TEXAS AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 171 DECEMBER, 1914

DIVISION OF CHEMISTRY

LOSSES OF MOISTURE AND PLANT FOOD BY PERCOLATION

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

VON BOECKMANN-JONES CO., PRINTERS
AUSTIN, TEXAS
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BY

G. S. FRAPS, Ph. D., Chemist

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*As of November 30, 1914.
†In cooperation with United States Department of Agriculture.

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LOSSES OF MOISTURE AND PLANT FOOD BY PERCOLATION

BY G. S. FRAPS, PH. D., CHEMIST.

Certain fundamental conditions are essential to plant life. These include light, water, favorable temperature, favorable soil conditions, and plant food. A deficiency of any one of these will limit the growth of the plant. From the standpoint of plant nutrition, no one is more important than the others. From the viewpoint of the farmer, however, the important conditions are those which, under ordinary agricultural conditions, may be deficient and so control the growth of the plant and the crop produced, and which, being deficient, may be supplied, to a greater or less extent, or the deficiency controlled, by the farmer. In other words, the practical farmer is not much concerned with conditions beyond his control which limit plant growth, or those which are favorable under ordinary agricultural practice. He is much concerned, however, with deficiencies which he can correct or control. Temperature and light are little subject to control in agricultural practice, but water, soil conditions, and plant foods ordinarily deficient—phosphoric acid, nitrogen and potash—are more or less subject to control. The quantity of rainfall cannot be regulated, but the amount of water stored in the soil and that lost by evaporation may, more or less, be modified by agricultural practices.

QUANTITY OF WATER NEEDED.

The quantity of water needed by the plant depends upon conditions, but is very large. According to estimations of King, corn requires 233 to 272 pounds of water to produce one pound dry matter. This does not refer to the grain but to the entire plant. Barley requires from 262 to 774 pounds of water to produce one pound dry matter, and red clover from 249 to 453 pounds. The quantity estimated by different investigators varies, but we can assume, as a basis for calculation, that one pound of dry matter requires 300 pounds of water. This quantity of water is taken up by the roots of the plants and evaporated through their leaves. An additional quantity of water is lost by evaporation from the soil, during the period of growth of the plants.

The amount of water required by plants* depends upon several conditions:

(a) Dryness of the air. Plants evaporate more water into a dry atmosphere than into a moist.

(b) The water in the soil. Plants evaporate more water from a soil when wet than from the same soil when it contains a fair quantity of moisture.

(c) Light. More moisture is used in light than in darkness.

(d) Fertility of the soil. Plants use less water when grown on a fertile soil than when grown on a poor soil. The addition of needed

*Fraps, Principles of Agricultural Chemistry, p. 120.

plant food to a poor soil decreases the consumption of water. Hence, the use of the proper kind of plant food will economize water. For example, the Nebraska Experiment Station found that corn grown on a poor soil used 540 pounds of water for each pound of dry matter produced. When same soil was manured, corn used only 350 pounds water per pound of dry matter produced.

(e) Variety of plants. Different varieties vary considerably in their requirements for water.

If we estimate that it requires 300 pounds water to produce 1 pound dry matter, to be evaporated by the plant, the following are the approximate quantities of several crops which would be produced per acre by one inch water (227,000 pounds) used by the crop:

Cotton, pounds, lint	80
Corn, bushels	6
Wheat, bushels	4
Oats, bushels	9
Alfalfa, pounds	760
Hay, pounds	760

The supply of water is undoubtedly, at various times, the controlling condition of plant growth, and unfavorable moisture conditions often have their effect upon crop production. Methods for decreasing the effect of unfavorable moisture conditions are, therefore, of great advantage in practical agriculture.

WATER AVAILABLE TO CROPS.

The amount of water at the disposal of the crop will depend upon:

(1) The quantity of available water in the soil at the beginning of the growing season.

(2) The amount and distribution of rainfall during the period of crop growth.

(3) The loss from the soil by evaporation from its surface.

(4) The loss of the rain water which runs off on the surface of the soil.

(5) The loss from water which passes through the soil and into the ground water.

The quantity of available water present in the soil at the beginning of the growing season depends, in turn, upon a number of conditions. These include: (a) Character of soil, (b) depth of soil, (c) character and depth of subsoil, (d) rooting habits of the plant, (e) quantity and distribution of the previous rainfall, (f) previous treatment of the soil.

The character of the soil determines the amount of water it will hold when saturated, its readiness to lose water by evaporation or percolation, and the quantity of water which, though present, is held so firmly that plants cannot take it from the soil.

The depth of the soil, together with the depth of the subsoil, determines the volume of soil from which water may be drawn. It is obvious, for example, that when plant roots can occupy eighteen inches of the soil, they have more water at their disposal than when they occupy only twelve inches of the same soil. The depth and character of the subsoil affect the soil volume occupied by the plants, the quantity of water retained in the subsoil, and the quantity of water which can be moved by soil forces, from areas below the roots, to within reach of the roots.

The rooting habits of the plant determine, to a certain extent, the soil volume which the roots will occupy. There is a great difference in plants in this respect. In arid climates, plants seem to send their roots deeper than in humid sections.

The quantity and distribution of the previous rainfall determines the degree of saturation of the soil at the time of planting. The soil may, or may not, be saturated at this time. In some sections, it is usual to speak of having "a good season in the ground," meaning thereby that the previous rains have placed the soil in a good condition of saturation at the time of planting the crop.

The previous treatment of the soil may have some effect upon the depth of rooting of the plant and thus on the soil volume occupied. Subsoiling may, with certain soils, be of advantage in this respect. The previous treatment will also determine, to a certain extent, whether the winter rains sink into the soil or run off on its surface. It will also determine whether the soil has been in good condition to absorb the rains, and will affect the losses of water by evaporation. Shallow surface cultivation, previous to planting the crop, may be needed for the purpose of conserving soil moisture. Fall plowing may be needed to open the soil to the winter rains. On the other hand, fall plowing of other soils may be a disadvantage. Spring plowing may be all right on some soils and in some seasons, but, under other conditions, it may cause loss of moisture through the drying out of the soil.

It is not our purpose to discuss fully any of the factors above mentioned.

The amount and distribution of the rainfall during the period of growth of the crops affect not only the quantity of water which penetrates into the soil and the quantity which runs off, but also the length of the period between rains governs the length of the time during which the plant must rely upon the store of water in the soil.

The loss of the rainwater which runs off from the soil surface depends on the slope of the soil, the condition of its surface, and the character of the soil. The average run-off, due to the average precipitation, is considered to be approximately as follows:*

Rainfall.	Run-off on	
	Steep slopes.	Gentle slopes.
5 inches	0 inches	0 inches
10 inches	2 inches	0 inches
15 inches	4 inches	1 inch
20 inches	8 inches	3 inches
25 inches	12 inches	4 inches
30 inches	17 inches	8 inches
35 inches	22 inches	12 inches
40 inches	28 inches	15 inches
45 inches	....	20 inches

*Wilson, Irrigation Engineering.

The run-off in dry climates is less than in humid. It is, of course, difficult to estimate accurately the run-off from cultivated lands. The above figures may be an aid in forming an estimate. The run-off also depends on the rate of precipitation. There will be more run-off from a precipitation of one inch during three hours than from the same quantity during forty-eight hours.

PERCOLATION APPARATUS.

A percolation apparatus consists of a definite area of soil enclosed in a water-tight receptacle, with an outlet tube at the bottom, and a vessel to receive the water which percolates. All the water which falls in this apparatus must either evaporate or percolate through the soil. There is no run-off. In some experiments, plants have been grown in such vessels. Percolation apparatus are in use at the Rothamsted, England, Experiment Station, at the New York Cornell Station, and at the Florida Station. Other investigators and experiment stations have also carried out experiments with this form of apparatus.

Description of Apparatus.—The percolation apparatus used in this work consists of 48 galvanized iron cans 12 inches in diameter and 24 inches deep, with a block tin tube at the bottom. These cans are buried in the ground. Figures 1 and 2 are drawn to scale, and show the arrangement of the apparatus. The cans are connected with the bottles to receive the water by means of a tight cork. The apparatus was set up and filled with soil in March, 1910. Six pots were filled with each soil. Each pot of the same soil receives a different treatment. Each of the pots received first ten pounds of washed gravel, which filled them to a depth of one and one-half inches. The subsoil and surface soil were then placed in them. The first forty-two pots were filled in the middle of March, 1910. The last six pots were filled about ten days later. As the earth settled considerably, further additions of soil, to the amounts shown in the table below, were made on May 24, 1910. The soil was in all cases in a moist condition as it was received from the field.

On account of various difficulties and for the purpose further of allowing the soil to settle and assume more or less its natural condition, the percolation waters were not collected until January 1, 1911. At the end of December, 1910, a heavy rainstorm set in, which saturated the soils thoroughly; they therefore went into the experiment in a saturated condition.

The following table shows the quantities of the soil added to the pots:

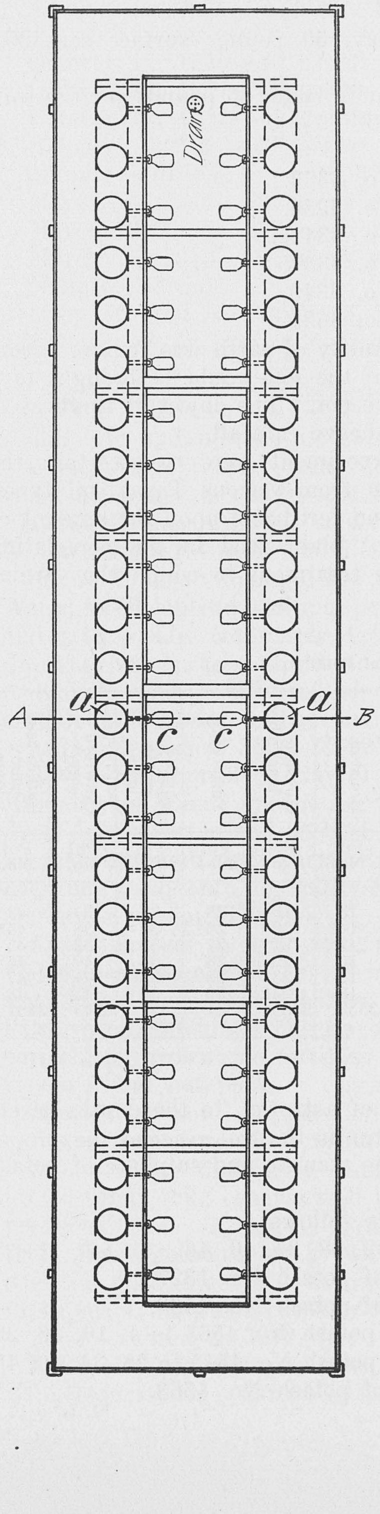
Pots Nos. 1-6 inc.—Norfolk sand, surface soil about 117 pounds, No. 2377.

Pots Nos. 7-12 inc.—Orangeburg fine sandy loam, 110 pounds, No. 2378.

Pots Nos. 13-18 inc.—Houston loam, 57 pounds surface soil, No. 3333; 57 pounds subsoil, No. 3334.

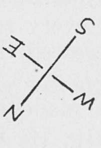
Pots Nos. 19-24 inc.—Houston black clay, 45 pounds surface soil, No. 3335; 45 pounds subsoil, No. 3336.

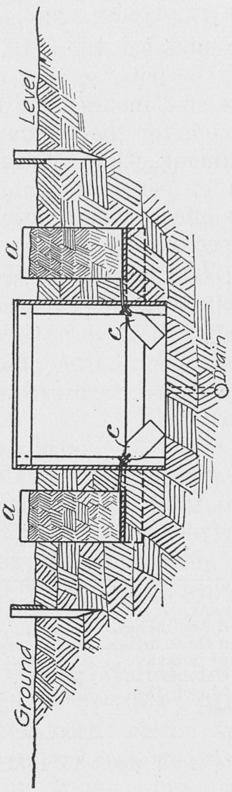
Pots Nos. 25-30 inc.—Yazoo clay, 47 pounds surface soil, No. 3341; 47 pounds subsoil, No. 3342.



TOP VIEW OF PERCOLATION PIT

Scale 12"





SECTION OF PERCOLATION PIT AT A-B

Scale 12"

Pots Nos. 31-36 inc.—Miller fine sandy loam, 56 pounds subsoil, No. 3337; 56 pounds surface soil, No. 3338.

Pots Nos. 37-42 inc.—Crawford clay, 50 pounds surface soil, No. 3343; 50 pounds subsoil, No. 3344.

Pots Nos. 43-48 inc.—Lufkin fine sandy loam, 55 pounds surface soil, No. 3631; 55 pounds subsoil, No. 3632.

Additions May 24, 1910:

Pots Nos. 13-18—35 pounds soil No. 3333.
Pots Nos. 19-24—15 pounds soil No. 3335.
Pots Nos. 25-30—12 pounds soil No. 3341.
Pots Nos. 31-36—33 pounds soil No. 3337.
Pots Nos. 37-42—10 pounds soil No. 3343.
Pots Nos. 43-48—33 pounds soil No. 3631.

On September 16, 1910, a small quantity of earth was removed from each of the pots, so that the surface of the soil would be brought to a distance of 3 inches from the top of the pot. The object of this was to allow room for the accumulation of a heavy rainfall.

Treatment.—The objects of the experiment were to ascertain the amount of percolation and evaporation from various Texas soil types, and the effect of cultivation, manure and fertilizers upon the amount of water percolating and on the losses of plant food in the percolating water. The following table shows the treatment to which the various pots were subjected:

TABLE NO. 1.

Plan of Treatment of Pots.

Treatment.	Norfolk sand.	Orangeburg fine sandy loam.	Houston loam.	Houston black clay.	Yazoo clay.	Miller fine sandy loam.	Crawford clay.	Lufkin fine sandy loam.
	Pot No.	Pot No.	Pot No.	Pot No.	Pot No.	Pot No.	Pot No.	Pot No.
No treatment	1	7	13	19	25	31	37	43
Cultivated two inches	2*	8*	14*	20*	26*	32*	38*	44*
Cultivated three inches	3	9	15	21	27	33	39	45
Sulphate of potash	4	10	16	22	28	34	40	46
Manure, October 15	5	11	17	23	29	35	41	47
Manure, March 15	6	12	18	24	30	36	42	48
Soil numbers	2377	2378	3333	3335	3341	3337	3343	3631

*Nitrate added March 15, 1912.

The cultivation was done by means of a trowel, to the depths given, every week, and as soon after every rain as the soil reached the proper condition. The pots which received the manure and sulphate of potash were not cultivated.

Additions.—Additions were made as follows:

Potash additions to pots 4, 10, 16, 22, 28, 34, 40, 46.
October 15, 1910—1 gm. sulphate of potash No. 13274.
October 15, 1911—1 gm. sulphate of potash No. 4563.
March 15, 1912—2 gm. sulphate of potash No. 4563 to 4, 10, 16, 22.
March 15, 1912—4 gm. sulphate of potash No. 4515 to 28, 34, 40, 46.
October 15, 1912—1 gm. sulphate of potash No. 4563.

October 15, 1913—1 gm. sulphate of potash No. 4563.

Manure additions to pots 5, 11, 17, 23, 29, 36, 41, worked in to the depth of 3 inches.

October 15, 1910—30 grams excrement No. 3223.

October 15, 1911—30 grams excrement No. 4561.

October 15, 1912—30 grams excrement No. 3258.

October 15, 1913—30 grams excrement No. 3258.

Manure additions to pots 6, 12, 18, 24, 30, 36, 42, 48.

March 15, 1911—30 grams excrement No. 3223.

March 15, 1912—30 grams excrement No. 3258.

March 15, 1913—30 grams excrement No. 3258.

Nitrate additions:

March 15 and November 15, 1912—Added 1 gm. nitrate of soda No. 13967 to 2, 8, 14, 20; added 2 gm. to 26, 32, 38, 44.

DESCRIPTION OF SOILS.

The soils and subsoils used are described as follows::

2377—Norfolk sand; gray sandy soil, surface; Jacksonville; cultivated 15 years; has been idle 6 years.

2378—Orangeburg fine sandy loam; red sandy soil; surface; on C. D. Jarrett's farm near Dialville; cultivated since 1855.

3333—Houston loam, 0-10″; J. N. Worthy's farm, 4½ miles from Waco; good upland, rolling prairie; produces 25 to 30 bushels corn and ¼ to ¾ bales cotton per acre; light brown sandy soil; suffers from drought; known as mesquite and post oak land; cotton and corn are the principal crops; cultivated since 1882; no fertilizer used; no green crops plowed under, and no manure used.

3334—Subsoil to 3333, 10-22″; dark brown loam.

3335—Houston black clay, 0-12″; black clay; sticky when wet; Mrs. Ellis Blake, Waco; known as "black waxy land"; very good soil; produces ½ bale cotton and 35 bushels corn; cotton and corn chiefly grown; no fertilizer used; soil packs, dries into clods; does not wash, and dirt does not wash onto it; cultivated 30 to 40 years; no green crops or manure ever plowed under.

3336—Subsoil to 3335, 12-24″; black clay.

3341—Yazoo clay, 0-12″; 6 miles east of Waco; farm of Dr. Sanderson; black clay; fertile bottom land, subject to overflow; produces ½ bale cotton, 40 to 50 bushels oats, 45 bushels corn; cotton, corn and oats chiefly grown; no fertilizer used; sticky in wet seasons; works well in dry; does not pack or crack; crumbles on drying; does not wash; cultivated 50 years; no green crops or manure plowed under.

3342—Subsoil to 3341, 12-24″.

3337—Miller fine sandy loam, 0-12″; Mrs. Ellis Blake, Waco; light brown sandy soil; behaves well in wet and dry seasons; good soil; level; produces 30 to 35 bushels corn and ½ to 1 bale cotton; cotton, corn, fruit and vegetables are grown; no fertilizer used; soil crumbles and does not pack, crack or wash; nor does dirt wash onto it; cultivated 30 to 40 years; no green crops or manure plowed under.

3338—Subsoil to 3337, 12-24″; yellow clay.

3343—Crawford clay, depth 0-7″; 6 miles east of Waco; farm of Dr. Sanderson; rolling, dark brown clay; poor yields except in wet seasons;

behaves poorly when dry; grain chiefly grown; 15 bushels corn and 25 bushels oats per acre; no fertilizer used; does not crack, pack or run together; dirt does not wash onto it; does not wash; has not been cultivated much; no manure used.

3344—Subsoil to 3343, 7-14"; black clay.

3631—Lufkin fine sandy loam, 0-6"; moderate upland; 1½ miles southwest of Giddings; produces 1200 pounds seed cotton, 45 bushels corn; well drained; moist in dry seasons; does not wash; crumbles; commercial fertilizer and manure tripled the yield; mellow in wet seasons; does not crack on drying; cultivated 25 years; 8 tons manure applied per acre.

3632—Subsoil to 3631, 6-12".

Composition of Soils.—The chemical composition of the soils is given in Table No. 2 following:

TABLE NO. 2.

Composition of Soils Used in Percolation Work.

	Norfolk sand.	Orangeburg fine sandy loam.	Houston loam.		Houston black clay.		Yazoo clay.		Miller fine sandy loam.		Crawford clay.		Lufkin fine sandy loam.	
	Surface 2377	Subsoil 2378	Surface 3333	Subsoil 3334	Surface 3335	Subsoil 3336	Surface 3341	Subsoil 3342	Surface 3337	Subsoil 3338	Surface 3343	Subsoil 3344	Surface 3631	Subsoil 3632
Percent.														
Phosphoric acid	....	.02	.02	.012	.11	.093	.254	.249	.05	.039	.21	.137	.035	.045
Nitrogen	.03	.043	.034	.040	.119	.079	.149	.152	.05	.035	.151	.098	.056	.063
Potash	.11	.12	.21	.19	.79	.78	.70	1.04	.202	.28	.84	.77	.185	.39
Lime	.09	.11	.17	.195	3.30	4.40	2.86	2.57	.15	.15	1.12	1.29	.59	.53
Magnesia	.09	.13	.17	.155	1.12	1.05	.76	.81	.18	.285	.54	.60	.16	.43
Alumina and oxide of iron	1.21	4.16	2.73	3.59	11.67	11.85	8.23	9.14	2.51	3.84	8.50	10.82	3.09	11.64
Insoluble and soluble silica	97.22	93.69	94.84	92.68	69.78	67.67	75.28	73.65	94.87	93.20	79.83	76.79	91.93	76.22
Loss on ignition	....	....	1.49	1.99	8.25	8.17	....	....	....	....	5.53	5.67	....	....
Moisture	....	....	.54	1.09	4.60	5.21	3.24	4.25	....	.87	3.27	3.78	....	....
Parts Per Million.														
Active phosphoric acid	30.	8.	21.	10.	379.	259.	1116.	649.	122.	90.	414.	462.	94.	10.
Active potash	69.	153.	155.	113.	447.	288.	997.	849.	309.	240.	568.	461.	250.	310.
Acidity	0	0	0	0	0	0	0	0	0	0	0	0	0	0

RAINFALL.

The rainfall by months and by quarters is shown in Tables Nos. 3 and 4.

On December 4, 1913, there was a rainfall of 7.54 inches, following a steady rain of 1.39 inches the previous day. This greatly exceeded the capacity of the apparatus, as the cans overflowed at the top, and the percolating bottles were also full. For this reason, December, 1913, is excluded from the discussions in this Bulletin.

TABLE NO. 3.

Rainfall in Inches, 1911.

Days of Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1			.02	.75			.33					
2	Trace				.98		.03		.07			
3	Trace			1.22	.07				.08		.01	
4				.44			.02		.01			
5												
6							1.14					.60
7							.09			.03	.45	.06
8		.19		1.42			.82				1.11	.02
9		.11		.03							.01	
10		.30						.20			.02	1.88
11		.20						.08		.16		.01
12					1.29					1.83	.01	
13		.09					.11			.53		
14		.02	.01				.01	1.25				.75
15		Trace	.09	.02			.17					.58
16				.05			.05			.16		
17	.03	.06		.50			.16				.16	
18			.41	.05			2.74	.06				
19		2.33	.35			.14						1.15
20				.04	.03							.24
21					.31	.20			.03	.28		
22			.25	1.26		.04			.03	.01		.12
23			.36	.03					.41		.07	.20
24	.18		1.53					.10	.24			.02
25	.05		.01	.13				1.78				.20
26				.92	.01							.47
27	.05	Trace						.12			.03	
28		.20			.01			.05				
29									.75	.06		.74
30				.22					.02	.47		.21
31										.02		
Totals....	0.31	3.50	3.03	7.08	2.70	.38	5.67	3.64	1.61	3.55	1.87	7.25

Rainfall in Inches, 1912.

Days of Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1				.10		.37			.15			Trace
2			.02		.47	.27	.19					.02
3			.02		Trace	.03		.02	.09			1.29
4			.01		.89							.30
5			1.60		.01	.34						.10
6	.04			Trace	.42	.08		.01				
7	.01		.02	1.49								
8	.02		.05	.10								.04
9			Trace	.15								.09
10				.03	.06							.24
11	.61		.23									1.01
12	.05			.10								.35
13		1.07										.01
14			.43									
15					.27					.13		Trace
16				Trace				.26	.26	.76		.01
17						.06	.84		.05	.55		Trace
18						.82	.02		.48	.08		
19						.10	1.85					

TABLE NO. 3—Continued.

Rainfall in Inches, 1912.

Days of Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
20	.....	.01	.....	.04	.....	.04	.....	.....	.....	.....	.....	.19
21	.....	.....	.09	Trace	.....	.....	.....	.....	.11	.....	.01	.72
22	.06	.....	2.28	.....	.....	.....	.08	.01	.....	.07	.73	.26
23	.06	.11	.85	.....	.....	.....	.....	.....	.....	.....	Trace	.44
24	.....	1.33	.....	.....	.....	.....	.....	.16	.....	.04	.....	.....
25	.....	.01	.....	Trace	.....	.....	.....	.01	.....	.....	.12	.....
26	.....	.....	.....	Trace	.....	.....	.....	.....	.....	.....	Trace	.....
27	.02	.....	Trace	.....	.....	.....	.....	.....	.....	.....	.05	.....
28	.05	.....	.92	.10	.....	.10	.....	.....	.....	.....	.....	.....
29	.....	.....	.....	.....	2.00	.....	.....	.....	.....	.....	.....	.26
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	Trace	.....	.....
31	.....	.....	.06	.....	.....	.....	.....	.....	.....	.01	.01	.....
Totals....	.92	2.53	6.58	2.11	4.12	2.21	2.98	.21	1.14	1.64	.92	5.33

Rainfall in Inches, 1913.

Days of Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	.....	.00	.....	.....	.....	.....	.....	Trace	.....	1.13	.....	Trace
2	.....	.08	.....	.....	.....	.....	.....	.....	.04	1.24	.....	.20
3	.....	.01	.....	.85	.15	.....	.....	.....	.02	.04	.....	1.39
4	.....	.....	.....	Trace	.08	.....	.....	.....	Trace	.45	.07	7.54
5	.....	.....	.....	.....	.10	.....	.....	.....	.....	.02	1.22	.75
6	Trace	.....	.....	.....	.....	.....	.....	.....	.....	.....	.03	Trace
7	.07	.49	.02	.....	.....	.....	.....	.....	.28	Trace	.02	.....
8	.....	.20	.02	.05	.....	.....	.....	.....	.....	.....	.....	.....
9	.....	Trace	1.73	.73	.....	.22	.....	.....	.46	.....	.....	.....
10	.16	1.62	.04	Trace	.....	.04	.01	Trace	.01	.....	.....	.03
11	.54	.15	.....	.....	.....	.01	.....	.01	Trace	.....	.....	.....
12	.01	.02	1.11	.....	.....	.....	.....	.01	Trace	.....	.....	.01
13	.....	Trace	.03	.....	.....	.....	.....	.....	.31	.....	.....	.24
14	.....	.....	.....	.....	.....	.....	.....	.....	.04	.....	.....	.01
15	.....	.....	.....	.....	.....	.02	.....	.....	.02	Trace	.....	.....
16	Trace	.....	.....	.....	1.00	.04	.....	.....	.....	.12	.....	.09
17	.01	.....	.....	.....	.....	.01	.....	.06	.08	1.03	.....	.66
18	.01	.....	.....	.....	.....	.07	.....	.07	.....	.05	.01	Trace
19	Trace	.....	.....	.....	.....	.....	.....	.....	.....	.01	Trace	.....
20	.02	.....	.07	.....	.48	.....	.....	.....	.....	.....	.07	.....
21	.03	.06	.17	.....	Trace	.....	.....	.....	.....	.....	.16	.....
22	.50	Trace	.....	.....	.63	.....	.....	.....	.....	.09	.01	.30
23	.07	.....	Trace	1.34	.....	.....	.....	.....	.....	.24	.86	.....
24	Trace	.....	.....	.01	.....	.07	.....	.....	.....	.....	.35	.53
25	.....	.....	.04	.....	.....	.....	.01	.....	.30	.....	.....	.....
26	.61	.....	.....	.....	.....	.....	.....	.....	.64	.01	.....	.....
27	.95	1.00	.....	.....	.....	.02	.....	.....	.21	.....	.85	.79
28	.....	.....	.....	.....	.....	.58	.....	.....	.....	.....	.11	.11
29	.....	.....	.....	.....	.....	.44	.....	.....	.....	.....	.94	.01
30	.....	.....	.....	.....	.....	.01	.....	.73	.74	.....	.04	.....
31	.....	.....	.....	.....	.....	.....	.04	.....	.....	.....	.....	.....
Totals.....	2.98	3.63	3.23	2.98	2.44	1.53	.06	.88	3.15	4.43	4.74	12.66

TABLE NO. 4.

Rainfall in Inches, College Station, Texas—1911, 1912 and 1913.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1911	0..31	3..50	3..05	7..08	2..70	0..38	5..67	2..64	1..61	3..55	1..87	7..25	39..61
1912	0..92	2..53	6..58	2..11	4..12	2..21	2..98	0..21	1..14	1..64	0..92	5..33	30..69
1913	2..98	3..63	3..23	2..98	2..44	1..53	0..06	0..88	3..15	4..43	4..74	12..66	42..71
1911		6..86			10..16			9..92			12..67		
1912		10..03			8..44			4..33			7..89		
1913		9..48			6..95			4..09			21..83		

THE PERCOLATING WATER.

The following table—Table No. 5—shows the quantity of water which percolated from the various pots, by months, during the calendar years 1911, 1912 and 1913. The symbols after the names of the soils refer to the treatment described on page 10.

TABLE NO. 5.

Water Percolated in Inches, 1911.

Pot No.		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1	Norfolk sand—O″	......	.34	.81	1.66	.15	......	.20	......	......	......	.01	2.55	15.72
2	Norfolk sand—O 2″	......	1.61	1.63	4.03	1.16	......	1.89	......	......	.80	.77	5.05	16.94
3	Norfolk sand—O 3″	......	1.89	1.41	4.48	1.27	......	1.70	......	......	.11	.04	3.07	13.97
4	Norfolk sand—O-K_2SO_4	......	.76	.18	2.87	.58	......	.23	......	......	......	.31	4.38	9.31
5	Norfolk sand–O-manure, October	......	.95	.65	2.98	.53	......	.31	......	......	.03	.99	4.98	11.42
6	Norfolk sand—O-manure, March	......	.53	.45	3.61	1.02	......	.84	......	......	.98	1.03	5.13	13.59
7	Orangeburg fine sandy loam—O″	......	.65	.09	3.11	.59	......	.04	......	......	.01	.01	2.95	7.45
8	Orangeburg fine sandy loam—O 2″	......	1.34	1.07	3.32	.90	......	.77	......	......	.12	.27	5.43	13.22
9	Orangeburg fine sandy loam—O 3″	......	1.50	1.03	3.55	.91	......	.62	......	......	.04	.46	5.15	13.26
10	Orangeburg fine sandy loam—OMK_2SO_4	......	.54	.11	3.15	.57	......	.03	......	......	.01	.01	3.91	8.33
11	Orangeburg fine sandy loam—O-manure, October	......	1.35	.81	3.97	.96	......	......	......	......	......	.32	4.98	12.39
12	Orangeburg fine sandy loam—O-manure, March	......	.51	.21	3.39	.54	......	.05	......	......	.62	.01	3.61	8.94
13	Houston loam—O″	......	1.42	1.06	3.63	1.31	......	1.50	.24	......	1.04	.81	5.06	16.07
14	Houston loam—O 2″	......	1.16	1.18	3.30	1.30	......	1.03	.27	......	.99	.61	5.23	15.07
15	Houston loam—O 3″	......	1.65	1.40	2.87	1.55	......	1.79	.44	......	1.07	.76	5.07	16.60
16	Houston loam—O-K_2SO_4	......	1.16	1.00	3.42	1.02	......	1.27	.24	......	.99	.81	4.93	14.84
17	Houston laom—O-manure, October	......	1.92	1.36	4.14	1.26	......	1.57	.40	......	1.32	1.28	5.55	18.80
18	Houston loam—O-manure, March	......	1.45	1.12	3.53	.97	......	1.65	.32	......	1.14	.81	5.12	16.11
19	Houston black clay—O″	......	1.94	1.54	3.46	1.26	......	1.72	.44	......	1.31	1.02	5.23	17.92
20	Houston black clay—O 2″	......	1.74	1.57	4.27	1.36	......	1.85	.38	......	1.24	.95	5.16	18.52
21	Houston black clay—O 3″	......	1.95	1.57	4.58	1.41	......	2.01	.38	......	1.28	.89	5.06	19.18
22	Houston black clay—O-K_2SO_4	......	.28	.55	1.13	.19	......	.95	......	......	.09	.03	1.47	4.69
23	Houston black clay—Omanure, October	......	1.91	1.54	3.99	1.29	......	1.55	.40	......	1.43	1.09	1.51	14.71
24	Houston black clay—O-manure, March	......	.97	1.27	2.03	.41	......	1.66	.38	......	1.27	.68	4.02	12.69
25	Yazoo clay—O″	......	1.23	1.20	3.10	.93	......	1.05	.26	......	1.10	.72	4.77	14.36
26	Yazoo clay—O 2″	......	1.69	1.40	3.90	1.10	......	.09	......	......	.06	.58	5.09	13.91
27	Yazoo clay—O 3″	......	1.75	1.52	3.92	1.31	......	1.62	......	.29	1.01	.85	4.93	17.20
28	Yazoo clay—O-KrSOr.	......	1.25	1.04	3.11	.83	......	1.27	.20	......	.92	.73	4.91	14.26
29	Yazoo clay—O-manure, October	......	1.30	1.21	3.23	.98	......	1.39	.28	......	1.06	.91	4.81	15.17
30	Yazoo clay—O-manure, March	......	1.43	1.31	3.47	.98	......	1.31	.30	......	.89	.85	4.71	15.25
31	Miller fine sandy loam—O″	......	.53	.35	3.92	.54	......	.54	......	......	.19	.15	4.53	10.75
32	Miller fine sandy loam—O 2″	......	.85	.59	2.66	.71	......	1.11	......	......	.40	.19	4.41	10.92
33	Miller fine sandy loam—O 3″	......	1.13	.85	3.08	.85	......	1.30	......	......	.45	.25	4.94	12.85
34	Miller fine sandy loam—O-K_2SO_4	......	.42	.12	2.68	.48	......	.18	......	......	.08	.04	3.93	7.93
35	Miller fine sandy loam—O-manure, October	......	.45	.35	2.73	.55	......	.78	......	......	.25	.81	4.63	10.55
36	Miller fine sandy loam—O-manure, March	......	.11	.03	.35	.04	......	.13	......	......	.07	.02	.44	1.19
37	Crawford clay—O″	......	1.91	1.69	3.96	1.45	......	2.24	.63	......	1.43	.99	5.22	19.52
38	Crawford clay—O 2″	......	2.33	1.65	2.92	1.30	......	1.94	.40	......	1.17	.73	4.61	17.05

TABLE NO. 5—Continued.

Water Percolated in Inches, 1911.

Pot No.		January.	February.	Mareh.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
39	Crawford clay—O 3″..	......	1.93	1.68	4.48	1.30	......	2.14	.43	......	1.19	.92	5.48	19.55
40	Crawford clay—O-K_2SO_4	......	1.65	1.54	3.90	1.22	......	1.88	.47	......	1.25	.95	4.78	17.64
41	Crawford clay—O-manure, October	......	1.69	1.51	4.01	1.36	......	1.95	.43	......	1.38	1.04	5.33	18.70
42	Crawford clay—O-manure, March	......	1.65	1.45	3.83	1.23	......	1.71	.46	......	1.20	1.03	4.73	17.29
43	Lufkin sandy loam—O″	......	.81	.12	3.26	.93	......	.70	......	......	.57	.38	3.97	10.74
44	Lufkin sandy loam—O 2″..	......	1.23	.71	3.56	.82	......	1.08	......	.08	.67	.34	4.56	13.05
45	Lufkin sandy loam—O 3″..	......	1.09	.46	3.92	.93	......	1.11	......	.11	.63	.34	5.03	13.62
46	Lufkin sandy loam—O-K_2SO_4	......	1.04	.62	2.76	.81	......	.83	......	......	.56	.36	4.15	11.13
47	Lufkin sandy loam—O-manure, October	......	.95	.67	3.74	.72	......	1.01	......	......	.58	.76	4.77	13.20
48	Lufkin sandy loam—O-manure, March	......	1.57	1.55	4.09	.63	......	.74	......	......	.44	.29	4.36	13.67

TABLE NO. 5—Continued.

Inches of Water Removed from Percolation Pots, 1912.

Pot No.		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1	Norfolk sand—O″	.03	.23	2.60	1.40	.01	.....	.....	.....	.....	.....	.02	.23	4.52
2	Norfolk sand—O 2″	.11	1.05	3.69	1.49	.67	1.03	.26	.....	.....	.....	.01	2.81	11.12
3	Norfolk sand—O 3″	.08	.27	3.11	.66	.40	.77	.27	.....	.....	.....	.04	.04	5.64
4	Norfolk sand—O-K_2SO_4	.11	.35	3.70	1.43	.01	.08	.01	.....	.....	.....	.01	1.35	7.05
5	Norfolk sand—O-manure, October	.13	.50	3.11	1.80	.01	.11	.03	.....	.....	.....	.06	2.18	7.93
6	Norfolk sand—O-manure, March	.14	.50	3.59	1.70	.05	.40	.....	.....	.....	.....	.....	.196	8.34
7	Orangeburg fine sandy loam—O″	.04	.09	3.51	1.62	.01	.....	.01	.....	.....	.....	.05	.99	6.32
8	Orangeburg fine sandy loam—O 2″	.13	.61	3.94	1.97	.31	.79	.....	.....	.....	.....	.....	1.76	9.51
9	Orangeburg fine sandy loam—O 3″	.07	.67	3.90	2.09	.21	.54	.....	.....	.....	.....	.03	2.14	9.65
10	Orangeburg fine sandy loam—O-K_2SO_4	.05	.04	3.60	1.80	.....	.....	.....	.....	.....	.....	.....	.42	5.91
11	Orangeburg fine sandy loam—O-manure, October	.13	.86	3.52	1.89	.01	.26	.03	.....	.....	.....	.01	1.23	7.94
12	Orangeburg fine sandy loam—O-manure, March	.07	.18	3.78	1.61	.02	.01	.01	.....	.....	.....	.....	.82	6.50
13	Houston loam—O″	.20	.128	3.31	2.19	.42	1.11	.03	.....	.....	.....	.03	2.99	11.56
14	Houston loam—O 2″	.18	.82	2.30	2.43	.56	1.21	.21	.....	.....	.....	.07	2.54	10.32
15	Houston loam—O 3″	.35	.79	2.08	2.52	.43	1.04	.34	.....	.....	.....	.07	3.14	10.76
16	Houston loam—O-K_2SO_4	.12	.75	3.37	1.93	.23	.97	.16	.....	.....	.....	.05	2.91	10.49
17	Houston loam—O-manure, October	.16	1.21	3.88	2.15	.49	1.31	.06	.....	.....	.....	.09	3.43	12.78
18	Houston loam—O-manure, March	.11	.76	3.41	1.72	.35	1.14	.19	.....	.....	.....	.01	2.81	10.50
19	Houston black clay—O″	.11	1.37	4.01	2.13	.52	1.17	.11	.....	.....	.....	.02	3.33	12.77
20	Houston black clay—O 2″	.13	1.36	3.91	1.79	.55	1.15	.25	.....	.....	.....	.01	3.05	12.20
21	Houston black clay—O 3″	.13	1.29	4.05	2.15	.55	1.12	.31	.....	.....	.....	.06	3.10	12.76
22	Houston black clay—O-K_2SO_4	.03	.15	1.64	.42	.07	.56	.02	.....	.....	.....	.01	.11	3.01
23	Houston black clay—O-manure, October	.14	1.42	3.91	2.10	.54	1.24	.25	.....	.....	.....	.06	3.40	13.06
24	Houston black clay—O-manure, March	.01	.64	3.26	1.53	.33	1.08	.21	.....	.....	.....	.....	1.79	8.87
25	Yazoo clay—O″	.02	.97	3.37	1.75	.29	.79	.04	.....	.....	.....	.01	2.74	9.98
26	Yazoo clay—O 2″	.08	.99	3.83	1.89	.46	.98	.02	.....	.....	.....	.01	2.63	10.89
27	Yazoo clay—O 3″	.06	1.15	3.87	1.89	.38	.86	.06	.....	.....	.....	.06	2.88	11.21
28	Yazoo clay—O-K_2SO_4	.02	.86	3.53	1.60	.33	.82	.02	.....	.....	.....	.....	2.61	9.79
29	Yazoo clay—O-manure, October	.04	1.17	3.33	1.85	.40	.97	.12	.....	.....	.....	.03	2.80	10.71
30	Yazoo clay—O-manure, March	.04	.93	3.55	1.52	.29	.79	.02	.....	.....	.....	.01	1.38	8.53
31	Miller fine sandy loam—O″	.10	.23	3.21	1.92	.01	.10	.03	.....	.....	.....	.08	2.30	7.98
32	Miller fine sandy loam—O 2″	.03	.02	2.59	1.59	.22	.43	.01	.....	.....	.....	.01	2.27	7.17
33	Miller fine sandy loam—O 3″	.03	.28	3.12	2.08	.19	.21	.01	.....	.....	.....	.06	2.64	8.62
34	Miller fine sandy loam—O-K_2SO_4	.01	.05	3.03	1.45	.02	.03	.02	.....	.....	.....	.....	1.77	6.38
35	Miller fine sandy loam—O-manure, October	.02	.21	2.93	1.91	.01	.02	.07	.....	.....	.....	.02	.70	5.89
36	Miller fine sandy loam—O-manure, March	.....	.....	.57	.21	.....	.03	.02	.....	.....	.....	.....	.11	.94
37	Crawford clay—O″	.11	.89	2.53	2.08	.58	1.31	.40	.....	.....	.....	.01	3.23	11.14
38	Crawford clay—O 2″	.04	1.36	3.67	1.80	.42	.67	.01	.....	.....	.....	.....	2.60	10.57

TABLE NO. 5—Continued.

Inches of Water Removed from Percolation Pots, 1912.

Pot No.		January.	February.	March.	Apirl.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
39	Crawford clay—O 3″	.12	1.38	2.89	2.13	.55	.23	.36	......	......	......	.07	3.15	10.88
40	Crawford clay—O-K_2SO_4	.04	.93	3.67	1.84	.33	.16	.11	......	......	......	.01	3.17	10.26
41	Crawford clay—O-manure, October	.13	1.46	2.53	2.21	.57	1.42	.34	......	......	......	.01	3.14	11.81
42	Crawford clay—O-manure, March	.09	1.13	2.26	1.77	.47	1.16	.26	......	......	......	......	2.95	10.09
43	Lufkin fine sandy loam—O″	.31	.27	1.56	1.99	.15	.54	.09	......	......	......	.09	2.17	7.17
44	Lufkin fine sandy loam—O 2″	.11	.20	1.84	2.29	.27	.51	.14	......	......	......	.01	2.50	7.87
45	Lufkin fine sandy loam—O 3″	.19	.28	1.94	2.88	.21	.74	.11	......	......	......	.05	2.78	9.18
46	Lufkin fine sandy loam—-K_2SO_4	.12	.40	2.95	1.73	.14	.56	.02	......	......	......	......	2.31	8.23
47	Lufkin fine sandy loam—O-manure, October	.06	.22	2.31	2.92	.01	1.27	.01	......	......	......	.05	2.01	8.86
48	Lufkin fine sandy loam—O-manure, March	.02	.21	2.81	1.87	.02	.41	......	......	......	......	......	.70	6.04

TABLE NO. 5—Continued.

Inches of Water Percolated from Percolation Pots, 1913.

Pot No.		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals 11 months.
1	Norfolk sand—O″	.08	.01	.12	.01	.01	......	......	......	......	.03	.02	......	.28
2	Norfolk sand—O 2″	1.58	1.69	2.06	.42	.17	......	......	......	......	2.13	.88	......	8.93
3	Norfolk sand—O 3″	.04	.05	.08	.03	......	.01	......	......	......	.05	.05	......	.31
4	Norfolk sand—O-K_2SO_4	1.53	1.68	1.72	.02	.02	......	......	......	......	.77	.03	......	5.77
5	Norfolk sand—O-manure, October	1.43	1.73	2.29	.37	.22	.02	......	......	......	1.11	.04	......	7.21
6	Norfolk sand—O-manure, March	1.33	1.42	2.11	1.00	.52	.01	......	......	......	2.54	1.43	......	10.36
7	Orangeburg fine sandy loam—O″	1.39	1.24	1.75	.03	.01	.02	......	......	......	.38	.03	......	4.85
8	Orangeburg fine sandy loam—O 2″	1.66	1.67	1.77	.03	.01	.01	......	......	......	1.14	.19	......	6.48
9	Orangeburg fine sandy loam—O 3″	1.68	1.82	2.00	......	......	......	......	......	......	1.72	.78	......	8.00
10	Orangeburg fine sandy loam—O-K_2SO_4	1.09	1.56	1.39	.02	......	.01	......	......	......	.20	.01	......	4.28
11	Orangeburg fine sandy loam—O-manure, October	1.40	1.75	2.51	.53	.17	.01	......	......	......	1.22	.09	......	7.68
12	Orangeburg fine sandy loam—O-manure, March	1.38	1.65	1.80	.42	.15	......	......	......	......	1.39	1.13	......	7.92
13	Houston loam—O″	1.43	1.94	2.28	.46	.16	.02	......	......	......	2.48	.76	......	7.53
14	Houston loam—O 2″	1.25	2.11	1.90	.63	.17	.01	......	......	......	2.65	.89	......	9.61
15	Houston loam—O 3″	.96	1.94	1.70	.49	.15	.04	......	......	......	2.85	.96	......	9.09
16	Houston loam—O-K_2SO_4	1.18	1.95	1.95	.57	.14	.05	......	......	......	2.36	.68	......	8.88
17	Houston loam—O-manure, October	1.53	2.05	2.65	.90	.37	......	......	......	......	3.01	1.16	......	11.67
18	Houston loam—O-manure, March	1.32	1.82	2.08	1.02	.16	.04	......	......	......	2.67	1.22	......	10.33
19	Houston black clay—O″	1.60	1.99	2.69	.79	.31	.05	......	......	......	2.83	1.03	......	11.29
20	Houston black clay—O 2″	1.67	2.01	2.59	.76	.25	.03	......	......	......	2.59	.90	......	10.80
21	Houston black clay—O 3″	2.72	2.06	2.86	.79	.25	.02	......	......	......	2.30	1.26	......	12.26
22	Houston black clay—O-K_2SO_4	.06	.25	.04	.14	.03	.01	......	......	......	.06	.05	......	.64
23	Houston black clay—O-manure, October	1.78	2.04	2.76	.77	.25	.03	......	......	......	2.83	1.10	......	11.56
24	Houston black clay—O-manure, March	.93	1.37	1.43	.22	.01	......	......	......	......	.14	.06	......	4.16
25	Yazoo clay—O″	1.42	1.82	2.26	.37	.04	.02	......	......	......	2.70	.92	......	9.55
26	Yazoo clay—O 2″	1.56	1.86	2.38	.85	.18	.02	......	......	......	1.45	.01	......	8.31
27	Yazoo clay—O 3″	1.68	2.05	2.71	.69	.19	.03	......	......	......	2.54	1.14	......	11.03
28	Yazoo clay—O-K_2SO_4	1.35	1.69	2.17	.22	.08	.02	......	......	......	2.75	.80	......	9.08
29	Yazoo clay—O-manure, October	1.47	1.88	2.44	.65	.04	.02	......	......	......	2.81	1.04	......	10.35
30	Yazoo clay—O-manure, March	1.06	1.22	1.66	.68	.02	.02	......	......	......	.87	.28	......	5.81
....	Miller fine sandy loam—O″	1.39	1.86	1.85	.04	.02	.01	......	......	......	.62	.05	......	5.84
32	Miller fine sandy loam—O 2″	1.48	1.63	1.58	.27	.04	.01	......	......	......	2.08	.65	......	7.74
33	Miller fine sandy loam—O 3″	1.44	1.83	1.90	.13	......	......	......	......	......	2.30	.67	......	8.27
34	Miller fine sandy loam—O-K_2SO_4	.89	1.52	1.24	.03	.01	.02	......	......	......	1.22	.01	......	4.94
35	Miller fine sandy loam—O-manure, October	.79	.57	.28	......	......	......	......	......	......	.36	......	......	2.00
36	Miller fine sandy loam—O-manure, March	.04	.01	.03	......	......	......	......	......	......	1.14	......	......	1.22
37	Crawford clay—O″	1.49	1.97	2.56	.80	.02	......	......	......	......	2.90	1.18	......	10.92
38	Crawford clay—O 2″	1.44	1.87	2.41	.53	.04	.01	......	......	......	1.77	.18	......	8.25

TABLE NO. 3—Continued.

Inches of Water Percolated from Percolation Pots, 1913.

Pot No.		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
39	Crawford clay—O 3″	1.62	2.03	2.72	.88	.33	.03	......	......	......	2.69	1.15	......	11.45
40	Crawford clay—O-K_2SO_4	1.56	1.86	2.40	.52	.16	......	......	......	......	3.11	1.05	......	10.66
41	Crawford clay—O-manure, October	1.34	1.90	2.60	.63	.02	.02	......	......	......	1.99	.84	......	9.34
42	Crawford clay—O-manure, March	1.46	1.74	2.20	.71	.29	.03	......	......	......	2.84	1.04	......	10.31
43	Lufkin fine sandy loam—O″	.62	1.99	1.01	.04	......	.01	......	......	......	.81	.21	......	4.69
44	Lufkin fine sandy loam—O 2″	.53	1.32	.84	.06	.02	......	......	......	......	1.92	.32	......	5.01
45	Lufkin fine sandy loam—O 3″	.78	1.97	1.75	.12	.01	.02	......	......	......	2.41	.72	......	7.78
46	Lufkin fine sandy loam—O-K_2SO_4	1.07	1.67	1.55	.09	.03	......	......	......	......	1.67	.28	......	6.36
47	Lufkin fine sandy loam—O-manure, October	1.06	1.90	1.70	.01	.01	......	......	......	......	1.70	.28	......	6.66
48	Lufkin fine sandy loam—O-manure, March	.40	.09	.32	.05	.01	......	......	......	......	.64	.02	......	1.53

EFFECT OF SOIL TYPE ON PERCOLATION AND EVAPORATION.

The soils may be divided into two groups with respect to the quantity of water which passed through them when uncultivated: (a) Those whose average annual percolation is less than 10 inches, and (b) those whose average annual percolation is over 10 inches.

Table No. 6 contains a summary of percolation from the uncultivated soils by groups.

TABLE NO. 6.

Total Percolation in Inches from Uncultivated Soils.

Pot No.	Name.	1911.	1912.	1913 (December excluded).	Average.	Evaporation.
1	Norfolk sand	5.72	4.52	.28	3.51	....
7	Orangeburg fine sandy loam	7.45	6.32	4.85	6.21	....
31	Miller fine sandy loam	10.75	7.98	5.84	8.19	....
43	Lufkin sandy loam	10.74	7.17	4.69	7.53	....
	Average	8.67	6.50	3.92	6.36	27.09
13	Houston loam	16.07	11.56	7.53	11.72	....
19	Houston black clay	17.92	12.77	11.29	13.99	....
25	Yazoo clay	14.36	9.98	9.55	11.30	....
37	Crawford clay	19.52	11.14	10.92	13.86	....
	Average	16.97	11.36	9.82	12.72	20.73
	Average rainfall, December, 1913, excluded	....	....	....	....	33.45

The average percolation from the clays is double the quantity from the sands or sandy loams. Conversely, the sands and sandy loams lost much greater quantities of water by evaporation than did the clays. The above refers to the uncultivated soils.

The average annual rainfall for the three years (December, 1913, excluded) is 33.45 inches. According to the table previously cited, we may expect a loss by run-off of about 8 inches on gentle slopes and 17 inches on steep slopes. As a portion of the Texas rainfall comes in heavy rains of short duration, we may consider a loss of 8 inches by run-off as a moderate estimate.

The run-off of 8 inches is, however, less than the amount of percolation from the sands and sandy loams. In other words, there would be no percolation if we deduct this quantity of run-off.

The percolation from the Houston loam and the clays exceeds the estimated run-off by 6 inches.

The quantity of percolating water may be assumed to represent that at the disposal of the crops. This is not strictly true, for the shade and presence of the growing crop decreases evaporation from the soil; while, on the other hand, a large portion of the percolation comes during the winter season when there is no crop on the ground. Hence, this water can be of advantage only if it remains in the soil, instead of percolating. These facts must be duly considered, and also that the uncultivated soil only is being considered. The following is the crop yield for which the average amounts of percolating water given above would suffice, based upon the *assumption* that the water required is the quantity given on page 6 of this Bulletin.

Water for Crop Production.

	Sands and loams.	Clays.
No run-off assumed—		
Cotton	510 lbs. lint	1,016 lbs. lint
Corn	38 bu.	76 bu.
Oats	57 bu.	114 bu.
Alfalfa or hay	4,860 lbs.	9,650 lbs.
Run-off of eight inches assumed—		
Cotton	....	376 lbs.
Corn	....	28 bu.
Oats	....	43 bu.
Alfalfa or hay	....	3,570 lbs.

It must be remembered that these are uncultivated soils, and that, when cultivation is given, much larger quantities of water are retained by the cultivated soils.

The rainfall, percolation and evaporation at Rothamsted, England, for an average of twenty years, are given below, together with similar results of the Texas experiments:

	Rainfall.	Percolation.	Evaporation.
Rothamsted	28.5	15.0	13.5
Texas, light soils	35.15	7.67	27.09
Texas, heavy soils	35.15	14.15	20.73

The Rothamsted soil is a heavy clay, and is not cultivated. Evaporation at Rothamsted is much less than in Texas, but the percolation through the heavy soils of Texas is remarkably close to that through the one at Rothamsted.

Evaporation and Percolation by Quarters.—The following table, No. 7, shows the evaporation and percolation from the uncultivated soil types by quarters. The results given are the average of the three years.

TABLE NO. 7.

Percolation by Quarters.

	Jan., Feb., Mar.	April, May, June.	July, Aug., Sept.	Oct., Nov., Dec.
Norfolk sand	1.41	1.08	0.07	0.95
Orangeburg fine sandy loam	2.92	1.80	0.02	1.47
Miller fine sandy loam	3.17	2.19	0.19	2.64
Lufkin fine sandy loam	2.23	2.31	0.26	2.73
Average	2.43	1.85	0.14	1.95
Houston loam	4.64	3.43	0.59	4.39
Houston black clay	5.08	3.56	0.76	4.96
Yazoo clay	4.10	2.43	0.45	4.32
Crawford clay	4.05	3.40	1.09	4.99
Average	4.47	3.21	0.72	4.67

TABLE A.

Group 1, Sands.

	Precipitation.	Percolation.	Evaporation.	Per cent evaporated.
January, February, March.........	8.91	2.43	6.48	72
April, May, June..................	8.52	1.85	6.67	78
July, August, September..........	6.11	0.14	5.97	98
October, November, December.....	9.91	1.95	7.96	80

Group 2, Clays.

	Precipitation.	Percolation.	Evaporation.	Per cent evaporated.
January, February, March.........	8.91	4.47	4.44	50
April, May, June..................	8.52	3.21	5.31	62
July, August, September..........	6.11	0.72	5.39	88
October, November, December.....	9.91	4.67	5.24	53

If we assume that all the water precipitated during the quarter either evaporates or percolates during that quarter—an assumption which is not true, as some of the water may be stored up, or some stored up may be evaporated—the results would be as given in Table A.

Attention should be directed to the high percentages of water evaporated, especially during the summer months. This emphasizes the need for storing water in the soil.

EFFECT OF CULTIVATION UPON EVAPORATION AND PERCOLATION.

Table No. 8 shows the annual percolation from the soils, uncultivated, and cultivated, to the depth of two or three inches. The cultivation was made every week throughout the year, or, in case a rain intervened, as soon as the soil became in condition suitable for cultivation.

The soils are divided into the same two groups as in the previous discussion. The average gain in percolation, due to the cultivation to a depth of 2 inches was, with the first group, 3.52 inches, and in the second group, zero. Cultivation to a depth of two inches caused a gain in percolation from all the soils in Group 1.

TABLE NO. 8.

Percolation in Inches from Soils.

	No cultivation.	Cultivated.	
		2 inches.	3 inches.
Norfolk sand—			
1911..................................	5.72	16.94	13.97
1912..................................	4.52	11.12	5.64
1913..................................	0.28	8.93	0.31
Average..............................	3.51	12.33	6.64
Orangeburg fine sandy loam—			
1911..................................	7.45	13.22	13.26
1912..................................	6.32	9.51	9.65
1913..................................	4.85	6.48	8.00
Average..............................	6.21	9.74	10.30

TABLE NO. 8—Continued.

Percolation in Inches from Soils.

	No cultivation.	Cultivated.	
		2 inches.	3 inches.
Miller fine sandy loam—			
1911	10.75	10.93	12.85
1912	7.98	7.17	8.62
1913	5.84	7.74	8.27
Average	8.19	8.61	9.91
Lufkin fine sandy loam—			
1911	10.74	13.05	13.62
1912	7.87	9.18	8.23
1913	4.69	5.01	7.78
Average	7.77	9.08	9.88
Group average	6.42	9.94	9.18
Houston loam—			
1911	16.07	15.07	16.60
1912	11.56	10.32	10.76
1913	7.53	9.61	9.09
Average	11.72	11.67	12.15
Houston black clay—			
1911	17.92	18.52	19.13
1912	12.77	12.20	12.76
1913	11.29	10.80	12.26
Average	13.99	13.84	14.72
Yazoo clay—			
1911	14.30	13.91	17.20
1912	9.98	10.89	11.21
1913	9.55	8.31	11.03
Average	11.30	11.04	13.15
Crawford clay—			
1911	19.52	17.05	19.55
1912	11.14	10.57	10.88
1913	10.92	8.25	11.45
Average	11.86	11.96	13.96
Group average	12.22	12.13	13.50

On the other hand, cultivation to the depth of 2 inches did not cause a gain in percolating water with any of the soils in Group 2.

Cultivation to the depth of three inches caused a less average decrease in evaporation with the sands and loams than did the two-inch cultivation. There is a decrease with two of the soils, and an increase with the other two. Cultivation to the depth of three inches decreased evaporation on an average, from all the loam and clays of Group 2.

Water was observed to stand upon pots 14 and 15 of the Houston loam, and on pots 43, 44 and 45 of the Lufkin fine sandy loam more frequently than on other pots in the series. This is reflected in the table, by the decreased percolation from these two soils in 1912 and in 1913.

The following table shows the average evaporation from the two groups of soils:

Evaporation from Uncuitivated and Cultivated Soils.

	No cultivation.	Cultivated.	
		2 inches.	3 inches.
Four sands and loams	27.03	23.51	24.27
Four loams and clays	21.23	21.32	19.95

It is evident, from the foregoing discussion, that cultivation is much more effective in decreasing evaporation from some soils than from others, and that those on which it is effective are the sands or loam soils which lose water rapidly by evaporation from the uncultivated soil. The difference, however, may be due to some other factor operating during wet periods, and not to natural evaporation differences.

The average evaporation from the clays and loam is much less, even from the uncultivated soils, than it is from the sands and loams. A three-inch cultivation may also be effective on the heavier soils, where a two-inch cultivation has little or no value.

The gain of water due to the checking of evaporation by a two-inch cultivation of the sands or loams averages 3.52 inches per year. If this saving of moisture occurred during the crop season, and could all be utilized by the crop, it would be sufficient approximately for the following production:

Cotton, pounds lint	280
Corn, bushels	21
Wheat, bushels	14
Oats, bushels	33

Table No. 9 shows the percolation by quarters from the cultivated and uncultivated soils. Table No. 10 shows the increased quantity of water percolated, due to the cultivation. The table brings out clearly the low percolation during the summer months. Part of the diminished percolation during the winter months may be due to the replacement of water evaporated during the summer.

These tables again emphasize the necessity of storing water in the soil and subsoil for use during the growing season. They also bring out the very slight effect of the cultivation of the clay group of soils, on the loss of water in percolation pots.

TABLE NO. 9.

Percolation in Inches by Quarters.

	No cultivation.	Cultivated.	
		2 inches.	3 inches.
January, February, March, 1911-1912—			
Norfolk sand	1.41	4.47	2.31
Orangeburg fine sandy loam	2.92	4.10	4.19
Miller fine sandy loam	3.17	2.92	3.53
Lufkin fine sandy loam	2.23	2.26	2.82
Average	2.43	3.44	3.21
Houston loam	4.64	3.60	3.59
Houston black clay	5.08	4.99	5.54
Yazoo clay	4.10	4.56	4.93
Crawford clay	4.05	4.92	4.79
Average	4.47	4.50	4.71
April, May, June, 1911-1912—			
Norfolk sand	1.08	2.99	2.54
Orangeburg fine sandy loam	1.80	2.45	2.43
Miller fine sandy loam	2.19	1.98	2.18
Lufkin fine sandy loam	2.31	2.51	2.94
Average	1.85	2.48	2.52

TABLE NO. 9—Continued.

Percolation in Inches by Quarters.

	No cultivation.	Cultivated.	
		2 inches.	3 inches.
Houston loam	3.43	3.20	3.06
Houston black clay	3.56	3.39	3.62
Yazoo clay	2.43	3.13	3.09
Crawford clay	3.40	2.56	3.31
Average	3.21	3.08	3.27
July, August, September, 1911-1912—			
Norfolk sand	.07	.72	.66
Orangeburg fine sandy loam	.02	.26	.21
Miller fine sandy loam	.19	.37	.44
Lufkin fine sandy loam	.26	.43	.44
Average	.14	.45	.44
Houston loam	.59	.50	.86
Houston black clay	.76	.83	.90
Yazoo clay	.45	.64	.66
Crawford clay	1.09	.78	.98
Average	.72	.54	.85
October, November, December, 1911-1912—			
Norfolk sand	.95	4.15	1.13
Orangeburg fine sandy loam	1.47	3.30	3.44
Miller fine sandy loam	2.64	3.34	3.77
Lufkin fine sandy loam	2.73	3.44	3.99
Average	1.95	3.56	3.08
Houston loam	4.39	4.33	4.41
Houston black clay	4.96	4.63	4.65
Yazoo clay	4.32	3.28	4.47
Crawford clay	4.99	3.69	4.88
Average	4.67	3.98	4.60

TABLE NO. 10.

Increase in Quantity of Water Percolated, by Quarters, Over Uncultivated Soil.

	Cultivated 2 inches.	Cultivated 3 inches.
Sand Group—		
January, February, March	1.01	0.78
April, May, June	0.63	0.67
July, August, September	0.31	0.30
October, November, December	1.61	1.13
Clay Group—		
January, February, March	.05	.24
April, May, June	.13	.06
July, August, September	.18	.13
October, November, December	.69	.07

The decreased loss in evaporation, due to the cultivation during the six crop months, is nearly an inch of water, which would be sufficient for about 80 pounds cotton, 6 bushels corn, or 9 bushels oats. The average production of cotton in Texas in 1909, according to the U. S. census, is 125 pounds cotton lint, and 14.7 bushels corn. The gain of water by cultivation would thus be two-thirds of the average cotton crop or two-fifths of the average corn crop. It might, indeed, be much more.

Table No. 11 shows the percentages evaporated, based upon the assumption that all the water which fell during the season either evaporated or percolated. This assumption is, of course, not true, but the table emphasizes the high percentage evaporation during the summer months, which are probably really higher than the figures given.

TABLE NO. 11.

Percentages Evaporated and Percolated (estimated).

	Precipitation.	Percolation 2"	Evaporation 2"	Per cent evaporated 2". Approximate.	Per cent evaporated from uncultivated soil.
Sandy Group—					
January, February, March	8.91	3.44	5.47	61	72
April, May, June	8.52	2.48	6.02	71	78
July, August, September	6.11	0.45	5.66	93	98
October, November, December	9.91	3.56	6.35	64	80
Clay Group—					
January, February, March	8.91	4.71	4.20	47	50
April, May, June	8.52	3.27	5.25	62	62
July, August, September	6.11	0.85	5.26	86	88
October, November, December	9.91	4.60	5.31	54	53

EFFECT OF SULPHATE OF POTASH AND MANURE ON PERCOLATION.

Table No. 12 compares the percolation from the soils which received sulphate of potash, and manure, with the zero pot. None of these soils were cultivated, except to the extent necessary to work in the manure when it was applied.

Sulphate of potash caused an average increase of percolation with the sandy soils. This increase occurred with two of the four soils of the group; with the Miller fine sandy loam, there was a decided decrease. On the other hand, the sulphate of potash caused a decided decrease in percolation with the loam and clay soils, amounting on an average to 3.20 inches, and occurring with all the soils of the group. This is perhaps due to the saline material causing the surface soil to run together, decreasing the penetration of water, and causing it to remain near the surface to undergo evaporation. The Houston black clay, particularly, showed a great decrease in percolation, due to the presence of the sulphate of potash.

The quantity of sulphate of potash used in 1911 was equal to an annual application of 68 pounds potash (K_2O). In 1912, three times this quantity was added to the Norfolk sand, Orangeburg fine sandy loam, Houston loam and Houston black clay, and five times as much to the Yazoo clay, Miller fine sandy loam, Crawford clay and Lufkin fine sandy loam, but there is no evidence that the increased application caused an increased evaporation during the year 1912 over that of 1911. According to these results, application of soluble salts to the heavy soils may result in no increased loss of moisture.

The application of the manure resulted in a decreased loss of water by evaporation from the sandy soils especially. With the clay soils, the manure applied October 15 caused a decreased loss of water, while that applied March 15 increased the loss. With almost all the soils, the fall application of manure resulted in a greater saving of moisture than the spring application. Some of the pots to which manure was applied evidently had something wrong with them and did not allow the water to percolate as it should. This is particularly true of the Miller fine sandy loam, and also the Lufkin fine sandy loam.

TABLE NO. 12.

Percolation in Inches from Uncultivated Soils.

	No addition.	Sulphate of potash.	Manure, Oct. 15.	Manure, Mar. 15.
Norfolk sand—				
1911	5.72	9.31	11.42	13.59
1912	4.57	7.05	8.30	8.34
1913	0.28	5.77	7.21	10.36
Average	3.52	7.38	8.98	10.36
Orangeburg fine sandy loam—				
1911	7.45	8.33	12.39	8.94
1912	6.32	5.91	7.94	6.50
1913	4.85	4.28	7.68	7.92
Average	6.21	6.17	9.34	7.79
Miller fine sandy loam—				
1911	10.75	7.93	10.53	1.19
1912	7.98	6.38	5.89	0.94
1913	5.84	4.94	2.00	1.22
Average	8.19	6.42	6.14	1.12
Lufkin fine sandy loam—				
1911	10.74	11.13	13.20	13.67
1912	7.87	8.23	8.86	6.04
1913	4.69	6.36	6.66	1.53
Average	7.77	8.57	9.57	7.08
Average of sands and loams	6.42	7.14	8.51	6.69
Houston loam—				
1911	16.07	14.84	18.80	16.11
1912	11.56	10.49	12.78	10.50
1913	7.53	8.88	11.67	10.33
Average	11.72	11.40	14.42	12.31
Houston black clay—				
1911	17.92	4.73	14.71	12.69
1912	12.77	3.01	13.06	8.85
1913	11.29	0.64	11.56	4.16
Average	13.99	2.79	13.11	8.57
Yazoo clay—				
1911	14.36	14.26	15.17	15.25
1912	9.98	9.79	10.71	8.53
1913	9.55	9.08	10.35	5.81
Average	11.30	11.04	12.08	9.86
Crawford clay—				
1911	19.52	17.64	18.64	17.29
1912	11.14	10.26	11.81	10.09
1913	10.92	10.66	9.34	10.31
Average	13.86	12.85	13.26	12.56
Average of clays	12.72	9.52	13.22	10.83

The average saving of moisture by the manure on the sandy and loam soils is as follows:

Manure—October 15 .... 2.09
Manure—March 15 .... 0.27

The saving by cultivation is 3.52 inches. The saving due to the manure would suffice for the production of the following crops, if it could all be used:

	Manure, October 15.
Cotton, pounds	167
Corn, bushels	13
Wheat, bushels	8
Oats, bushels	19
Hay, pounds	1600

With the clays and heavy loams, the saving is much less.

The important effect of manure on the saving of moisture with the sands and sandy loam soils deserves especial emphasis. Manure or green crops are undoubtedly needed by these soils, not only for this purpose, but for the other favorable effects upon the condition of the soil. But it appears that an application of ten tons of manure per year on the sands and sandy loam soils may result in a saving of moisture from loss by evaporation sufficient to make more than an average crop of cotton, and nearly an average crop of corn.

PERCOLATION OF NITRATES.

The plan of the work at first included only the estimation of the nitrates from the pots not cultivated, which received no addition, and which received manure March 15 and October 15. Later, however, the plan was expanded to include the estimation of nitrates in all the percolates.

The nitrates were in each case estimated colorimetrically by the phenol-sulphuric acid method the same day that the percolates were collected.

We will discuss first the results from the work which was carried out on the original plan, and take up the other nitrate work on another page.

Table No. 13 shows the nitric nitrogen in the percolates for 1911, 1912 and 1913 in parts per million of the percolating water. This gives the concentration of nitric nitrogen in the percolate.

Table No. 14 shows the quantity of nitric nitrogen lost per pot per month, in the groups studied.

As pointed out elsewhere in this Bulletin, a heavy rain in December, 1913, exceeded both the capacity of the free space of the pots to retain on the surface, and the capacity of the bottles which received the percolates, and, for this reason, December is not included in the work for the year. As, however, the analyses are of some interest, they are recorded in the tables.

TABLE NO. 13.

Nitrates Percolated, Parts Per Million, 1911.

Pot Number.	February.		March.				April.							May.	
	18-19th.	23rd.	3rd.	21st.	24th.	27th.	3rd.	5th.	10th.	14th.	20th.	25th.	28th.	5th.	10th.
1	......	23	......	......	......	30	......	22	14	......	......	10	12	7	......
5	13	10	......	......	......	14	......	19	14	......	......	10	10	6	8
6	......	......	......	......	......	33	......	28	22	......	......	12	11	10	12
7	111	90	......	......	......	111	87	95	74	......	......	38	36	19	......
11	67	......	......	......	......	54	43	40	31	......	......	19	33	16	16
12	......	......	......	......	......	87	71	66	50	......	......	29	31	17	......
13	75	35	30	17	......	33	33	26	23	22	11	14	13	11	11
17	33	29	33	26	36	28	23	22	16	14	9	13	14	12	13
18	......	......	......	......	28	31	26	28	19	17	11	13	14	12	16
19	62	59	58	58	62	41	37	36	26	22	12	19	20	19	18
23	71	48	58	58	53	41	28	36	25	22	20	18	21	23	26
24	......	......	......	......	......	50	......	30	26	......	......	20	23	4	20
25	200	133	......	......	160	180	......	100	83	......	40	38	57	29	48
29	160	148	......	......	57	166	95	138	95	......	53	47	66	48	50
30	......	......	......	......	133	125	100	91	74	......	53	40	50	33	48
31	17	100	......	14	......	105	......	93	71	......	......	40	45	33	......
35	......	103	......	......	......	111	......	100	71	......	......	42	55	31	36
36	......	......	......	......	......	117	......	138	111	......	......	62	62	50	1
37	125	61	80	108	105	51	59	42	36	36	38	25	27	25	31
41	38	80	55	105	100	66	55	49	40	37	37	24	33	24	40
42	......	......	......	......	143	133	95	102	95	66	43	24	50	38	40
43	26	26	23	......	......	15	17	17	12	11	5	20	2	1	1
47	43	19	40	......	......	36	33	44	31	21	......	21	13	8	5
48	......	......	......	......	......	24.4	29	35	27	32	......	14	28	20	21

TABLE NO. 13.

Nitrates Percolated, Parts Per Million, 1911.

Pot Number.	July.		Aug.	October.			November.		December.				January, 1912.		
	10th.	20th.	22nd.	4th.	16th.	24th.	10th.	16th.	13th.	18th.	24th.	28th.	1st	4th.	6th.
1	......	37.7	......	......	......	......	4.3	......	83.3	102.5	78.4	67.8	85.1	......	......
5	......	51.2	......	......	......	......	90.9	......	86.9	90.9	95.2	40.0	22.9	......	......
6	......	40.0	......	......	72.7	......	83.3	59.6	95.2	88.8	53.3	21.0	10.2	......	......
7	......	3.4	......	......	......	......	2.1	......	8.3	173.9	121.2	117.6	114.3	......	......
11	......	......	......	......	......	......	111.1	......	95.2	125.0	148.1	125.0	90.9	......	......
12	......	6.3	......	......	2.2	......	2.0	......	6.8	170.8	100.0	95.2	81.6	......	......
13	......	50.0	39.4	29.8	50.6	46.5	74.1	74.0	45.4	67.8	49.3	44.9	33.3	34.8	......
17	......	64.5	85.1	27.0	88.8	74.0	80.0	83.3	63.5	56.3	32.6	25.0	16.6	14.2	......
18	......	57.1	86.9	33.5	80.0	74.0	90.0	80.0	40.8	66.6	51.7	33.9	25.0	25.9	......
19	......	66.6	115.0	20.0	129.0	105.2	153.8	166.6	90.9	102.5	54.7	45.4	37.9	40.5	......
23	......	68.2	137.9	75.4	133.3	105.2	173.9	190.4	117.6	85.1	51.2	25.3	13.3	12.2	......
24	......	36.3	90.9	6.2	95.2	......	153.8	......	137.9	137.9	81.6	81.6	64.5	......	......
25	......	45.4	173.9	......	102.5	......	210.5	235.3	200.0	235.3	142.8	114.2	114.3	81.6	......
29	......	52.6	190.4	5.4	160.0	102.5	235.3	250.0	222.2	250.0	133.3	125.0	93.0	78.4	......
30	......	44.4	83.3	......	108.1	......	166.6	181.8	235.3	266.6	160.0	166.6	95.2	102.5	......
31	......	33.3	......	......	75.4	......	111.1	114.2	105.2	148.1	95.2	83.3	48.7	......	......
35	......	14.4	......	......	81.6	......	111.1	125.0	153.8	200.0	114.2	88.8	72.7	......	......
36	......	52.6	......	......	11.6	......	4.8	......	166.6	190.4	97.5	105.2	85.1	......	......
37	66.0	45.4	153.8	......	138.0	......	253.3	190.4	160.0	166.6	52.6	74.0	58.8	57.1	......
41	......	45.4	235.3	......	173.9	......	253.3	190.4	181.8	200.0	102.5	100.0	86.9	93.0	......
42	......	31.7	105.3	......	148.1	......	210.5	222.2	210.5	250.0	125.0	105.2	95.2	74.0	......
43	......	31.7	......	4.2	54.0	47.0	86.9	76.9	80.0	93.0	51.2	53.3	42.5	45.9	47.0
47	......	45.4	......	......	88.8	......	105.2	100.0	95.2	105.2	71.4	66.6	49.3	48.7	......
48	......	31.7	......	......	83.3	......	108.1	102.5	117.6	133.3	81.6	74.0	62.5	56.3	......

TABLE NO. 13.

Nitrates Percolated, Parts Per Million, 1912.

Pot Number.	Jan.	February.		March.				April.			May	June.			July	Aug.
	16th.	19th.	28th.	7th.	18th.	23rd.	27th.	6th.	11th.	17th.	9th.	3rd.	15th.	25th.	25th.	
1	91.7	......	50.6	37.5	18.1	11.9	6.3	1.3	1.3	......	1.4	......	......	......	......	......
5	12.8	......	12.2	14.2	9.3	9.2	11.3	12.8	13.3	1.2	......	7.9	......	0.5	3.0	......
6	5.7	......	3.1	4.6	3.2	6.6	5.5	4.2	3.4	......	......	2.7	0.1	0.5	......	......
7	74.1	12.0	54.0	51.9	34.4	20.4	11.3	12.3	8.4	3.8	0.7	......	......	......	0.5	......
11	75.4	......	57.9	41.9	26.3	16.1	11.2	13.3	13.2	3.0	......	14.0	11.2	......	1.0	......
12	65.5	4.2	54.7	57.1	40.0	30.3	8.7	11.6	7.5	1.3	......	......	......	1.3	......	......
13	42.2	23.0	13.5	15.8	9.5	8.2	4.7	4.8	5.3	3.0	4.5	12.6	5.2	0.5	12.0	......
17	15.8	10.9	11.3	13.4	6.9	7.5	4.9	7.0	8.2	5.9	9.1	28.1	10.0	5.5	......	......
18	28.1	25.9	12.2	14.7	8.8	8.4	4.8	6.5	6.6	4.5	5.5	20.0	6.9	......	16.0	......
19	43.0	27.3	25.9	25.6	12.9	11.9	5.9	8.1	8.0	7.0	10.5	20.0	13.1	8.9	17.0	......
23	12.9	11.2	9.4	10.7	6.7	7.5	4.0	6.9	8.0	2.3	8.8	17.0	15.6	12.0	28.0	......
24	83.3	34.0	43.0	35.3	7.4	12.5	3.8	10.4	11.1	1.5	12.5	25.0	17.8	13.0	34.8	......
25	85.1	80.0	68.9	75.4	33.3	38.4	12.5	20.0	20.0	7.2	8.1	29.0	0.8	......	21.0	......
29	78.4	70.1	71.4	61.5	31.7	32.2	10.6	18.8	16.6	8.7	16.1	31.2	12.8	......	47.1	......
30	100.0	95.2	86.9	81.6	45.4	39.2	10.1	18.1	14.9	8.5	14.2	33.3	5.3	......	18.0	......
31	34.8	......	23.5	26.3	6.8	8.5	3.0	3.2	4.5	......	10.9	......	......	0.5	7.5	......
35	63.5	......	44.4	48.2	12.8	15.1	7.5	13.1	13.9	7.2	.9	......	......	......	14.0	......
36	......	......	......	37.5	13.9	20.4	8.9	12.5	9.0	......	3.2	0.5	0.8	......	27.0	......
37	65.5	46.5	37.5	31.9	13.3	12.3	6.4	8.0	9.1	5.4	7.9	27.0	37.2	......	46.3	......
41	86.9	80.0	66.6	58.9	16.6	11.9	5.5	9.5	9.0	3.8	7.7	23.5	13.5	......	38.0	......
42	83.3	57.9	64.5	62.5	15.8	13.1	6.9	11.9	12.0	7.0	8.7	20.0	8.1	19.0	40.0	......
43	48.7	44.4	51.9	64.5	29.0	35.7	10.9	40.0	16.6	9.0	......	12.0	10.4	0.5	27.0	......
47	56.3	43.4	44.4	57.1	21.0	12.2	6.5	14.9	11.7	6.8	10.0	3.1	7.3	......	8.0	......
48	61.5	8.4	57.1	54.7	33.3	29.4	7.9	16.6	15.1	14.7	4.4	18.8	12.0	......	......	......

TABLE NO. 13.

Nitrates Percolated, Parts Per Million, 1912.

Pot Number.	Sept.	Oct.	Nov.	December.						
			25th.	6th.	12th.	17th.	31st.	23rd.	28th.	31st.
1	.....	.....	5.0	0.3	.....	7.6	.....	.....	79.5	.....
5	.....	.....	5.0	0.3	83.3	32.3	.....	100.0	112.5	106.5
6	.....	.....	.....	.....	.....	117.0	.....	100.0	88.5	84.0
7	.....	.....	5.0	0.3	.....	0.2	.....	100.0	150.0	135.0
11	.....	.....	5.0	.....	.....	12.8	.....	100.0	166.7	161.3
12	.....	.....	.....	.....	.....	0.2	.....	200.0	166.7	150.0
13	.....	.....	5.0	24.4	33.0	17.3	.....	166.6	15.0	24.0
17	.....	.....	8.0	36.4	57.7	57.2	.....	113.6	31.5	39.0
18	.....	.....	95.0	26.4	60.0	45.4	.....	125.0	33.0	43.5
19	.....	.....	9.0	64.5	83.3	60.9	.....	104.1	73.5	88.5
23	.....	.....	10.0	62.5	90.9	74.4	.....	219.8	79.5	109.5
24	.....	.....	.....	69.0	96.8	21.1	.....	250.0	103.5	.....
25	.....	.....	20.0	.....	120.0	203.0	.....	210.5	217.4	230.8
29	.....	.....	35.0	69.0	100.0	227.3	.....	215.0	194.8	150.0
30	.....	.....	25.0	83.4	111.1	214.2	.....	.....	192.4	.....
31	.....	.....	8.0	10.0	43.5	67.5	.....	104.1	69.0	75.0
35	.....	.....	10.0	.....	.....	72.0	.....	259.7	94.5	.....
36	.....	.....	.....	.....	.....	48.0	.....	.....	57.0	.....
37	.....	.....	20.0	83.4	85.7	117.0	.....	106.3	87.0	.....
41	.....	.....	15.0	60.6	79.0	158.0	.....	222.2	172.5	185.2
42	.....	.....	.....	80.0	93.8	176.4	.....	184.0	166.7	136.5
43	.....	.....	5.0	25.0	.....	52.5	40.5	.....	48.0	55.5
47	.....	.....	5.0	.....	.....	60.0	.....	111.1	66.0	73.5
48	.....	.....	.....	.....	.....	217.5	.....	263.1	82.5	.....

TABLE NO. 13.

Nitrates, Parts Per Million, 1913.

Pot Number.	January.				February.				March.				April.		
	10th.	14th.	25th.	28th.	1st.	10th.	15th.	24th.	3rd.	12th.	17th.	25th.	7th.	12th.	28th.
1	......	15.0	......	48.0	......	......	27.0	......	......	4.0	4.0	......	......	......	1.0
5	......	42.0	68.0	49.0	......	17.0	6.0	......	4.0	6.0	4.5	......	2.5	2.5	5.0
6	......	36.0	50.0	36.0	......	11.0	6.0	......	6.0	5.5	5.0	......	3.5	5.0	5.0
7	......	......	88.0	100.0	......	51.0	38.0	......	18.0	15.5	14.0	......	3.0	......	0.5
11	......	67.5	163.9	147.0	......	67.0	38.0	......	22.5	16.0	9.5	......	......	5.5	8.0
12	......	......	138.9	137.0	......	58.0	34.0	......	17.5	19.0	15.0	......	2.0	6.0	9.0
13	......	12.0	20.0	9.0	......	4.0	2.0	3.0	5.0	3.5	3.0	......	2.5	......	5.0
17	......	22.5	42.0	26.0	......	15.0	15.0	17.0	17.5	12.0	7.5	7.5	15.0	8.5	11.5
18	......	13.5	32.0	13.0	......	5.0	7.0	......	7.5	10.0	6.5	......	14.0	12.0	13.0
19	......	40.5	78.0	55.0	......	23.0	15.0	......	10.0	8.5	7.5	......	12.5	10.0	13.0
23	......	49.5	80.0	60.0	......	42.0	36.0	......	21.0	18.0	16.5	......	2.5	8.0	11.5
24	......	......	......	79.0	......	42.0	39.0	......	13.0	20.0	20.0	......	3.5	......	10.5
25	......	93.0	185.3	164.0	......	64.0	46.0	......	36.0	25.0	18.0	......	2.0	......	15.5
29	......	93.0	135.6	131.6	......	83.0	55.0	......	55.6	37.5	32.0	......	79.4	32.0	40.0
30	......	82.5	114.9	153.9	......	......	80.0	......	50.0	35.0	32.5	......	75.8	33.0	34.0
31	......	......	55.0	43.0	......	15.0	11.0	......	6.0	7.5	4.5	......	15.0	......	......
35	......	......	......	99.0	......	......	40.0	......	......	22.0	20.0	......	......	......	......
36	......	3.0	......	54.0	......	......	43.0	......	......	21.5	22.5	......	......	......	......
37	......	43.5	......	70.0	......	70.0	79.0	......	36.0	32.0	32.5	......	49.0	32.5	21.0
41	......	87.0	181.8	147.0	......	73.0	86.0	......	3.8	35.0	23.0	......	4.5	7.0	13.0
42	......	88.5	60.0	147.0	......	75.0	66.0	......	37.5	32.5	37.5	......	42.5	30.0	31.5
43	48.0	31.5	73.0	620.0	54.0	......	47.0	42.5	26.0	25.0	30.0	22.5	......	5.5	18.5
47	......	18.0	149.2	57.0	53.0	......	42.0	35.0	26.0	22.5	22.0	......	......	......	9.0
48	......	......	......	45.0	......	......	40.0	......	......	25.0	20.0	......	5.0	......	10.0

TABLE NO. 13.

Nitrates Removed in Parts Per Million in 1913.

Pot Number.	May.		July	October.			November.		December.									Jan.
	19th.	26th.	5th.	2nd.	7th.	20th.	10th.	27th.	2nd.	4th.	4th. No. 2.	4th. No. 3.	5th.	6th.	10th.	16th.	27th.	1st. (1914)
1	......	0.4	......	13.4	......	......	......	......	18.0	20.0	......	......	......	......	0.5	2.0	......	......
5	......	7.0	0.7	61.6	24.0	26.0	1.0	24.0	59.0	7.0	......	......	......	......	......	......	......	......
6	3.0	7.6	2.0	46.4	107.0	112.0	90.0	55.0	18.0	7.0	1.0	1.0	......	......	......	......	......	......
7	......	0.6	1.2	2.4	56.0	......	12.0	6.0	74.0	60.0	30.0	......	6.0	......	4.0	......	2.5	2.0
11	......	9.4	0.7	52.0	78.0	124.0	80.0	120.0	112.0	58.0	1.0	......	......	......	......	......	......	......
12	......	3.0	......	44.6	70.0	128.0	148.0	128.0	74.0	23.0	1.0	......	......	......	......	......	0.5	1.0
13	0.8	6.2	0.6	31.2	32.0	26.0	21.0	20.0	9.0	2.0	1.0	......	1.0	......	4.0	14.0	5.0	2.0
17	4.0	7.0	......	54.0	55.0	48.0	46.0	40.0	18.0	2.0	......	......	4.0	......	8.0	20.0	8.5	4.5
18	0.4	7.4	0.5	49.2	53.0	41.0	33.0	30.0	17.0	3.0	1.0	......	1.0	......	4.0	12.0	7.0	4.5
19	4.0	16.8	0.4	45.6	68.0	68.0	73.0	67.0	49.0	3.0	......	......	......	......	2.0	4.0	3.0	3.0
23	2.0	14.0	0.5	49.8	86.0	88.0	76.0	62.0	48.0	7.0	......	......	4.0	......	4.0	4.0	3.0	4.0
24	......	1.0	......	48.0	......	15.0	29.0	60.0	90.0	14.0	......	......	......	......	3.5	......	2.5	3.5
25	1.2	1.6	0.7	49.6	72.0	93.0	104.0	128.0	96.0	88.0	......	......	6.0	......	9.0	9.0	8.5	7.0
29	0.8	1.4	0.4	80.0	144.0	166.0	156.0	130.0	150.0	63.0	25.0	......	5.0	......	4.0	6.0	6.0	5.0
30	1.0	26.8	0.7	87.0	130.0	140.0	116.0	140.0	120.0	50.0	......	......	......	......	4.5	2.0	3.5	5.0
31	1.0	......	2.0	18.4	43.0	......	8.0	9.0	42.0	11.0	1.0	......	......	......	1.0	2.0	2.0	2.5
35	......	......	......	37.2	100.0	......	......	......	92.0	12.0	......	......	......	......	9.5	......	15.0	10.5
36	......	......	......	77.0	154.0	15.0	......	......	75.0	75.0	......	......	......	......	37.5	......	29.0	24.5
37	0.6	......	......	52.0	104.0	116.0	100.0	93.0	72.0	10.0	......	......	4.0	......	4.0	7.0	6.5	8.0
41	0.8	......	0.7	41.4	84.0	76.0	92.0	106.0	76.0	20.0	......	......	1.0	......	3.0	1.0	3.5	4.5
42	30.8	30.4	0.7	66.0	154.0	116.0	146.0	148.0	80.0	33.0	......	......	12.0	......	17.5	12.0	8.5	8.0
43	......	......	1.9	13.2	24.0	......	30.0	40.0	15.0	9.0	......	......	4.0	5.0	5.5	20.0	8.0	4.5
47	......	1.6	......	40.0	50.0	22.0	49.0	60.0	54.0	60.0	......	......	43.0	......	31.0	77.0	28.5	24.0
48	......	0.6	......	45.0	100.0	20.0	......	85.0	65 0	7.0	......	......	3.0	......	6.0	26.0	22.0	12.0

TABLE NO. 14.

Nitrate in Milligrams, Per Pot Per Month, 1911.

Pot Number.		Feb.	Mar.	April.	May.	July.	Aug.	Oct.	Nov.	Dec.	Total.
1	Norfolk sand	15	45	40	2	14	......	......	......	400	516
5	Norfolk sand, manure October 15	23	17	80	7	29	......	......	168	685	1009
6	Norfolk sand, manure, March 15	......	27	139	19	64	......	136	163	586	1134
7	Orangeburg fine sandy laom	107	18	358	19	......	......	......	......	663	1165
11	Orangeburg fine sandy loam, manure, October 15	167	8	327	26	......	......	......	67	1090	1685
12	Orangeburg fine sandy loam, manure, March 15	......	34	299	17	......	......	......	......	740	1090
13	Houston loam	113	62	134	24	139	18	97	111	457	1155
17	Houston loam, manure, October 15	134	75	133	25	187	64	211	191	439	1459
18	Houston loam, manure, March 15	......	61	127	25	173	52	167	134	422	1161
19	Houston black clay	315	126	194	38	210	100	206	289	679	2157
23	Houston black clay, manure, October 15	214	123	200	50	196	103	349	353	671	2259
24	Houston black clay, manure, March 15	......	117	98	14	112	64	221	192	797	1605
25	Yazoo clay	450	400	425	65	89	83	208	281	1477	3478
29	Yazoo clay, manure, October 15	379	369	544	89	135	100	303	396	1609	3924
30	Yazoo clay, manure, March 15	......	279	431	68	104	46	170	257	1635	2990
31	Miller fine sandy loam	101	66	370	33	33	......	23	30	833	1489
35	Miller fine sandy loam, manure, October 15	85	72	350	32	21	......	37	166	1106	1869
36	Miller fine sandy loam, manure, March 15	......	59	141	4	13	......	1	......	217	435
37	Crawford clay	386	196	266	38	152	177	359	444	1045	3063
41	Crawford clay, manure, October 15	348	193	289	79	155	188	443	480	1420	3595
42	Crawford clay, manure, March 15	......	314	531	92	101	84	330	390	1473	3315
43	Lufkin fine sandy loam	40	5	69	4	41	......	54	58	445	716
47	Lufkin fine sandy loam, manure, October 15	36	112	91	9	84	......	89	145	687	1253
48	Lufkin fine sandy loam, manure, March 15	......	67	192	23	43	......	67	56	751	1199

6, 12, 18, 24, 30, 36, 42, 48, nitrate not begun until after manure added, March 15th.

TABLE NO. 14.

Nitrate in Milligrams Per Pot Per Month, 1912.

Pot Number.		Jan.	Feb.	Mar.	April.	May.	June.	July.	Nov.	Dec.	Total.
1	Norfolk sand	4.6	20.2	76.9	3.3	0.1	......	......	......	26.7	131.8
5	Norfolk sand, manure, October 15	3.2	11.6	61.5	44.3	......	1.0	0.9	......	388.4	510.9
6	Norfolk sand, manure, March 15	1.6	2.9	39.1	11.8	......	1.7	......	......	355.3	412.4
7	Orangeburg fine sandy loam	5.9	9.2	174.7	28.0	0.1	......	......	......	177.3	395.2
11	Orangeburg fine sandy loam, manure, October 15	18.8	91.5	144.3	46.6	......	6.5	0.1	......	228.2	536.0
12	Orangeburg fine sandy loam, manure, March 15	8.2	18.3	230.5	26.9	......	......	......	......	295.0	578.9
13	Houston loam	15.8	39.2	55.3	20.0	3.5	23.4	0.7	......	419.0	576.9
17	Houston loam, manure, October 15	4.6	25.2	60.3	30.9	8.2	60.0	......	0.1	439.8	629.1
18	Houston loam, manure, March 15	5.6	19.3	56.0	20.4	3.5	37.9	5.6	0.2	380.0	528.5
19	Houston black clay	8.6	66.4	107.5	31.2	9.9	41.8	3.6	......	543.1	812.1
23	Houston black clay, manure, October 15	3.3	26.4	55.4	29.0	8.8	38.7	13.3	0.1	832.8	1007.8
24	Houston black clay, manure, March 15	1.2	50.0	108.7	31.0	7.7	48.3	13.9	......	495.6	756.4
25	Yazoo clay	3.8	127.9	262.2	69.9	4.4	40.0	1.5	......	877.8	1380.5
29	Yazoo clay, manure, October 15	5.5	154.2	221.6	57.3	12.1	53.4	10.8	0.2	840.6	1355.7
30	Yazoo clay, manure, March 15	7.5	148.4	283.4	42.1	9.2	45.4	0.5	......	362.3	898.8
31	Miller fine sandy loam	6.6	8.5	59.3	14.0	0.1	......	0.5	0.1	334.1	423.2
35	Miller fine sandy loam, manure, October 15	2.8	17.3	96.5	46.7	......	......	1.7	......	291.6	456.6
36	Miller fine sandy loam, manure, March 15	......	......	16.0	4.7	0.2	......	0.9	......	11.5	33.3
37	Crawford clay	13.1	98.4	93.0	29.7	8.3	65.3	34.4	......	557.1	899.3
41	Crawford clay, manure, October 15	20.8	191.2	151.7	36.3	8.2	60.3	29.8	......	796.7	1295.0
42	Crawford clay, manure, March 15	14.1	130.5	137.7	38.2	7.4	40.1	19.4	......	734.5	1121.9
43	Lufkin fine sandy loam	28.0	24.0	86.9	95.5	2.8	11.1	1.1	0.1	199.0	448.5
47	Lufkin fine sandy loam, manure, October 15	6.2	17.6	97.4	66.1	......	8.1	0.1	0.1	302.6	498.2
48	Lufkin fine sandy loam, manure, March 15	2.5	22.1	127.6	52.7	0.2	13.3	......	......	301.2	519.6

TABLE NO. 14.

Nitrates Percolated in Milligrams Per Pot in 1913.

Pot Number.		Jan.	Feb.	Mar.	April.	May.	July.	Oct.	Nov.	Total.	Dec.
1	Norfolk sand	7.0	0.7	0.8	......	.01	......	0.8	......	9.3	0.6
5	Norfolk sand, manure, October 15	133.2	47.5	22.7	3.2	2.87	.021	80.2	0.6	290.3	51.5
6	Norfok sand, manure, March 15	93.6	27.4	21.8	9.1	6.20	.03	150.5	200.9	509.5	31.5
7	Orangeburg fine sandy loam	250.6	152.3	48.0	0.1	.01	.036	3.6	0.6	455.2	51.5
11	Orangeburg fine sandy loam, manure, October 15	370.7	203.3	69.2	7.1	3.00	.014	93.9	19.6	766.8	50
12	Orangeburg fine sandy loam, manure, March 15	351.7	168.5	58.1	6.3	.84	......	84.7	290.8	960.9	53
13	Houston loam	26.7	12.6	14.5	4.1	1.55	.024	109.5	29.0	211.9	49
17	Houston loam, manure, October 15	77.2	57.6	54.0	18.5	4.38	......	239.2	92.7	543.6	83
18	Houston loam, manure, March 15	35.9	18.3	32.5	24.5	1.70	.035	165.4	71.2	349.5	78
19	Houston black clay	162.1	78.0	42.2	17.5	7.49	.036	206.9	132.7	646.9	151
23	Houston black clay, manure, October 15	199.6	154.3	92.7	14.1	5.55	.03	224.3	139.9	830.5	164
24	Houston black clay, manure, March 15	136.6	105.1	51.9	4.0	.02	.021	11.8	6.9	316.3	143
25	Yazoo clay	422.4	200.9	98.3	10.2	.08	.021	222.2	198.2	1152.3	633
29	Yazoo clay, manure, October 15	348.7	267.3	175.1	50.1	.01	.012	372.6	276.1	1489.9	699
30	Yazoo clay, manure, March 15	285.6	175.2	109.1	47.9	.27	.028	118.8	66.6	803.5	72
31	Miller fine sandy loam	113.2	49.1	21.2	0.5	......	.04	8.8	0.9	193.7	137
35	Miller fine sandy loam, manure, October 15	144.5	42.0	10.9	......	......	......	22.9	......	220.3	57
36	Miller fine sandy loam, manure, March 15	2.8	0.9	1.1	......	......	......	154.5	......	159.3	17
37	Crawford clay	160.8	242.2	152.4	40.8	......	......	257.4	206.6	1060.2	251
41	Crawford clay, manure, October 15	355.7	268.3	156.2	13.3	......	.021	327.3	155.2	1276.0	291
42	Crawford clay, manure, March 15	365.9	234.5	140.2	43.0	16.45	.042	318.9	264.7	1383.7	370
43	Lufkin fine sandy loam	67.1	175.1	431.9	0.9	......	.038	9.7	12.5	697.2	99
47	Lufkin fine sandy loam, manure, October 15	120.7	135.6	70.1	0.1	.02	......	......	27.9	354.4	455
48	Lufkin fine sandy loam, manure, March 15	32.9	6.8	14.6	0.8	.01	......	......	3.4	58.5	36

QUANTITY OF NITRIC NITROGEN PERCOLATING.

Table No. 16 is a summary of Table No. 14 and shows the total quantities of nitric nitrogen percolating from the uncultivated soil, both those which received no additions and those which received manure.

An examination of the tables show that the concentration of the nitrates in the water percolating from the pots reaches its maximum in the fall, usually in December, and its minimum in the spring, usually in April. This may be due to the accumulation of nitrates during the summer months, when the temperature is favorable to nitrification, and there is little percolation, and to washing the nitrates out by the fall and winter rains. Nitrification is of course less active during the winter months. From Table No. 14, showing the nitrates in milligrams percolated per pot, we likewise see that the nitric nitrogen washed out in December forms a large proportion of the total loss.

NITROGEN LOST IN POUNDS PER ACRE.

The loss of 1 mg. per pot represents a loss of 0.122 pounds per acre. Table No. 15 shows the average loss of nitrogen in pounds per acre per year for the several soils (December, 1913, excluded). The loss varies from 26.7 to 244.2 pounds per acre. The average for the sandy group is 67.2 pounds and for the clay group 168.6. The nitrogen content of soil and subsoil is also stated in the table. It is seen that the loss of nitrates is related to the total nitrogen of the soil. The quantity increases with the content of soil and subsoil in nitrogen. As it takes approximately 1.5 pounds nitrogen for grain, stalk, leaves, etc., for a bushel of corn, we have also calculated the loss of nitrogen to bushels corn per acre. This is 45 bushels for the first group and 114 bushels for the second.

TABLE NO. 15.

Loss of Nitric Nitrogen Per Year Per Acre.

	Pounds per acre.	Per cent nitrogen. Surface.	Per cent nitrogen. Subsoil.	Average of surface and subsoil.	Corn in bushels equal to nitrates.
Norfolk sand	26.7	.03	....	.03	18
Orangeburg fine sandy loam	81.9	.04	....	.04	54
Miller fine sandy loam	85.5	.05	.035	.04	57
Lufkin sandy loam	75.6	.05	.063	.059	51
Average for group	67.2	.044	.044	....	45
Houston loam	78.9	.034	.040	.037	51
Houston black clay	147.0	.119	.079	.099	99
Yazoo clay	244.2	.149	.152	.151	162
Crawford clay	203.1	.151	.098	.125	135
Average for group	168.6	.113	.092	....	114

While it is not probable that all the nitrates produced were washed from the soil each year, yet the figures ought to give us a fairly good idea of the amount formed. We can also compare these figures with the corn possibility based upon the nitrogen taken up in pot experiments as follows:

	Per cent nitrogen average of soil and subsoil.	Corn equal to nitrates.	Corn possibility of total nitrogen. (Bushels per acre.)
Norfolk sand	.03	18	13
Houston loam	.037	51	13
Orangeburg fine sandy loam	.04	54	18
Miller fine sandy loam	.04	57	18
Average of first group	.044	45	18
Lufkin sandy loam	.059	51	18
Houston black clay	.099	99	28
Average of second group	.092	104	28
Crawford clay	.125	135	38
Yazoo clay	.151	162	43

It is evident that the average quantity of nitrates produced is large. The losses from cropped land would, of course, be much less than these given here. The nitrates formed would be absorbed by the crops. The percolation would be reduced, both by the water evaporated from the crops, and by water running off on the surface.

Nevertheless, considerable losses of plant food may occur from bare, uncropped soils during the winter months. The nitrates are not all taken up by the plants, and a portion of the water percolates from the soil.

NITRATES FROM MANURE.

Table No. 16 shows the nitric nitrogen, in milligrams per pot, percolating from the manured and unmanured pots. As previously stated, manure was added at the rate of 30 grams of dried sheep excrement per pot, on October 15 or March 15. This represented an application of 9.15 tons per acre of manure containing 80 per cent water. The quantity of nitrogen added was equal to 456 milligrams per year, October 15, and 474 milligrams March 15, or 55.6 pounds per acre for the former.

An examination of the table shows that, with one exception, more nitrates percolated from the manure applied October 15 than from that applied March 15. This may be compared with the fact, discussed elsewhere in this Bulletin, that the manure applied October 15 decreased evaporation better than that applied March 15. The difference may be partly due to the fact that some of the pots to which the manure was applied March 15 did not percolate properly.

The average quantity of nitric nitrogen per year produced from the manure applied October 15 is as follows:

	Milligrams per pot.	Pounds per acre.	Sufficient for bushels corn per acre.
Group 1	234	28.5	19
Group 2	256	31.2	21
Average	245	29.8	20

This is 53.7 per cent. of the 456 milligrams nitrogen applied in the manure each year. According to this, an application of 9 tons manure per acre annually would raise the corn possibility (so far as nitrogen is concerned) 20 bushels per acre.

TABLE NO. 16.

Nitrogen Percolated as Nitrates in Milligrams Per Pot.

	No addition.	Manure October 15.	Manure March 15.
Norfolk sand, 1911	516.0	1009.0	1134.0
Norfolk sand, 1912	131.8	510.9	412.4
Norfolk sand, 1913	9.3	209.3	509.5
Average	219.0	603.4	685.3
Orangeburg fine sandy loam, 1911	116.5	168.5	1090.0
Orangeburg fine sandy loam, 1912	395.2	536.0	578.9
Orangeburg fine sandy loam, 1913	455.2	766.8	960.9
Average	671.8	995.9	876.6
Miller fine sandy loam, 1911	1489.0	1869.0	435.0
Miller fine sandy loam, 1912	423.2	456.6	33.3
Miller fine sandy loam, 1913	193.7	220.3	159.3
Average	702.0	848.6	209.2
Lufkin sandy loam, 1911	716.0	1253.0	1199.0
Lufkin sandy loam, 1912	448.5	498.2	519.5
Lufkin sandy loam, 1913	697.2	354.4	58.5
Average	620.6	701.9	592.4
Average for group	553.4	787.5	590.9
Houston loam, 1911	1155.0	1459.0	1161.0
Houston loam, 1912	576.9	629.1	528.5
Houston loam, 1913	211.9	543.6	349.5
Average	647.9	877.2	679.7
Houston black clay, 1911	2157.0	2259.0	1605.0
Houston black clay, 1912	812.1	1007.8	756.4
Houston black clay, 1913	646.9	830.5	316.3
Average	1205.3	1365.8	892.6
Yazoo clay, 1911	3478.0	3924.0	2990.0
Yazoo clay, 1912	1380.5	1355.7	898.8
Yazoo clay, 1913	1152.3	1489.9	803.5
Average	2003.6	2256.5	1564.1
Crawford clay, 1911	3063.0	3595.0	3315.0
Crawford clay, 1912	899.3	1295.0	1121.9
Crawford clay, 1913	1060.2	1276.0	1383.7
Average	1674.2	2055.3	1940.2
Average for group	1382.8	1638.7	1269.2

TABLE NO. 17.

Nitrates Percolated Parts per Million 1912 (March 23 to December 31.)

Pot Number.		March 23d.	March 27th.	April 6th.	April 11th.	April 17th.	May 9th.	June 3rd.	June 15th.	June 25th.	July 25th.	August.	September.	October.	November 25.	December 6th.	December 12th.	December 17th.	December 31st.	December 23rd.	December 28th.	December 31st.
1	Norfolk sand, 0″	11.9	6.3	1.3	1.3	....	1.4	....	....	....	....	..	..	..	5.0	0.3	....	7.6	....	....	79.5	....
2	Norfolk sand, 2″ and nitrates	8.0	8.9	6.3	12.5	8.9	33.3	40.0	....	....	28.5	..	..	..	10.0	36.4	41.1	20.0	....	50.0	72.0	....
7	Orangeburg fine sandy loam, 0″	20.4	11.3	12.3	8.4	3.8	.7	....	....	....	0.5	..	..	..	5.0	0.3	....	0.2	....	100.0	150.0	105.0
8	Orangeburg fine sandy loam, 2″ and nitrates	7.9	7.3	9.0	16.6	35.7	35.3	31.5	....	....	....	..	..	..	....	....	....	66.7	....	107.5	117.0	189.5
13	Houston loam, 0″	8.2	4.7	4.8	5.3	3.0	4.5	12.6	5.2	0.5	12.0	..	..	..	5.0	24.4	33.0	17.3	....	166.6	15.0	24.0
14	Houston loam, 2″ and nitrates	9.6	6.9	15.1	28.5	28.1	27.4	33.3	25.0	20.0	38.0	..	..	..	100.0	33.3	....	144.0	52.5	....	45.0	58.5
19	Houston black clay, 0″	11.9	5.9	8.1	8.0	7.0	10.5	20.0	13.1	8.9	17.0	..	..	..	9.0	64.5	83.3	60.9	....	104.1	73.5	88.5
20	Houston black clay, 2″ and nitrates	16.6	11.7	38.9	38.0	29.0	30.3	31.2	30.0	15.0	34.0	..	..	..	83.0	80.0	96.8	86.3	....	212.8	117.0	150.5
25	Yazoo clay, 0″	38.4	12.5	20.0	20.0	7.2	8.1	29.0	0.8	....	21.0	..	..	..	20.0	....	120.0	203.0	....	210.5	217.4	230.8
26	Yazoo clay, 2″ and nitrates	21.7	11.5	58.8	85.1	66.6	47.0	43.9	28.5	....	....	..	..	..	30.0	76.9	93.8	234.5	....	219.8	217.4	....
31	Miller fine sandy loam, 0″	8.5	3.0	3.2	4.5	....	0.9	....	....	0.5	7.5	..	..	..	8.0	10.0	43.5	67.5	....	104.1	69.0	75.0
32	Miller fine sandy loam, 2″ and nitrates	78.8	59.0	60.6	64.5	66.6	45.4	56.6	60.6	1.5	9.0	..	..	..	75.0	....	62.5	97.5	....	263.8	93.0	....
37	Crawford clay, 0″	12.3	6.4	8.0	9.1	5.4	7.9	27.0	37.2	....	46.3	..	..	..	20.0	83.4	85.7	117.0	....	106.3	87.0	....
38	Crawford clay, 2″ and nitrates	12.8	8.0	29.5	50.0	53.3	46.1	50.6	....	2.5	7.0	..	..	..	....	83.4	111.1	202.7	....	208.3	189.9	120.0
43	Lufkin sandy loam, 0″	35.7	10.9	40.0	16.6	9.0	10.0	12.0	10.4	0.5	27.0	..	..	..	5.0	25.0	....	52.5	40.5	....	48.0	55.5
44	Lufkin sandy loam, 2″ and nitrates	24.1	8.4	37.9	43.4	44.4	35.0	41.6	51.0	9.5	38.0	..	..	..	20.0	57.2	....	72.5	76.5	....	82.5	81.0

The results here given show a high nitrification of the manure accompanied with a high percolation of the nitrates produced. The manure applied was dry, finely ground sheep excrement, and should not nitrify as readily as ordinary barnyard manure, which has usually fermented to some extent.

LOSS OF NITRATES BY PERCOLATION.

On March 15, 1912, and again on November 15, 1 gram nitrate of soda containing 152 mg. nitrogen was added to four cultivated pots, Nos. 2, 8, 14 and 20, and two grams were added to four others, of different soils, Nos. 26, 32, 38 and 44. The object of the application was to ascertain how rapidly the nitrates would percolate. The additions made were at the rate of 122 and 244 pounds nitrate of soda per acre.

Table No. 17 shows a comparison in parts per million of nitric nitrogen of these pots and the soils receiving no additions. With two of the soils, an increase in the proportion of nitrates is seen at once, but with the other six the nitrates had no effect on the percolating water until the collection of April 6th or April 11th, the third or fourth percolation since the nitrates were added. The loss of nitrogen in milligrams per month for the year is shown in Table No. 18.

TABLE NO. 18.

Milligrams Nitric Nitrogen Removed Per Pot, 1912.

Pot Number.		March 23rd and 27th.	April.	May.	June.	July.	November.	December.	Total.
1	Norfolk sand, 0	36.9	3.3	0.1	.....	.....	.....	26.7	67.0
2	Norfolk sand, 2.. and nitrates	30.8	29.9	41.6	76.0	13.5	.....	241.8	433.6
7	Orangeburg fine sandy loam, 0	32.6	28.0	0.1	.....	.....	.....	177.3	238.0
8	Orangeburg fine sandy loam, 2.. and nitrates	70.8	54.5	20.5	46.0	.....	.....	312.5	504.3
13	Houston loam, 0	15.5	20.0	3.5	23.4	0.7	.....	419.0	482.1
14	Houston loam, 2.. and nitrates	12.4	10.0	28.3	69.8	14.4	1.2	273.3	499.7
19	Houston black clay, 0	49.6	31.2	9.9	41.8	3.6	.....	543.1	679.2
20	Houston black clay, 2.. and nitrates	71.3	123.0	30.3	64.6	15.0	0.2	787.1	1091.5
25	Yazoo clay, 0	128.3	62.9	4.4	40.0	1.5	.....	877.8	1114.9
26	Yazoo clay, 2.. and nitrates	84.6	276.3	39.9	78.5	.....	.....	788.0	1267.3
31	Miller fine sandy loam, 0	16.4	14.0	0.1	.....	0.5	0.1	334.1	365.2
32	Miller fine sandy loam, 2.. and nitrates	192.8	179.9	18.2	43.2	0.2	0.2	599.1	1033.6
37	Crawford clay, 0	17.8	29.7	8.3	65.3	34.4	.....	557.1	712.6
38	Crawford clay, 2.. and nitrates	40.4	49.5	35.5	62.2	0.1	.....	776.5	964.2
43	Lufkin sandy loam, 0	14.7	95.5	2.8	11.1	1.1	0.1	199.0	324.3
44	Lufkin sandy loam, 2.. and nitrates	13.9	172.6	17.5	42.0	1.0	.....	414.2	661.2

The difference in the nitrates from these pots is due, however, not only to the addition of nitrates, but also to the cultivation, the pots to which the nitrates were added being cultivated, and the pots to which no addition was made not being cultivated. It is difficult to allow for this difference. The cultivation caused a greater percolation through a number of the pots, and consequently a greater removal of the nitrates. There appears to be little danger of loss of nitrates during the growing reason.

PERCOLATION OF POTASH.

One gram sulphate of potash was added to pots Nos. 4, 10, 16, 22, 28, 34, 40 and 46 on October 15, 1910, 1911, 1912 and 1913. In addition, two grams were added to pots Nos. 4, 10, 16 and 22 and four grams to 28, 34, 40 and 46 on March 15, 1912. The object of these extra additions was to see if they increased the loss of potash. The sulphate of potash used contained 50.1 per cent. potash (K_2O). One gram of sulphate of potash is equal to an application of 122 pounds per acre of sulphate of potash, or 61 pounds actual potash per acre.

The parts per million of potash in the percolates is given in Table No. 19. The addition of fertilizer potash increased the potash content of the percolates in several instances.

TABLE NO. 19.

Parts Per Million of Potash in Percolates.

Pot Number.		Potash.						
		Jan. 1, 1911, to April 1, 1911.	April 1, 1911, to June 17, 1911.	June 17, 1911, to Jan. 1, 1912.	Jan. 1, 1912, to July 1, 1912.	July 1, 1912, to Jan. 1, 1913.	Jan. 1, 1913, to July 1, 1913.	July 1, 1913, to Dec. 1, 1913.
1	Norfolk sand	14	......	17	9	......	......	......
4	Norfolk sand and potash	16	19	15	11	18	9.1	11.6
7	Orangeburg fine sandy loam	27.7	30	26	22	26	17.1	24.3
10	Orangeburg fine sandy loam and potash	32	33	27	22	......	20.5	21.9
13	Houston loam	7	9	8	6	5	4.2	8.2
16	Houston loam and potash	11	9	7	4	7	4.8	10.9
19	Houston black clay	3	4	5	5	3	2.2	5.5
22	Houston black clay and potash	2	......	5	5	......	......	......
25	Yazoo clay	36	31	31	22	28	16.0	25.9
28	Yazoo clay and potash	33	29	33	20	30	18.8	31.7
31	Miller fine sandy loam	24	26	24	24	17	11.7	20.9
34	Miller fine sandy loam and potash	34	41	32	30	36	26.9	29.8
37	Crawford clay	17	13	16	12	12	3.0	12.6
40	Crawford clay and potash	22	13	17	15	15	3.0	14.7
43	Lufkin fine sandy loam	2	4	4	5	3	2.1	5.4
46	Lufkin fine sandy loam and potash	3	4	6	13	6	2.6	8.1

Table No. 20 shows the potash, in mgr., percolating from the untreated soils, and those which received potash. In considering the potash applied, that introduced October 15, 1910, is excluded. The maximum loss in the three years on any one soil, is 303 mg. with the Norfolk sand, which is 12 per cent. of the potash added. Next comes the Miller fine sandy loam, 142 mg. or 4 per cent. of that added, and the Lufkin fine sandy loam, 4.5 per cent. loss. The Crawford clay lost a little less than 2 per cent., the Orangeburg fine sandy loam 2.2 per cent., the Yazoo clay 0.3 per cent. and the Houston loam and Houston black clay, none.

TABLE NO. 20.
Potash in Milligrams Per Part from Untreated Soils and Soils Which Received Potash.

	No addition.				Potash added.			Loss.				Potash added, Mgs.
	1911	1912	1913	Total.	1911	1912	1913	1911	1912	1913	Total.	
Norfolk sand	165	75	....	240	281	162	101	115	87	101	303	2500
Orangeburg fine sandy loam	371	261	156	788	450	235	159	79	....	3	55	2500
Houston loam	236	123	98	457	230	95	112	....	....	14	......	2500
Houston black clay	141	104	69	214	33	28	....	....	....	....	......	2500
Yazoo clay	851	438	350	1639	845	412	390	....	....	40	14	3500
Miller fine sandy loam	508	323	138	959	506	368	247	....	45	109	142	3500
Crawford clay	567	253	129	949	577	285	150	10	32	21	63	3500
Lufkin fine sandy loam	73	58	24	145	94	168	51	21	110	27	158	3500

We must take into consideration the fact that these soils were uncropped and uncultivated, and that all the water which fell on the soil either evaporated or went through. Growing crops would, of course, use the potash in solution, and decrease the percolation of water, as they evaporate it also. Hence the loss of potash due to the fertilizer would be less on a cropped soil. We should judge from these results that there is little loss of potash of fertilizer, due to percolation, when the potash is applied to a soil on which crops are growing. Even on the light sandy soil, the Norfolk sand, there should be only small loss, if any.

Table No. 21 shows the loss of potash in pounds per acre, from the uncultivated, unfertilized, uncropped soils, to which no fertilizer had been applied. The loss varies from 9.7 to 66.6 pounds per acre. These losses would, of course, be much less when crops are grown on the soil.

TABLE NO. 21.
Average Loss Per Year in Pounds Per Acre.

	Potash.	Lime.	Magnesia.
Norfolk sand	9.7	70.4	13.0
Orangeburg fine sandy loam	32.1	181.0	26.8
Houston loam	18.5	258.1	46.8
Houston black clay	8.2	441.7	40.5
Yazoo clay	66.6	582.0	51.1
Miller fine sandy loam	39.0	259.0	49.2
Crawford clay	38.6	569.0	43.3
Lufkin fine sandy loam	58.6	172.0	52.7

Let us assume that a bushel of corn requires one pound of potash. Then the quantity of potash lost by percolation would produce the quantity of corn given in the following table. We also give the average active potash content of these soils, and the corn possibility as based on the active potash:

	Corn equal to potash removed in percolate.	Active potash of soil.	Corn possibility of active soil potash.
Houston black clay	8.7	362	157
Norfolk sand	9.7	69	37
Houston loam	18.5	134	51
Orangeburg fine sandy loam	32.1	153	80
Crawford clay	38.6	515	182
Miller fine sandy loam	39.0	275	120
Lufkin fine sandy loam	58.6	280	120
Yazoo clay	66.6	911	230

There is little relation between these figures, except that, in a general way, with the exception of the Houston black clay, a higher percentage of active potash is accompanied by a higher percolation of potash. The percolation of potash depends, however, not only on the solubility of the soil potash but also on the fixing power of the soil, and, as we have seen, the fixing powers of these soils are such as to reduce to a minimum the loss of fertilizer potash by percolation, except with the Norfolk sand. It is of some interest to note, however, the quantities of potash which percolated from the uncultivated soil. It is evident that losses of soil potash take place during the winter and spring months, when there are often heavy rains, and the soils are not covered with crops.

PHOSPHORIC ACID.

The quantity of phosphoric acid in some of the percolates is given in Table No. 22, but the quantities are very small. The maximum quantity lost in 1913 is 11.5 milligrams, or about 1.5 pounds per acre. The average quantity lost is 4.1 mg. per pot or 0.5 pounds per acre. These figures serve to show the small losses of phosphoric acid from these unfertilized soils.

LIME.

As was to be expected, large losses of lime occurred. Table No. 23 shows the lime and magnesia in parts per million, and Table No. 24 in milligrams per pot. With one exception, the addition of potash increased the loss of lime, although the increase is slight with several of the soils.

TABLE NO. 22.

Phosphoric Acid in Percolates.

Pot Number.		Parts per million.			Magnesia per pot.			
		July 1, 1912, to Jan. 1, 1913.	Jan. 1, 1913, to July 1, 1913.	July 1, 1913, to Dec. 1, 1914.	July 1, 1912, to Jan. 1, 1913.	Jan. 1, 1913, to July 1, 1913,	July 1, 1913, to Dec. 1, 1914.	Total, 1913.
1	Norfolk sand	......	......	......	......	......	......	......
4	Norfolk sand and potash	......	0.3	0.3	......	2.7	0.5	3.2
7	Orangeburg fine sandy loam	......	0.2	0.2	......	1.8	0.2	2.0
10	Orangeburg fine sandy loam and potash	......	0.2	0.3	......	1.5	0.1	1.6
13	Houston loam	......	0.3	0.3	......	3.6	1.8	5.4
16	Houston loam and potash	......	0.2	0.5	......	2.2	2.8	5.0
19	Houston black clay	......	0.3	0.25	......	4.1	1.7	5.8
22	Houston black clay and potash	......	......	......	......	......	......	......
25	Yazoo clay	1.3	1.4	0.3	6.5	1.4	2.0	3.4
28	Yazoo clay and potash	1.3	1.4	0.7	6.5	1.4	4.3	5.7
31	Miller fine sandy loam	0.5	0.5	0.65	2.4	4.7	0.8	5.5
34	Miller fine sandy loam and potash	0.5	0.4	0.6	1.6	2.6	1.3	3.9
37	Crawford clay	0.5	0.6	0.2	3.0	7.2	1.5	8.7
40	Crawford clay and potash	0.5	0.7	0.4	3.0	8.4	3.1	11.5
43	Lufkin fine sandy loam	0.5	0.3	0.2	2.2	2.0	0.4	2.6
46	Lufkin fine sandy loam and potash	0.4	0.2	0.4	2.0	1.7	1.4	3.1

Table No. 21 shows the loss of lime and magnesia in pounds per acre. The loss of lime varies from 70 to 582 pounds per acre per year, on the average of three years. The loss of lime and magnesia is, in a general way, related to the lime soluble in strong hydrochloric acid. This is brought out in the table below.

TABLE NO. 23.

Parts Per Million of Lime and Magnesia in Percolates.

Pot Number.		Lime.							Magnesia.						
		Jan. 1, 1911, to April 1, 1911.	April 1, 1911, to June 17, 1911.	June 17, 1911, to Jan. 1, 1912.	Jan. 1, 1912, to July 1, 1912.	July 1, 1912, to Jan. 1, 1913.	Jan. 1, 1913, to July 1, 1913.	July 1, 1913, to Jan. 1, 1914.	Jan. 1, 1911, to April 1, 1911.	April 1, 1911, to June 17, 1911.	June 17, 1911, to Jan. 1, 1912.	Jan. 1, 1912, to July 1, 1912.	July 1, 1912, to Jan. 1, 1913.	Jan. 1, 1913, to July 1, 1913.	July 1, 1913, to Dec. 1, 1914.
1	Norfolk sand, 0	83	69	140	50	130	43.2	46.0	5	16	32	13	19	13.7	22.0
4	Norfolk sand and potash	79	66	145	51	266	111.2	78.0	5	19	29	10	38	22.8	21.5
7	Orangeburg fine sandy loam, 0	233	127	193	66	198	100.2	73.5	22	18	31	11	26	20.8	24.0
10	Orangeburg fine sandy loam and potash	274	147	171	71	202	147.6	97.0	34	25	32	14	29	31.1	27.5
13	Houston loam, 0	144	117	148	53	98	49.0	44.0	23	24	24	10	20	15.0	13.5
16	Houston loam and potash	158	86	126	76	145	85.6	71.0	24	25	29	17	27	17.4	19.5
19	Houston black clay, 0	203	107	198	66	208	100.6	97.0	10	12	18	9	15	8.2	20.5
22	Houston black clay and potash	189	108	136	90	97	121.8	105.5	10	11	15	7	4	10.0	19.0
25	Yazoo clay, 0	413	199	276	118	342	182.1	154.5	14	21	29	8	27	21.6	24.0
28	Yazoo clay and potash	286	102	307	134	381	222.4	196.0	15	17	30	9	29	23.5	25.5
31	Miller fine sandy loam, 0	268	170	233	32	146	74.2	66.5	51	32	38	9	15	22.8	24.5
34	Miller fine sandy loam and potash	299	232	233	89	279	170.2	90.0	49	47	50	8	56	38.7	28.5
37	Crawford clay, 0	250	150	247	91	250	151.1	138.5	17	9	19	7	13	14.5	14.5
40	Crawford clay and potash	299	162	310	100	398	245.3	192.0	17	9	25	14	17	15.4	19.0
43	Lufkin fine sandy loam, 0	111	115	137	52	122	75.2	72.5	43	31	41	14	28	32.0	22.0
46	Lufkin fine sandy loam and potash	119	117	152	75	216	119.4	87.5	45	34	49	12	57	30.1	42.0

The soils containing less than 0.7 per cent. lime soluble in acids lose from 172 to 259 pounds lime per acre per year. Those containing over 1 per cent. lime soluble in acids lose 442 to 582 pounds per acre per year. This loss would be replaced by about 500 pounds ground limestone on the first soils and 1000 pounds on the second. With the decreased percolation of soils growing cultivated crops, these soils would, of course, lose much less lime. These soils are in no case acid.

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TABLE NO. 24.

Milligrams Per Pot of Lime and Magnesia in Percolates.

Pot No.		Lime.				Per cent lime in soil.	Magnesia.			
		1911	1912	1913	Total.		1911	1912	1913	Total.
1	Norfolk sand, 0	1256	454	22	1732	0.09	204	112	7	323
4	Norfolk sand and potash	1944	1220	1151	4315	......	358	203	244	805
7	Orangeburg fine sandy loam	2575	1011	867	4453	0.11	319	156	186	659
10	Orangeburg fine sandy loam and potash	2981	865	1138	4984	......	464	162	240	866
13	Houston loam	4132	1389	835	6348	0.17	625	271	256	1152
16	Houston loam and potash	3507	1874	1326	6704	......	732	382	298	1412
19	Houston black clay	6378	2449	2056	10863	3.30	492	249	256	997
22	Houston black clay and potash	1283	500	142	1925	......	108	38	13	152
25	Yazoo clay	7935	3340	3038	14313	2.86	610	246	398	1354
28	Yazoo clay and potash	7037	3635	3504	14176	......	620	261	400	1281
31	Miller fine sandy loam	4596	982	792	6370	0.15	805	160	248	1213
34	Miller fine sandy loam and potash	3600	1649	1350	6599	......	717	250	324	1291
37	Crawford clay	8174	2971	2847	13992	1.12	597	187	281	1065
40	Crawford clay and potash	9152	3722	4440	17314	......	645	284	331	1260
43	Lufkin fine sandy loam	2556	994	649	4229	0.59	789	247	260	1296
46	Lufkin fine sandy loam and potash	2807	8748	1339	5894	......	896	377	409	1682

	Lime lost, pounds per acre.	Average per cent CaO soil and subsoil.
Norfolk sand	70	0.09
Lufkin fine sandy loam	172	0.56
Orangeburg fine sandy loam	181	0.11
Miller fine sandy loam	259	0.15
Houston loam	258	0.18
Houston black clay	442	3.85
Crawford clay	569	1.20
Yazoo clay	582	2.72

SUMMARY AND CONCLUSIONS.

1. This Bulletin contains the results of three years' experiments on the percolation of water and mineral matter through Texas soils, in 12-inch pots, under Texas conditions.

2. Uncultivated clays and loams allowed more water to percolate than uncultivated sands and sandy loams.

3. Cultivation increased percolation through the sands and sandy loams, but had little effect upon the percolation through the loams and clays.

4. Sulphate of potash increased percolation through the sandy soils but decreased percolation through the clay soils.

5. Application of manure increased percolation from the sandy soils especially. The fall application of manure was more effective than the spring application.

6. The nitrates in the water percolating from the uncultivated soils is related to a certain extent to the total nitrogen of soil and subsoil.

7. More nitrates appeared in the percolates from manure applied October 15 than from that applied March 15. On an average, 53.7 per cent. of the nitrogen was thus changed. The nitrates produced from 9 tons of manure per year were sufficient for about 20 bushels of corn.

8. An application of nitrate of soda gave an increase in the nitrates in the succeeding percolates of two of the soils, but, with the other six soils, no effect was observed until three or four weeks later.

9. Only small quantities of potash appeared in the percolates from most of the soils, even after heavy applications of potash were made. In three years, the maximum loss was 12 per cent. with the Norfolk sand, and from 0 to 4.5 per cent. with the other soils.

10. From 9.7 to 66.6 pounds per acre per year of potash were lost by percolation from the uncropped, uncultivated soils. Losses from cropped soils would, of course, be much less. The losses are to a certain extent related to the active potash of the soil.

11. Losses of phosphoric acid in the percolates was very small.

12. Losses of lime from the uncropped, uncultivated soils vary from 70 to 582 pounds per acre and is, in a general way, related to the quantity of lime soluble in strong hydrochloric acid.

The conclusions given above may be modified or supplemented by related work carried on at the same time, in which the soils were weighed, and which has not yet been digested for publication.