AN EXPERIMENT TO DETERMINE THE RELATION EXISTING BETWEEN DRAINAGE WATER AND THE SOIL AND THE RELATION EXISTING BETWEEN DRAINAGE WATER AND RAINFALL.

By

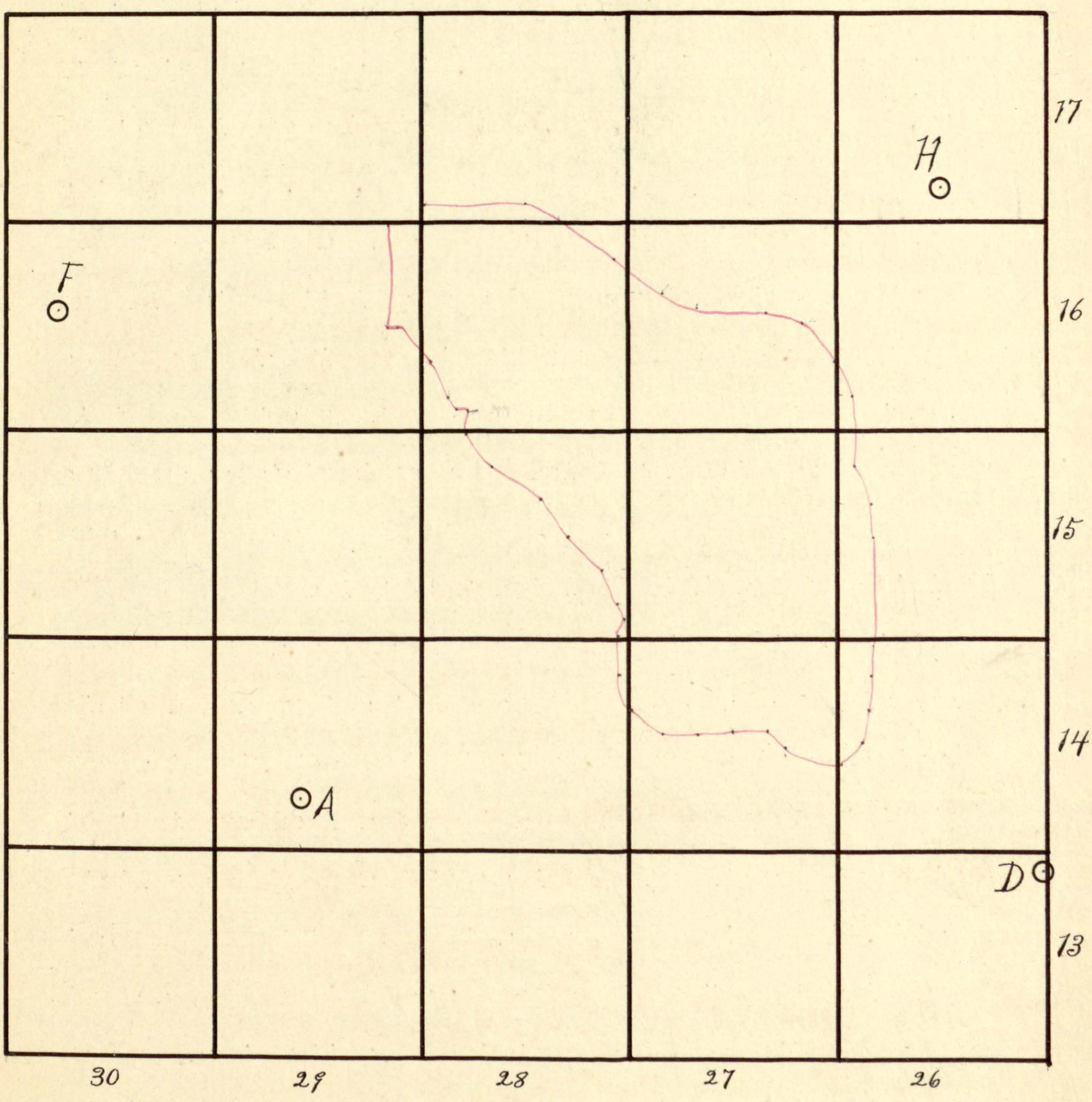
J. H. Norton.

1907.

The time chosen for conducting this experiment was the year of 1906. The drainage water taken was that of Richland creek which drains a territory of 84,954 acres. This valley is located in the southwestern part of Madison and the eastern part of Washington counties in the state of Arkansas with about nine elevenths of it in the former county. The whole territory concerned is found in townships 13, 14, 15, 16 and 17 North, and ranges 26, 27, 28, 29 and 30 West.

This region is especially adapted to this experiment as it is a purely agricultural one which contains only five post offices with a total population at these offices of 265 and is one in which as far as can be accertained no commercial fertilizers have been used.

The rainfall for this territory was obtained from the four rainfall stations of the United States Weather Bureau located near the boundary of this valley. The rainfall for each station was taken as applying to that particular territory which was nearest that station and by carefully calculating it was found that two eights of the territory was nearest Arnett, which is marked A on the map; two eights of the territory was nearest Dutton, which is marked D on the map; one eighthh of theterritory was nearest Fayetteville, which is marked F on the map; and three eights of the territory was nearest Huntsville, which is marked H on the map. The data from all four of these stations was complete for five months only, February, March, April, September and October and was used only for those months.



17
H
F
16
15
14
A
D
13
30
29
28
27
26

During the months of January, May, June, July and August the records which were complete and used from Arnett, Dutton and Fayetteville divided the territory in the proportion of 5, 5, 2. For November the rainfall was calculated from the stations at Dutton, Fayetteville and Huntsville which divided the territory in the proportion of 3, 2, 5. For December one fifth of the territory was assigned to Fayetteville and four fifths of the territory was assigned to Huntsville. The temperature records used were those taken from the Fayetteville station.

This experiment was conducted by making determinations on the stream every two weeks, with one period of fifteen days, and the calculations made by taking each period as one twenty-sixth of a year. The volume of water was determined by measuring the total width of the stream by stretching a steel tape, graduated to feet, across the stream and fastening it at both ends which remained there during all the determinations for that day. At regular intervals the depth and velocity were taken and the volume calculated as though it were so many little streams. As an illustration suppose that these determinations were taken every five feet with the depth at 15 feet, 12 inches; the depth at 20 feet, 14 inches; and the depth at 25 feet, 10 inches. This gives a cross-section of the streamlet, between 17.5 feet and 22.5 feet, with a width of 5 feet; a depth at one side of 13 inches, a depth at the other side of 12 inches and a depth in the middle of 14 inches; with the velocity at 15 feet applying to the whole section.

The velocity of the water was determined by the use of a current meter made by Gurley of Troy, N, Y.

A sample of water was taken at the time the other determinations were made and analyzed.

This experiment does not contain the highest degree of accuracy possible, but it does contain a degree of accuracy fairly high when the opportunities for conducting such an experiment are taken into consideration. The measurements at the creek on June 9 were made under trying circumstances. The creek had to be reached in a rowboat and the determinations made in the boat and by swimming. Many of the determinations at the creek were made at the beginning of the year on horseback and successfully made, too. This required a specially gentle horse which the author had at his disposal. The water flow would have been more nearly exact if the water could have been made to go through a water meter, but such an undertaking was not feasible for this stream and to have taken a smaller stream would have left a source of error in the underground drainage. It is true that any one day's flow of the stream is seldom if ever an average day for the year. It is believed that taking the samples at regular intervals as was the case for twenty six times will compensate errors and give totals for the whole year which are very nearly the real amounts. The flow on June 9 was not the greatest by any means that occurred during the year. A flood occurred just prior to March 31. Even when the determinations were taken on June 9 the stream was not at its highest.

The chemical analyses for chlorine, nitrogen,

total solids, loss on ignition and the reactions were made just as soon as possible after the samples were procured and the evaporation of the 10 liters were made usually within five days. After the evaporations they were transferred to a small beaker and set aside until the close of the year; then all were analyzed at the same time using two blanks and making corrections for the reagents. All reagents were measured or weighed carefully and the same amount was added to each sample so that the correction derived from the blank determinations was correct. Reagents of the highest purity were used, Kahlbaum's solid reagents and Eimer and Amend's liquid reagents.

The chemical analysis of the water was conducted as follows: For total solids, direct determination, 100 cc. of the water was evaporated to dryness in a tared platinum dish and weighed; then heated to a dull red and reweighed for loss on ignition. For nitrogen the determination was made by running duplicates and blanks as prescribed by the Gunning method modified to include nitrates using 500 cc. of the water in each case. The chlorine was determined by the method found in "Examination of water" by Mason. The other determinations were made by evaporating 10 liters to dryness in a Royal Berlin porcelain evaporating dish which had a capacity of 1 liter. This evaporation was conducted on the water bath with an inverted funnel over the dish containing a plug of glass wool in the stem. This same dish was used for each evaporation so as to make sure that no solids were lost by remaining in the dish. At the end of the year only a slight coloration could

be observed; no deposit could be detected; and the glazing seemed tb be perfect in the dish. The greater part of these solids were transferred from the porcelain to a beaker by means of aqua regia and the last trace was transferred by using crystals of ammonium nitrate and a clean finger. This was evaporated to dryness twice with aqua regia and then baked; it was then taken up in hydrochloric acid and filtered. The residue was fused with four grams of sodium carbonate and the silica carefully determined. The filtrate from the silica and that from the insoluble residue were treated exactly alike but kept separate. The iron, phosphorous and aluminium were separated out by precipitating all three with ammonia, then dissolving this precipitate in nitric acid and precipitating the phosphorous in the usual manner. The iron and the aluminium were weighed together as the oxides and the iron was determined volumetrically. The manganese and calcium were determined by the methods of analysis adopted by the Association of Official Agricultural Chemists for soils. Magnesium was determined from this filtrate by precipitating with ammonium phosphate instead of sodium phosphate. The sulphur was determined from the magnesium filtrate in the usual manner. The sodium and potassium were determined in the sulphur filtrate by the methods used for soils by the Association of Official Agricultural Chemists.

All of the chemical work was done by the author and all of the samples and measurements taken at the creek except five were done by the author. The samples and measurements taken at the creek July 7,

July 21, August18 and September 1 were taken by Professor J, Lee Hewitt while that of August 4 was done by Prof& essor H. E. Morrow.

Owing to accidents, all of the chemical analysis of the sample of August 4 had to be interpolated and all for the sample of February 3, except total solids and chlorine.

The volume of water on March 3 was calculated By adding to the amount of February 3 a sheet of water 2 inches deep and as wide as the total width of the stream with a velocity of twice the average velocity on February 3. The velocities for March 31 were calculated from the velocities on March 17. The bed of the stream remained so nearly constant during the whole year that the above calculations seem allowable.

Data on the volume of river water.

Under each date the first column, headed "Distance", is the distance in feet from the east bank of the stream; the second column, headed "Depth" is the depth in inches; and the third column, headed "Velocity", is the number of revolutions per minute of the current meter at each particular point.

January 6.
Total width 115 feet.

Distance	Depth	Velocity
6	21	74
11.5	20.5	68
17	18.5	72
23	17.5	75
29	17	73
34	14.5	77
40	14	72
46	14	67
51	14	60
57	13.5	53
63	13.5	47
69	14.5	41
74	15.5	40
81	18	35
87	18.5	24
93	20.5	24
99	20.5	28
107	25	17
114	27	6

January 20.
Total width 27 feet.

Distance	Depth	Velocity
1.5	11.25	20
4.5	15.5	40
7.5	21.5	75
10.5	25.5	70
13.5	25.5	60
16.5	23	44
19.5	17.5	26.5
22.5	9.	17
25.5	4.5	15.5

February 3.
Total width 106 feet.

Distance	Depth	Velocity
2	14	41
7	12	37.5
12	11	45.5
17	11.5	42.75
22	10.5	42.75
27	14	38.5
32	14	40
37	17.5	34.5
42	16.5	36.5
47	19	34
52	23	32.5
57	23.5	31
62	23	30.5
67	21.5	30.5
72	22	24
77	22.5	22.75
82	25	19
87	24	14
92	25.5	16
97	28	9
102	27.5	8

February 17.
Total width 106 feet.

Distance	Depth	Velocity
2	11	35
7	10	39
12	10.5	35.5
17	10	43.5
22	9.5	41.5
27	12	34
32	13	32
37	15	34
42	15	30
47	17.5	31
52	20.5	29
57	21.5	33
62	23	31
67	21	29
72	19.5	25.25
77	21	22.5
82	23.5	22
87	23	12
92	23	12.5
97	27	6.8
102	26	4

March 3.
Total width 107 feet.

Distance	Depth	Velocity

2 inches deeper than on February 3.

March 17.
Total width 108 feet.

Distance	Depth	Velocity
2	13	36
7	12	46.5
12	13	43.5
17	13	49.5
22	12.5	52.5
27	15.5	47
32	15.5	46.5
37	18	46.5
42	19	44.5
47	20.5	45
52	23.5	45
57	25	42
62	25	38
67	23	40
72	22	38.5
77	23	33
82	25	32.5
87	25.5	29.5
92	24	22
97	29.5	9
102	27	4
107	11	4

March 31.
Total width 108 feet.

Distance	Depth	Velocity
2	15	no velocities were taken
7	15	
12	15.5	
17	16	
22	17	
27	16	
32	15.5	
37	16	
42	18	
47	19	
52	21	
57	23	
62	24	
67	24	
72	25	
77	26	
82	26.5	
87	28	
92	29	
97	28	
102	26	
107	14.5	

April 14.
Total width 110 feet.

Distance	Depth	Velocity
2	6.5	27
7	28	78
12	24.5	93
17	22.5	97
22	22	98
27	24	97
32	25.5	96
37	26	98
42	28	103
47	28	100
52	29	101
57	30	98
62	33.5	94
67	33	93
72	32	89
77	35	79
82	35	72
87	37	71.5
92	37	66.5
97	39	60
102	41	56
107	26	5

April 28.
Total width 29 feet.

Distance	Depth	Velocity
1	4.25	12
4	11	57
7	13.5	72
10	14.5	86
13	14.25	83
16	13	83.5
19	12.5	82
22	13.25	74
25	12.25	67
28	3.5	39

May 12.
Total width 27 feet.

Distance	Depth	Velocity
1.5	6	46
4.5	9.75	63
7.5	12	71
10.5	13	75
13.5	12.5	69
16.5	12.5	70
19.5	12.5	61
22.5	11	65
25.5	4	47

May 26.
Total width 25 feet.

Distance	Depth	Velocity
2	3.5	13.8
5	7	36
8	8	41
11	9	44
14	9	39
17	8	36
20	8.5	35.5
23	5	31

June 9.
Total width 105 feet.

Distance	Depth	Velocity
5	20	25
10	44	40
15	43	55
20	46	63
25	44	72
30	42	84
35	43	68
40	42	81
45	45	99
50	48	88
55	52	96
60	58	100
65	59	100
70	61	78
75	63	85
80	68	64
85	68	44
90	66	42
95	69	40
100	69	30

June 23.
Total width 27 feet.

Distance	Depth	Velocity
1.5	4	23
4.5	8.5	43.5
7.5	10	55
10.5	11	65
13.5	9.5	62
16.5	7.5	56
19.5	6	41
22.5	8.5	44
25.5	2.5	19

July 7.
Total width 23 feet.

Distance	Depth	Velocity
1.5	3	13
4.5	6	28
7.5	8	36
10.5	7	45
13.5	6.5	38
16.5	2	16
19.5	4.5	9
22.5	3	7

July 21.
Total width 25 feet.

Distance	Depth	Velocity
1.5	3	8
4.5	6.5	26
7.5	7.5	36
10.5	8.5	38
13.5	8	33
16.5	5	25
18	2.5	15
19.5	3.5	12
22.5	6.5	24
24	4.5	7

August 4.
Total width 20 feet.

Distance	Depth	Velocity
3	12	11
6	14.5	25
9	13	15
12	10	12.5
15	6	7
18	6	3

August 18.
Total width 29 feet.

Distance	Depth	Velocity
1.5	6	35
4.5	9	53
7.5	13.5	57
10.5	15	53
13.5	14.5	38
16.5	9	27
19.5	11	44
22.5	6.5	33
25.5	5	19
28.5	3.5	11

September 1.
Total width 29.5 feet.

Distance	Depth	Velocity
1.5	5	15
4.5	9.5	35
7.5	12	45
10.5	14.5	41
13.5	14.5	37
16.5	9	32
19.5	10	36
22.5	8	39
25.5	5	23
28.5	3.5	5

September 15.
Total width 35 feet.

Distance	Depth	Velocity
1	9.5	42.5
4	13	57
7	16	63
10	16.5	62
13	16	64
16	16	59
19	14	57
22	13	62
25	8.5	53
28	8	60.5
31	2	22
34	1.5	0

September 29.
Total width 25 feet.

Distance	Depth	Velocity
2	4	
5	7.5	
8	9	
11	10	
14	8.5	
17	6.5	
20	6.5	
23	2	

October 13.
Total width 21 feet.

Distance	Depth	Velocity
1.5	3	12
4.5	6.5	37
7.5	7.5	41
10.5	8	40
13.5	6.5	38.5
16.5	4	34
19.5	3.5	18.5

October 28.
Total width 15.5 feet.

Distance	Depth	Velocity
.75	2	3.5
2.75	4	8.6
4.75	5	32
6.75	5.75	32
8.75	6	36
10.75	5.5	37
12.75	4.5	36.75
14.75	3.5	10.3

November 11.
Total width 20 feet.

Distance	Depth	Velocity
1	2.75	5.9
4	5.5	11.2
7	7	24
10	7.75	27.9
13	5	14.7
16	4.5	13.1
19	3	6.5

November 25.
Total width 24 feet.

Distance	Depth	Velocity
1.5	4	19.3
4.5	8	44
7.5	9.25	55.5
10.5	10	60
13.5	9	49.8
16.5	7	46
19.5	6.25	44.5
22.5	3.5	24

December 9.
Total width 33 feet.

Distance	Depth	Velocity
1	13	45
4	18.5	60
7	22.5	67
10	16	67
13	8	65
16	7.5	72
19	9	63
22	13.5	110
25	15	99
28	10.5	96
31	5.5	89

December 23.
Total width 35 feet.

Distance	Depth	Velocity
1	10.5	36
4	19.5	47
7	20.5	57
10	22	56
13	14.5	53
16	15.25	71
19	18.5	64
22	19.5	79
25	14.5	92
28	12.5	72
31	12.25	67
34	9	50

The volume of water passing down the stream was calculated from the data taken and the following current meter reduction table. The column headed "No" is the number of revolutions per minute of the current meter while the column headed "Vel" is the velocity of the water in feet per minute.

No.	Vel.	No.	Vel.	No.	VeL.
1	8.4	21	52.8	41	99.2
2	10.80	22	55.2	42	101.4
3	12.60	23	57.6	43	103.8
4	15.0	24	60.0	44	106.2
5	17.4	25	62.2	45	108.6
6	19.2	26	64.4	46	110.8
7	21.4	27	66.6	47	113.0
8	23.6	28	69.0	48	115.2
9	25.8	29	71.4	49	117.6
10	28.2	30	73.8	50	120.0
11	30.6	31	76.0	51	122.4
12	33.0	32	78.2	52	124.6
13	35.2	33	80.4	53	126.8
14	37.4	34	82.8	54	129.0
15	39.6	35	85.2	55	131.4
16	41.8	36	87.6	56	133.8
17	44.0	37	90.0	57	136.2
18	46.2	38	92.4	58	138.4
19	48.4	39	94.8	59	140.6
20	50.6	40	97.0	60	142.8

No.	Vel.	No.	Vel.	No.	Vel.
61	145.2	81	192.0	101	239.4
62	147.6	82	194.4	102	241.8
63	150.0	83	196.8	103	244.0
64	152.4	84	199.2	104	246.2
65	154.8	85	201.6	105	248.4
66	157.2	86	204.0	106	250.8
67	159.6	87	206.4	107	253.2
68	162	88	208.8	108	255.6
69	164.4	89	211.2	109	258.0
70	166.8	90	213.6	110	260.4
71	169.2	91	215.8	111	262.8
72	171.6	92	218.0	112	265.2
73	173.8	93	220.2	113	267.4
74	176.0	94	222.6	114	269.8
75	178.2	95	225.0	115	272.2
76	180.6	96	227.4	116	274.6
77	183.0	97	229.8	117	277.0
78	185.4	98	232.2	118	279.4
79	187.6	99	234.6	119	281.8
80	189.8	100	237.0	120	283.2
	192.0				

Rain fall chart.

Day	Jan.	Feb.	Mar.	Aprl	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1			.28		.49	1.72	.03	.07	✓			.06
2	.62		.34		.49	.98	.30					.09
3	.78	✓	✓		.42				1.66			
4	.02	.31		.17		1.67		✓				
5		.08		.29	.56	.60	.01	.29	.41			.84
6	✓		.44		.26			.44	.12	.11		
7			.04	.16			✓.20	.94	.10		.03	
8	.12			.88			.02	.25	.35			
9						1✓.57	.04	.89				✓
10	.02					.60	.05	2.49	.05			
11	.04		.26				.02	.65	.05		✓.10	
12					✓		.72	.08	.36			
13	.02	.48	.17	1.05		.44	.08	.08	.49	✓		
14		.26	.55	✓						.16		.54
15			.04		.04				✓	.67		.27
16					.03		.16	.07		.02		.50
17		✓.01	✓					.09		.03	.27	.14
18			.34			.54		✓.01				
19		.08	.53					.18			1.13	
20	✓	.82		.01		.13	.76				.66	
21	1.26	.03		.04			✓.44	.05			.12	
22	2.95		.19		.13			.23	.05		.05	
23		.39	2.12		.15	✓.26		.35		.03		✓
24		.01	1.26			.02		.01				
25			.01	.08		.29		1.08			✓	
26			1.14		✓		.17	1.12	.03		.21	
27							.55	.16	.58			
28			.06	✓			.32		.14	✓		
29									✓.29			.16
30			.05	.53		.02					.44	.33
31			✓									.01

The amount of rainfall by periods is as follows:

January	February	March	April	May	June
5.83	2.47	7.82	3.21	2.57	8.84

July	August	September	October	November
3.87	9.53	4.68	1.02	3.01

December	Total for the year
2.94	55.79

January 1-6	January 7-20	January 21-February 3
1.42	.20	4.21

February 4-17	February 18-March 3	March 4-17
1.14	1.95	1.50

March 18-31	April 1-14	April 15-28
5.70	2.55	.13

April 29-May12	May 13-26	May 27-June 9	June 10-23
2.75	.35	6.54	1.97

June 24-July 7	July 8-21	July 22-August 4
.87	2.29	1.11

August 5-18	August 19-September 1	September 2-15
6.28	3.18	3.59

September 16-29	September 30-October 13
1.09	.11

October 14-28	October 29-November 11	November 12-25
.91	.13	2.23

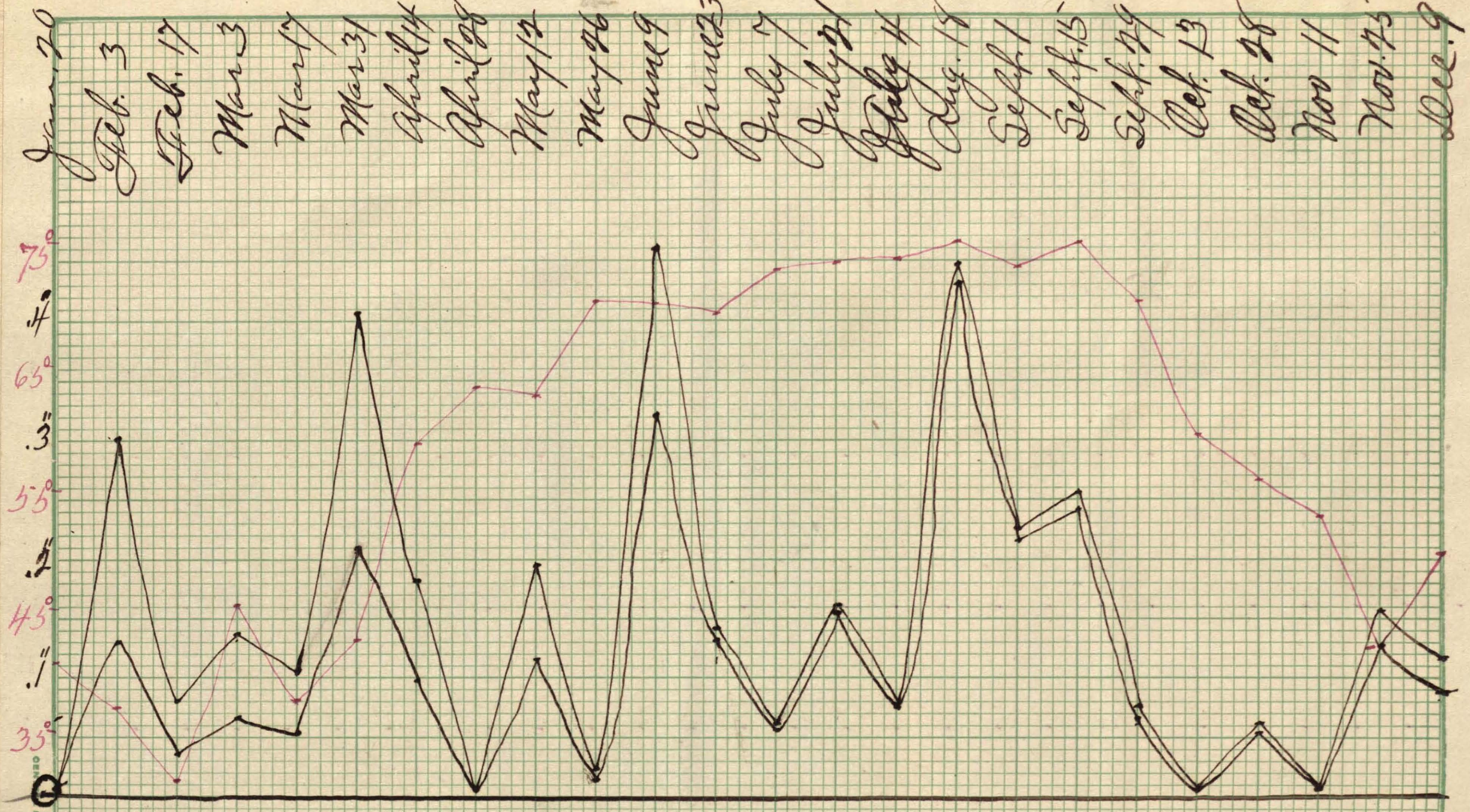
November 26-December 9	December 10-23	December 24-31
1.64	1.45	.50

During the last sixteen years the annual rainfall has exceeded that of 1906 only three times. The maximum rainfall occurred in 1905 and this it seems would have a tendency to make the drainage water or rather the effect of the drainage water about normal for the year of 1906.

Date	Cu.ft.of drainage water per min.	Cu.ft.of drainage water per acre in 1/26 yr.	Cu.ft.of rainfall per acre in 1/26 yr.	Cu.ft.of water evaporated from one acre in 1/26 yr.
Jan. 6	18588.00	4425.90	7969.60	3543.70
" 20	4395.50	1046.60	726.00	-320.60
Feb. 3	10542.40	2510.00	15282.00	12772.00
" 17	9454.30	2251.00	4138.00	1887.20
Mar. 3	13089.00	3116.50	7078.50	3962.00
" 17	15169.80	3611.80	5445.00	1833.20
" 31	16719.60	3980.80	20691.00	16711.20
Aprl.14	53104.20	12356.00	9256.60	-3099.40
" 28	4747.30	1130.40	470.80	-659.60
May 12	3544.60	844.00	9982.50	9138.50
" 26	1254.50	298.70	1270.50	971.80
June 9	70103.00	16692.00	23740.50	7048.50
" 23	1991.20	474.10	7151.20	6677.10
July 7	781.77	186.14	3158.20	2972.06
" 21	801.00	190.72	8312.80	8122.08
Aug. 4	586.22	139.58	4029.30	3889.72
" 18	2206.49	525.38	22797.00	22271.62
Sept. 1	1873.14	446.00	11543.50	11097.50
" 15	4623.32	1100.80	13031.60	11930.80
" 29	1543.04	367.40	3956.70	3589.30
Oct. 13	801.36	190.80	399.30	208.50
" 28	403.14	95.99	3303.30	3207.31
Nov. 11	381.54	90.84	471.90	381.06
" 25	1561.84	371.87	8094.80	7722.93
Dec. 9	5892.11	1402.90	5953.20	4550.30
" 23	6823.68	1624.70	5263.60	3638.90
Total		59470.92	202520.00	143049.08

The mean daily-

Date	Temper-ature	Rainfall	Evapor-ation	Per cent of rainfall evaporated
Jan. 6	34.8	.237	.1148	40
" 20	41.6	.014	.0059	42
Feb. 3	37.6	.301	.1324	44
" 17	31.2	.081	.0373	46
Mar. 3	46.1	.139	.0667	48
" 17	38.1	.107	.0535	50
" 31	43.2	.407	.2116	52
Aprl.14	59.8	.182	.0983	54
" 28	64.5	.009	.0050	56
May 12	63.9	.196	.1176	60
" 26	71.8	.024	.0156	65
June 9	71.6	.460	.3220	70
" 23	70.6	.141	.1311	93
July 7	74.1	.061	.0573	94
" 21	74.9	.161	.1546	96
Aug. 4	75.2	.079	.0758	96
" 18	76.5	.449	.4310	96
Sept. 1	74.4	.227	.2179	96
" 15	76.4	.256	.2406	94
" 29	71.6	.076	.0699	92
Oct. 13	60.4	.008	.0072	90
" 28	56.7	.061	.0537	88
Nov. 11	53.8	.009	.0076	85
" 25	42.5	.159	.1272	80
Dec. 9	50.5	.117	.0878	75
" 23	38.9	.104	.0728	70
Total		55.790		
Mean	57.9	.153		70.63



The mean daily temperature, rain fall and evaporation.

Analysis of 10 liters of river water in grams.

Date	Total solids by direct determination	Total solids by calculation	Solids unaccounted for
Jan. 6	.82	.6813	.1387
" 20	.87	.7255	.1445
Feb. 3	1.07	.9666	.1034
" 17	.83	.7788	.0512
Mar. 3	1.01	.9176	.0924
" 17	.85	.8921	-.0421
" 31	.97	.9293	.0407
Aprl.14	1.27	1.1392	.1308
" 28	.87	.7177	.1523
May 12	.82	.6789	.1411
" 26	1.00	1.1034	-.1034
June 9	5.01	4.3008	.7092
" 23	1.15	.8912	.2588
July 7	1.28	1.1195	.1605
" 21	1.89	1.8212	.0688
Aug. 4	1.60	1.3360	.2640
" 18	1.39	1.1216	.2684
Sept. 1	1.26	1.1367	.1233
" 15	1.32	1.2755	.0445
" 29	1.23	1.0723	.1577
Oct. 13	1.23	1.1945	.0355
" 28	1.30	1.2042	.0958
Nov. 11	1.16	1.2097	-.0497
" 25	1.46	1.3885	.0715
Dec. 9	1.13	.9736	.1564
" 23	.96	.8663	.0937
Total	33.75	30.4420	3.3080
Average	1.2981	1.1708	.1273
Ratio	100.00	90.199	9.801

Analysis of 10 liters of river water in grams.

Date	Silica SiO_2	Loss on ignition	Alumina Al_2O_3	Lime CaO	Sulphur trioxide SO_3
Jan. 6	.2056	.13	.0428	.1313	.0604
" 20	.0950	.15	.0119	.3173	.0634
Feb. 3	.3000	.17	.0450	.3000	.0640
" 17	.1679	.13	.0475	.2839	.0610
Mar. 3	.2531	.17	.2879	.0136	.0813
" 17	.1923	.24	.0725	.2254	.0829
" 31	.2125	.32	.0449	.2461	.0378
Aprl.14	.5150	.26	.1063	.1445	.0384
" 28	.1023	.19	.0195	.2818	.0400
May 12	.0768	.15	.0222	.3038	.0468
" 26	.0652	.36	.0135	.5003	.0492
June 9	2.6533	.64	.6469	.1781	.0318
" 23	.0815	.25	.0165	.4156	.0440
July 7	.1009	.24	.0080	.6098	.0496
" 21	.3766	.39	.0904	.5545	.1117
Aug. 4	.2300	.30	.0160	.5800	.0700
" 18	.1274	.27	.0164	.4847	.0746
Sept. 1	.2170	.28	.0265	.4814	.0421
" 15	.1730	.38	.0375	.5417	.0476
" 29	.0967	.21	.0093	.6020	.0531
Oct. 13	.0666	.27	.0135	.6623	.0586
" 28	.0692	.25	.0117	.7092	.0606
Nov. 11	.0700	.26	.0050	.7183	.0493
" 25	.0954	.31	.0127	.7277	.0939
Dec. 9	.1619	.22	.0403	.3857	.0635
" 23	.1217	.26	.0233	.3261	.0469
Total	6.8269	6.80	1.6880	10.7251	1.5225
Average	.26257	.26154	.06492	.4125	.05856
Ratio	20.228	20.148	5.001	31.778	4.511

Analysis of 10 liters of river water in grams.

Date	Chlorine Cl	Magnesia MgO	Potassium oxide K_2O	Nitrogen N
Jan. 6	.0350	.0434	.0147	.0000
" 20	.0350	.0241	.0176	.0026
Feb. 3	.0340	.0257	.0160	.0027
" 17	.0360	.0273	.0155	.0000
Mar. 3	.0300	.0244	.0266	.0115
" 17	.0350	.0230	.0161	.0000
" 31	.0300	.0182	.0046	.0075
Aprl.14	.0300	.0227	.0069	.0035
" 28	.0370	.0198	.0122	.0034
May 12	.0330	.0216	.0126	.0000
" 26	.0350	.0263	.0196	.0264
June 9	.0500	.0316	.0157	.0305
" 23	.0390	.0225	.0092	.0055
July 7	.0340	.0262	.0046	.0165
" 21	.0920	.0354	.1136	.0115
Aug. 4	.0500	.0300	.0090	.0150
" 18	.0370	.0294	.0112	.0185
Sept. 1	.0310	.0229	.0165	.0065
" 15	.0310	.0255	.0196	.0065
" 29	.0305	.0281	.0272	.0035
Oct. 13	.0340	.0307	.0199	.0250
" 28	.0350	.0335	.0165	.0025
Nov. 11	.0310	.0339	.0118	.0065
" 25	.0395	.0368	.0100	.0045
Dec. 9	.0350	.0290	.0180	.0025
" 23	.0410	.0221	.0156	.0000
Total	.9800	.7141	.4808	.2126
Average	.03769	.02746	.01849	.00818
Ratio	2.904	2.116	1.425	.630

Analysis of 10 liters of river water in grams.

Date	Sodium oxide Na_2O	Ferric oxide Fe_2O_3	Manganese Mn_3O_4	Phosphorous P_2O_5
Jan. 6	.0037	.0130	.0014	.0000
" 20	.0041	.0024	.0021	.0000
Feb. 3	.0048	.0020	.0022	.0002
" 17	.0047	.0018	.0023	.0009
Mar. 3	.0108	.0003	.0076	.0005
" 17	.0024	.0012	.0013	.0000
" 31	.0048	.0014	.0015	.0000
Aprl. 14	.0060	.0033	.0018	.0008
" 28	.0094	.0009	.0014	.0000
May 12	.0077	.0014	.0030	.0000
" 26	.0043	.0013	.0023	.0000
June 9	.0138	.0023	.0017	.0051
" 23	.0043	.0015	.0016	.0000
July 7	.0272	.0012	.0015	.0000
" 21	.0311	.0103	.0041	.0000
Aug. 4	.0290	.0042	.0028	.0000
" 18	.0150	.0010	.0651	.0013
Sept. 1	.0088	.0011	.0016	.0013
" 15	.0092	.0011	.0017	.0011
" 29	.0095	.0006	.0018	.0000
Oct. 13	.0099	.0006	.0025	.0009
" 28	.0094	.0009	.0043	.0014
Nov. 11	.0186	.0004	.0049	00000
" 25	.0186	.0014	.0368	.0012
Dec. 9	.0125	.0024	.0015	.0013
" 23	.0034	.0022	.0021	.0019
Total	.2830	.0602	.1309	.0179
Average	.01088	.00232	.00503	.00069
Ratio	.839	.178	.388	.053

Pounds of material contained in the drainage water from one acre of soil in one twenty-sixth of a year.

Date	Total solids	Silica SiO_2	Loss on ignition	Alumina Al_2O_3	Lime CaO
Jan. 6	22.6550	5.68150	3.59200	1.18358	3.62780
" 20	5.6841	.62062	.98000	.07774	2.07310
Feb. 3	16.7650	4.70050	2.66350	.70503	4.70050
" 17	11.6640	2.35970	1.82700	.66752	3.98980
Mar. 3	19.6500	4.92400	3.30710	5.60050	.26458
" 17	19.1650	4.33580	5.41060	1.63450	5.08110
" 31	14.1040	5.28050	7.95300	1.11580	6.11640
Aprl.14	98.0590	39.72100	20.05400	8.19910	11.14600
" 28	6.1395	.72190	1.34080	.13760	1.98860
May 12	4.3205	.40462	.79028	.11696	1.60060
" 26	1.8648	.12158	.67130	.02518	.93299
June 9	510.15000	270.19000	65.17000	65.87000	18.13600
" 23	3.4037	.24120	.73995	.48840	1.23000
July 7	1.4874	.11725	.27888	.00930	.70860
" 21	2.2503	.44840	.46435	.01076	.66020
Aug. 4	1.3942	.20040	.26140	.01394	.50538
" 18	4.5575	4.17820	8.85500	.05379	1.58970
Sept. 1	3.5080	.60410	.77960	.07378	1.34040
" 15	9.0710	1.18890	2.61140	.25770	3.72250
" 29	2.8211	.22176	.48165	.02131	1.38070
Oct. 13	1.4650	.07932	.32160	.01608	.78887
" 28	.7790	.04147	.14982	.00701	.42500
Nov. 11	.6578	.03970	.14745	.00284	.40735
" 25	3.3892	.22145	.71965	.02948	1.68920
Dec. 9	9.8970	1.41800	1.92690	.35296	3.37810
" 23	9.7355	1.23420	2.63700	.23630	3.30720
Total	794.6376	349.29607	134.13423	86.46662	80.79067
Ratio	100.000	43.96	16.88	10.88	10.17

Pounds of material contained in the drainage water from one acre of soil in one twenty-sixth of a year.

Date	Sulphur trioxide SO_3	Chlorine Cl	Magnesia MgO	Potassium oxide K_2O	Nitrogen N
Jan. 6	1.66775	.96710	1.19920	.40618	.00000
" 20	.41420	.22867	.15746	.01150	.01699
Feb. 3	1.00270	.53271	.40269	.25070	.04230
" 17	.85728	.50595	.38369	.21785	.00000
Mar. 3	1.58160	.58365	.47000	.40192	.22373
" 17	1.86910	.78910	.51858	.36300	.00000
" 31	.93940	.47555	.45261	.01143	.01864
Aprl. 14	2.96180	2.31390	1.75080	.53221	.26996
" 28	.28226	.26110	.13972	.08610	.02399
May 12	.24657	.17387	.11380	.06638	.00000
" 26	.09175	.06527	.04904	.03655	.04923
June 9	3.23810	5.09080	3.21780	1.59870	3.10570
" 23	.13023	.11543	.06660	.02733	.01628
July 7	.05764	.03951	.03044	.00534	.01917
" 21	.13299	.01095	.04215	.13526	.01369
Aug. 4	.06100	.04357	.02614	.00784	.01397
" 18	.24467	.12135	.09643	.03673	.06067
Sept. 1	.11722	.08632	.06376	.04594	.01809
" 15	.32710	.21304	.17523	.13478	.04466
" 29	.12178	.06995	.06445	.06238	.00803
Oct. 13	.06980	.04050	.03657	.02370	.02978
" 28	.03512	.02038	.02007	.00989	.00150
Nov. 11	.02796	.01758	.01923	.00669	.00369
" 25	.21798	.09170	.08541	.02321	.01045
Dec. 9	.55615	.30656	.25400	.15766	.02189
" 23	.57565	.41580	.22415	.15822	.00000
Total	17.72779	13.58029	10.06472	4.81741	4.01153
Ratio	2.231	1.709	1.266	.606	.505

Pounds of material contained in the drainage water from one acre of soil in one twenty-sixth of a year.

Date	Sodium oxide Na_2O	Ferric oxide Fe_2O_3	Manganese Mn_3O_4	Phosphorous P_2O_5
Jan. 6	.10223	.35920	.03869	.00000
" 20	.02679	.01568	.01372	.00000
Feb. 3	.07520	.03134	.03447	.00313
" 17	.06605	.02530	.03232	.01265
Mar. 3	.21010	.00584	.14785	.00973
" 17	.05410	.02706	.02931	.00000
" 31	.01193	.03479	.03728	.00000
Aprl.14	.46280	.25454	.13884	.06171
" 28	.06633	.00635	.00988	.00000
May 12	.04057	.00738	.01580	.00000
" 26	.00802	.00242	.00429	.00000
June 9	1.40520	.23420	.17311	.51930
" 23	.01273	.00444	.00474	.00000
July 7	.03161	.00139	.00174	.00000
" 21	.03073	.01226	.00488	.00000
Aug. 4	.02527	.00366	.00244	.00000
" 18	.04920	.00328	.11512	.00426
Sept. 1	.02450	.00306	.00446	.00362
" 15	.06322	.00756	.01168	.00756
" 29	.02179	.00138	.00413	.00000
Oct. 13	.01179	.00071	.00298	.00108
" 28	.00563	.00054	.00258	.00084
Nov. 11	.01055	.00023	.00278	.00000
" 25	.04318	.00325	.08542	.00279
Dec. 9	.10948	.02102	.01314	.01139
" 23	.03448	.02231	.02130	.01927
Total	3.00978	1.08919	.95294	.65731
Ratio	.379	.137	.120	.083

The reaction of this water at the temperature of the laboratory in every case was alkalime with cochineal. This water was not alkaline with phenolphtalein at the boiling point from June 9 to August 4 nor was it alkaline in December with this reagent. It is certainly to be expected that the alkalinity during the growing season would be less than at other seasons of the year which was the case. But the decline of the alkalinity in December is unaccounted for.

The drainage water from this valley gave the following number of pounds of material removed from one acre of soil in one year:- total solids, 794.6376; silica, 349.29607; loss on ignition, 134.13423; alumina, 86.46662; lime, 80.79067; sulphur trioxide,17.72779; chlorine, 13.58029; magnesia, 10.06472; potassium oxide, 4.81741; nitrogen, 4.01153; sodium oxide, 3.00978; ferric oxide, 1.08919; manganous manganic oxide, .95294; phosphorous pentoxide, .65731

The composition of these total solids by percentage is as follows:- silica, 43.96; loss on ignition, 16.88; alumina, 10.88; lime, 10.17; sulphur trioxide, 2.231; chlorine, 1.709; magnesia, 1.266; potassium oxide, .606; nitrogen, .505; sodium oxide, .379; ferric oxide, .137; manganous manganic oxide, .120; phosphorous pentoxide, .083 This leaves an amount unaccounted for which equals to 11.074 %. Calculating the calcium and magnesium as the carbonates would give 9.37 % carbon dioxide; this still leaves unaccounted for solids which amount to 1.704 %. This discrepency, in the author's opinion, should be added to the loss on ignition; for when it is considered that the loss

on ignition was made on amounts which were usually less than 10 milligrams and that there is great difficulty in burning all the organic matter without decomposing the carbonates it would seem reasonable that there was not complete combustion.

The composition of the soil of this region is approximated from eleven analyses of three soils in this locality just outside the Richland valley. The following average percentage composition is obtained for the surface soil from these analyses:- water, 5.53; silica, 86.67; alumina, 3.16; lime, .20; sulphur trioxide, .11; magnesia, .16; potassium oxide, .11; nitrogen, .061; sodium oxide, .16; ferric oxide, 2.22; manganous-manganic oxide, .12; phosphorous pentoxide, .112 These figures probably represent very well the soil of the Richland valley except for lime and magnesia which are omitted from the discussion.

Taking the dry weight of a cubic foot of soil as 70 pounds, this would mean that the drainage water removes .00313 inch of soil annually, or it would require about 300 years to remove one inch of soil.

The loss by drainage water is great enough to remove all of each of the elements to the following depths in inches:- silica, .00152; alumina, .01033; sulphur trioxide, .06082; potassium oxide, .01653; nitrogen, .02482; sodium oxide, .00710; ferric oxide, .00019; manganous manganic oxide, .00300; phosphorous pentoxide, .00221 In other words, the tendency of the drainage water is to accumulate silica, iron, manganese and phosphorous in the soil and a tendency to loose aluminium, sulphur, potassium, nitrogen and sodium. The tendency to the accumulation of phosphorous is so

very slight that it is negligible when the amount of that element removed by plant growth is taken into consideration. The loss of nitrogen is about equal to that supplied by rainfall. The Rothamsted station gives the nitrogen of rainfall on one acre per year as 3.31 to 4.43 pounds while the Kansas station gives 3.44 pounds. The loss of potassium is very marked and since the soil is already deficient in this element it is a question of no little importance. On the other hand the loss of sulphur is certainly a beneficial one as this soil already contains an excess of this element.

The literature on this subject seems to be almost entirely wanting;so much so that the author was able to find as having any important bearing on this subject, only the amount of nitrogen furnished the soil by rainfall.

The conclusions are:

1st. On the whole, the erosion due to drainage water is not serious when it requires three hundred years to remove one inch of soil.

2d. The annual loss per acre due to drainage water amounts to; nitrogen, sixty cents; potassium, twenty five cents and phosphorous, about four cents. This would make an annual loss per acre of eighty nine cents.

3d. During the growing season the evaporation amounts to more than ninety per cent of the rainfall, while for the whole year the evaporation amounts to seventy per cent of the rainfall.

April 27, 1907.