teeth could not possibly grow without a corresponding growth of the jaws, that produce them, we must conclude that the development of the skull is the primary cause or driving force in their development. Unconsciously the modern feeder has produced here some highly interesting facts, instructive to natural science at large. Hitherto zoologists have been of the opinion that the form of skull of a fixed species is unchangeable from generation to generation, we may say for thousands of years. This is correct as long as we think of individuals raised in the freedom of nature and under natural and similar circumstances. But domestication, with its forced feeding and breed-

ing for various demands, has brought about unexpected changes in many respects, and it is now evident that the form of skull does not rest merely upon heredity. Only a predisposition to a certain form of skull is transferable from parents to their offspring, but whether exactly the same form will be transmitted depends to a greater extent upon the nutrition, and but little less upon the employment of the muscles of the head and neck. It is not only important that the nourishment be abundant and well selected, but it is also necessary that the individual be in a healthy condition, and his digestive apparatus in such working order as to be able to utilize the offered food equally well. This is plainly seen by comparing skulls from animals which were healthy and growing vigorously, with those which received the same advantages of nutrition, but were suffering with a chronic disease. Continued weakness, caused either by disease or insufficient food, produces a long slender skull, while the skull from a strong pig shows a remarkable expansion in its latitude and altitude. The following reproductions, taken from originals in the agricultual museum at Berlin, will illustrate this point:

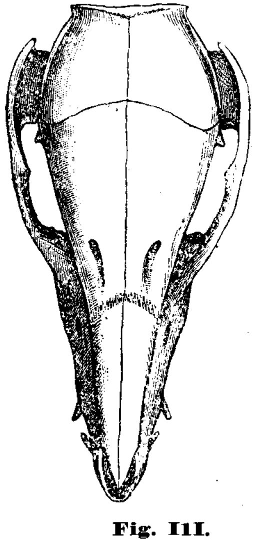


Fig. III.
Skull of a three months old pig, which died from tuberculosis, ½ natural size.
(*After Nehring*).

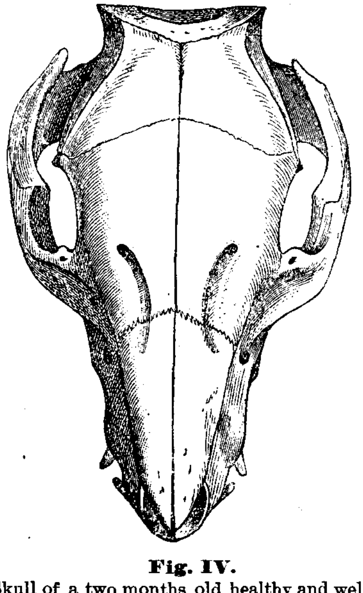


Fig. IV.
Skull of a two months old healthy and well fed pig, ½ natural size.
(*After Nehring.*)

Besides the nutrition influence, a strong or weak muscular action plays an important part in the production of form. The pulling and pressure of muscles extensively used for certain purposes, especially those of the head and neck, will give the head a characteristic shape. Pigs which are prevented from rooting will acquire a short, high and rounded head, while those which are forced to root to secure a portion of their food will develope a long and slender form of head. If we force both experiments to the greatest degree possible, we shall produce those extremes which distinguish the wild pig from our improved races. That this is true is proven by the fact that when our domestic hogs are returned to absolute liberty, it will require but a few generations to reproduce the original skull of the wild pig. And, vice versa, we have called into existance from the primative hog, all those different representative types of our day, by careful and continued selection, gradual assortment, and particular attention to the desired qualities of form, size, etc. The striking difference between the skull of a primative hog and a modern one is seen in the following illustration:

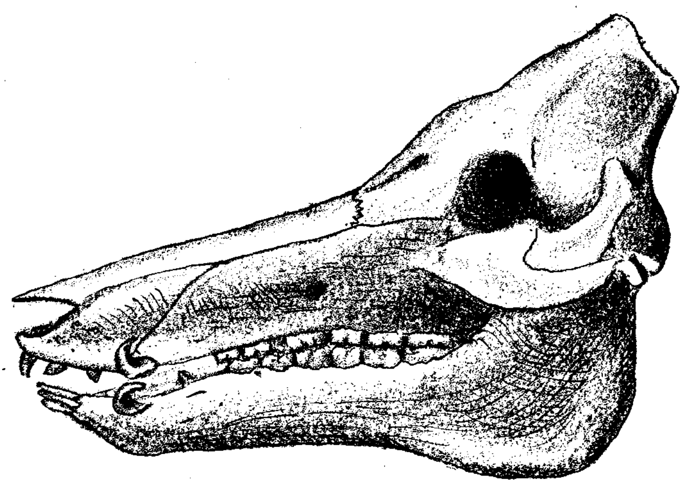


FIG. V.
Skull of a full grown primitive Texas Boar.
(Original.)

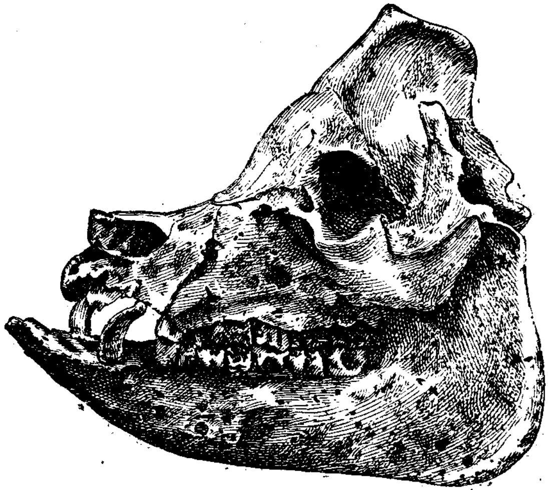


FIG. VI.
Skull of a full grown Sow of the small Yorkshire breed. (After Rhode.)

To express this idea in figures, see following table:

HEAD.	Basilar Length.	Zygomatic Breadth.	Greatest Heighth.
Fig. V...........	13¼ inches.	5½ inches.	5¾ inches.
Head similar to Fig. VI In possession of writer.	9¾ inches.	6¼ inches.	6⅘ inches.

The pig has, perhaps, the most elastic and changeable organization of any of our domestic animals. It also has the advantage of being able to digest all kinds of food as an omnivorous animal, and last, though not least, it multiplies more rapidly than any domestic animal, even the sheep. Therefore it has been at all times regarded, and properly, too, as the animal par excellence for experiments in breeding, and the pig is the best example of what men have accomplished in the production of animals.

Drawing, now, the conclusions from the above examinations shall summarize them in the following theses:

I. The order of succession of the teeth in our precocious pigs remains the same as in the primitive hog.

II. The times when the teeth appear are variable, according to the race, feeding and health. The same breeds, raised under the same conditions, will show the same appearance.

III. The form of the skull depends upon nutrition, health and more or less employment of certain muscles of the head and neck.