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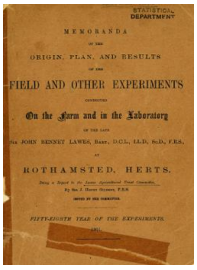
Yields of the Field Experiments 1901

Full Table of Content



Summary of Rainfall and Drainage at Rothamsted

Rothamsted Research

Rothamsted Research (1902) *Summary of Rainfall and Drainage at Rothamsted ;* Yields Of The Field Experiments 1901, pp 16 - 19 **- DOI: https://doi.org/10.23637/ERADOC-1-229**

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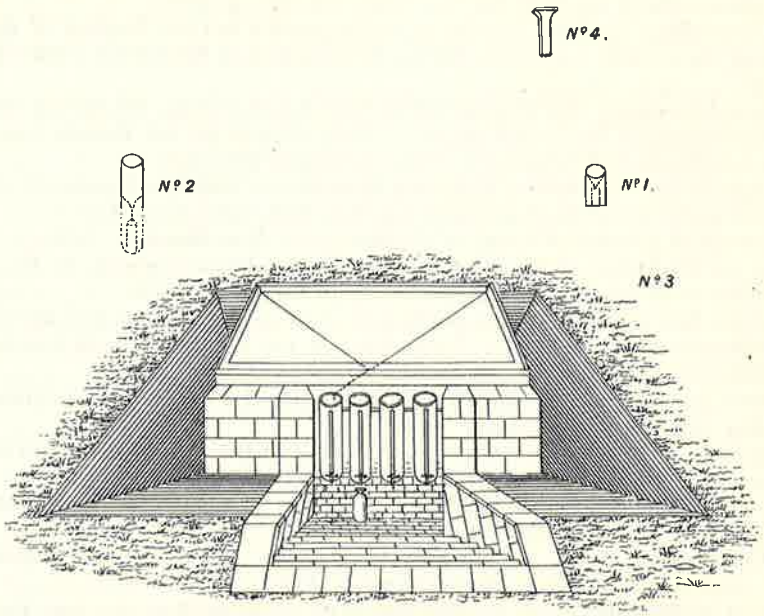
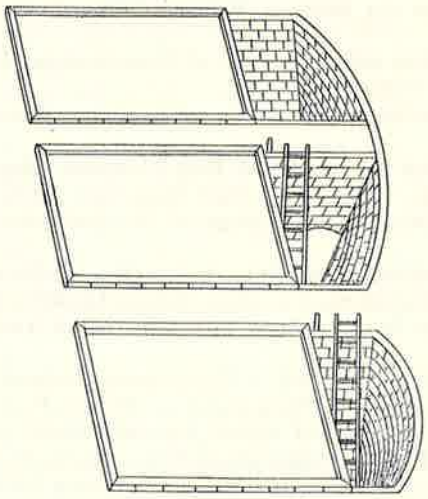
THE ROTHAMSTED RAIN GAUGES.



VIEW SHOWING THE COLLECTORS.

No. 1.—Small Funnel-gauge, 5 inches diameter.
No. 2.—Small Funnel-gauge, 8 inches diameter.
No. 3.—Large Gauge—
Size—7 feet 3·12 in. × 6 feet.
Area—One thousandth of an acre.
4 collectors, each holding Rain = 0·500 in.
Gauge-tubes graduated to .. 0·002 in.
Overflow tank to hold Rain = 2·000 ins.
Small cylinder, tube graduated to 0·001 in.
(For quantities less than 0·05 in.)
No. 4.—Stand with level marble top, for measuring.

THE ROTHAMSTED DRAIN GAUGES.



VIEW.

3 Drain Gauges—
Each 7 feet 3·12 in. × 6 feet = $\frac{1}{1000}$th acre area;
Respectively 20, 40, and 60 inches depth of soil.
2 collectors, each holding Drainage = 0·500 in.
Gauge-tubes graduated to .. .. 0·002 in.
Overflow tank to hold Drainage .. = 2·000 ins.

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GENERAL SUMMARY OF THE RESULTS RELATING TO RAINFALL AND DRAINAGE AT ROTHAMSTED.

As already explained (p. 6), the Rainfall has been measured at Rothamsted, in gauges of different sizes almost from the commencement of the Field Experiments; and the Drainage through 20 inches, 40 inches, and 60 inches, of unmanured and uncropped soil, in its natural state of consolidation, has been collected from September 1870, up to the present time, a period of nearly 31 Harvest-years. The nitrogen as nitric acid in the drainage waters was determined occasionally during the first 7 years of their collection (1870–1 to 1876–7); but from 1877–8 up to the present time, a period of nearly 24 Harvest-years, it has been determined in proportional samples for each month. A summary of the numerical results relating to rainfall, drainage, and loss of nitrogen by the drainage, will be found in the Tables at pp. 18–19.

The figures show that over the 20 Harvest-years, 1877–8 to 1896–7, there was an average annual loss of nitrogen in the drainage, of 35·07 lbs. through 20 inches, 30·83 lbs. through 40 inches, and 33·87 lbs. through 60 inches depth, of unmanured and uncropped soil; or, taking the average of the three gauges, of about 33 lb. per acre per annum of nitrogen, corresponding to an average annual loss of nearly 2 cwts. of nitrate of soda.

With reference to the large amounts of loss of nitrogen by the drainage thus indicated, it is to be borne in mind, that probably not more than an average of about 5 lbs. would be contributed annually per acre from the atmosphere in rain and the minor aqueous deposits, exclusive of any condensation by the soil. Moreover, the soil of the drain-gauges had been unmanured since 1868; but, being exposed to the access of air from below as well as from above, the oxidation of the nitrogenous matters of the soil and subsoil may be more active than in similar soil in its natural condition. On the other hand, the soil was without any vegetation to arrest the nitric acid formed; whilst, in some cases of fallow-land which had been manured and cropped in the ordinary course, and which would therefore be in a much higher "condition" than the soil of the drain-gauges, as much, or even more nitrogen as nitric acid, has been found to be present in the autumn, to the depth of 18 or 27 inches.

As the three drain-gauges of unmanured and uncropped soil have been in operation since September 1870—that is, for 30 Harvest-years to the end of August 1900—it is obviously of interest to consider whether or not there is evidence of decline in the amount of nitric acid annually formed in the soil over that period. As the drainage waters were not systematically sampled and analysed until 1877, accurate estimates of the amount of nitric acid in the drainage of the first 7 years of the experiments cannot be made; but the indication is, that it averaged more over those earlier than over the subsequent years. Examination of the results for the four 5-yearly periods of the 20 years, 1877–8 to 1896–7, shows that the average annual loss of nitrogen per acre in the drainage was, over the first 5 years considerably more than the average of the 20 years, but over the second 5 it was less than the average, and over the third 5 less than over the second; whilst over the last five years (1892–3 to 1896–7) the loss somewhat exceeded that of the preceding five years. The details show, that the excess over the first 5 years was due to very excessive amounts in the second and fourth years of the twenty; and that these were coincident with very excessive amounts of rain and of drainage. The loss over the second 5 years was considerably less than over the first, and somewhat lower than the average, and so also was the amount of rain, though the drainage was, on the average, slightly higher. The loss over the third 5 years was less than over the second, and less than the average, and so also were the average amounts of rain and drainage. Over the last 5 years again, the distinctly lower than average loss of nitrogen in the drainage, was coincident with lower than average rainfall, and generally lower than average drainage, especially in the first and fourth years.

With this general decline in the loss of nitrogen in the later years, there was, on the other hand, in the 8th year of the 20 considerably more than the average loss, in the 9th about the average, and in the 11th, 17th and 20th years considerably more, and in the 18th year rather more than the average; part of the excess in the 17th year (1893–4) being probably due to accumulation during the preceding year of drought. In each of the last four years of the first 15, however, the loss was considerably below the average, and in the 16th year, a year of drought (1892–3), there was, with nearly the lowest rainfall and drainage, also nearly the lowest loss of nitrogen by drainage. Lastly as to the details:—in October of the fifteenth Harvest-year (1891–2), there was, with a great excess of rain and drainage, very much more than the average amount of nitric acid in the drainage of that month. Indeed, in only one month during the preceding 14 years, namely in September 1880, was there more nitric acid passing through the 20-inch gauge than in October 1891. There was, however, in October of the 17th year, 1893–4, and in November of the 19th year, 1895–6, about as much loss of nitrogen as nitric acid as in October 1891. More pertinent still is the fact, that in September of the Harvest-year, 1896–7, which is the 27th of the parallel rain and drainage records, and the 20th of the monthly analysis of the drainage waters, there was, with the heaviest rainfall and drainage ever recorded at Rothamsted for a single month, also the greatest loss of nitrogen as nitric acid by the drainage, in any one month of the 20 years, and this was the case with the 20-, the 40-, and the 60-inch drain-gauges.

Obviously, the loss of nitrogen as nitric acid through the soil-drain-gauges was very directly dependent on the amount, and on the distribution, of the rain, and of the drainage. Indeed, although there seems to be some indication of a decline in the amount of nitric acid formed over the later than over the earlier years, the evidence is certainly not yet very conclusive. Thus, examination of the figures shows, that the loss of nitrogen was considerably higher in the 20th Harvest-year, 1896–7, than the average of the 20 years. On the other hand, it was actually lower in the 21st year, 1897–8, than in any of the preceding 20 years. In 1898–9 it was rather under, and in 1899–1900 over average. During the 9 months of the current Harvest-year, ending with May 1901, it was about average.

Finally, according to a revised estimate for the 30 Harvest-years ending with August 31, 1900, there has been a loss of nitrogen through the 20-inch gauge of nearly 17, through the 40-inch of 9, and through the 60-inch of more than 7½ per cent., of the total combined nitrogen in the soil and subsoil.

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NUMERICAL SUMMARY OF RESULTS RELATING TO RAINFALL AND DRAINAGE AT ROTHAMSTED.

In the Tables (pp. 18–19), are given—the average annual Rainfall over the 19 *Harvest-years*, 1851–2 to 1869–70; that is, from the commencement of the period for which the average produce, of continuous wheat (pp. 30–1), and of continuous barley (pp. 26–7), is given, up to the time when the experiments with the drain-gauges commenced. Next are given the averages of both rainfall and drainage for the first 7 Harvest-years during which drainage as well as rainfall was collected (1870–1 to 1876–7). Up to that time, the nitric acid in the drainage water had only been occasionally determined; but from 1877–8, up to the present time, it has been determined in proportionally mixed samples for each month; and the Table shows, in inches, the rainfall, and the drainage through each of the three soil-drain-gauges, respectively of 20, 40, and 60 inches depth of soil; also the difference (rainfall collected in the large gauge, $\frac{1}{1000}$ acre area, *minus* drainage), approximately representing evaporation. The Table further shows—the amounts of loss of nitrogen, in lb. per acre, in the drainage through each of the three drain-gauges, reckoned both as nitrogen, and as nitrate of soda (commercial, 5 per cent. impurity), for each of the 23 Harvest-years 1877–8 to 1899–1900; the maximum and the minimum annual rainfall, with the corresponding drainage, evaporation, and loss of nitrogen, over the 23 Harvest-years; and the averages for each of the four successive five-yearly periods, to 1896–7 inclusive; also the results for the 21st, 22nd, and 23rd, Harvest-years, 1897–8, 1898–9, and 1899–1900. Then are given, averages for four-monthly periods, and for the total Harvest-year, over the 20 years, 1877–8 to 1896–7. There are also given, in the last four divisions of the Table (p. 19)—first the average loss for each month, over the 20 years; secondly, the monthly results for the Harvest-year, 1898–9; thirdly, those for the last complete Harvest-year, 1899–1900; and lastly, similar results for the current Harvest-year (1900–1901) up to May inclusive.

Harvest-Years. September 1 to August 31.	Rainfall.		Drainage.			Difference (1), evaporated (or retained by soil).			Loss of Nitrogen per Acre in Drainage. Reckoned as Nitrogen.			Reckoned as Nitrate of Soda. (2)		
	5-inch Funnel Gauge.	$\frac{1}{1000}$th Acre Gauge.	Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.	Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.	Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.	Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Av. 19 yrs. 1851–2 to '69–70	23·80	27·04	..	..	..	..	..	..	..	..	..	..	..	..
Av. 7 yrs. 1870–1 to '76–7	28·29	30·26	12·29	12·79	10·86	17·97	17·47	19·40	..	..	..	..	..	..
1877–8	32·11	32·65	14·72	16·44	14·84	17·93	16·21	17·81	44·75	39·53	45·92	286	253	293
1878–9	40·17	41·05	24·44	26·03	24·38	16·61	15·02	16·67	59·36	46·52	60·94	379	297	389
1879–80	20·88	21·36	6·89	7·39	6·50	14·47	13·97	14·86	27·03	17·87	20·19	173	114	129
1880–1	35·85	36·77	22·38	22·84	21·26	14·39	13·93	15·51	57·78	44·22	49·95	369	283	319
1881–2	31·66	32·31	15·81	16·08	14·32	16·50	16·23	17·99	32·93	31·74	35·24	211	203	225
1882–3	33·69	34·71	20·82	21·72	19·72	13·89	12·99	14·99	32·67	36·08	38·26	209	231	244
1883–4	25·29	25·77	11·86	12·00	11·21	13·91	13·77	14·56	29·31	26·85	26·89	187	172	172
1884–5	25·90	26·78	14·82	15·14	13·98	11·96	11·64	12·80	39·55	36·71	33·86	253	235	216
1885–6	29·46	31·02	17·37	18·41	16·57	13·65	12·61	14·45	34·49	32·27	34·36	221	206	220
1886–7	22·63	23·61	10·64	12·58	11·72	12·97	11·03	11·89	25·28	21·88	24·98	161	140	160
1887–8	29·11	30·50	13·96	15·58	14·67	16·54	14·92	15·83	43·10	36·90	35·67	276	236	228
1888–9	28·79	30·09	14·64	15·82	14·33	15·45	14·27	15·76	31·96	29·25	30·50	204	187	195
1889–90	26·73	27·43	13·16	13·60	12·74	14·27	13·83	14·69	27·61	24·94	28·41	176	159	182
1890–1	22·30	23·41	9·95	9·70	9·73	13·46	13·71	13·68	25·70	19·90	22·04	164	127	141
1891–2	28·45	29·68	16·50	17·43	16·47	13·18	12·25	13·21	29·39	28·45	33·43	188	181	214
1892–3	23·11	24·08	11·58	12·35	12·10	12·50	11·73	11·98	22·61	20·40	23·72	144	130	152
1893–4	28·24	29·55	13·36	14·11	14·07	16·19	15·44	15·48	40·94	31·53	34·52	262	202	221
1894–5	27·76	28·94	15·50	16·95	16·31	13·44	11·99	12·63	37·12	33·18	34·36	238	212	220
1895–6	22·98	24·37	9·84	10·75	10·35	14·53	13·62	14·02	23·18	22·77	22·78	148	145	146
1896–7	34·91	37·24	21·88	23·86	22·80	15·36	13·38	14·44	36·62	35·77	41·40	234	229	265
1897–8	18·21	19·51	5·95	6·66	6·47	13·56	12·85	13·04	18·20	13·95	15·01	116	89	96
1898–9	23·25	24·70	11·99	12·48	12·48	12·71	12·22	12·22	33·23	28·65	30·91	213	183	197
1899–1900	30·04	31·02	16·33	16·93	17·02	14·69	14·09	14·00	37·00	33·85	37·68	236	216	241
Results for Maximum and Minimum Rainfall (Large Gauge). 23 Harvest-Years, 1877–8 to 1899–1900.														
Maximum (1878–9)	40·17	41·05	24·44	26·03	24·38	16·61	15·02	16·67	59·36	46·52	60·94	379	297	389
Minimum (1897–8)	18·21	19·51	5·95	6·66	6·47	13·56	12·85	13·04	18·20	13·95	15·01	116	89	96
Averages for 5, 5, 5, and 5 Harvest-Years (20 Years, 1877–8 to 1896–7). Also the results for the 21st year, 1897–8, the 22nd year, 1898–9, and the 23rd year, 1899–1900.														
5 yrs., 1877–8 to '81–2 ..	32·13	32·83	16·85	17·76	16·26	15·98	15·07	16·57	44·37	35·97	42·45	284	230	271
5 yrs., 1882–3 to '86–7 ..	27·39	28·38	15·10	15·97	14·64	13·28	12·41	13·74	32·26	30·76	31·67	206	196	202
5 yrs., 1887–8 to '91–2 ..	27·07	28·22	13·64	14·42	13·59	14·58	13·80	14·63	31·55	27·89	30·01	202	178	192
5 yrs., 1892–3 to '96–7 ..	27·40	28·83	14·43	15·60	15·12	14·40	13·23	13·71	32·09	28·73	31·36	205	184	200
Mean, 20 years	28·50	29·57	15·00	15·94	14·90	14·57	13·63	14·67	35·07	30·83	33·87	224	197	216
21st year, 1897–8	18·21	19·51	5·95	6·66	6·47	13·56	12·85	13·04	18·20	13·95	15·01	116	89	96
22nd year, 1898–9	23·25	24·69	11·99	12·48	12·48	12·70	12·21	12·21	33·23	28·65	30·91	214	183	198
23rd year, 1899–1900 ..	30·04	31·02	16·33	16·93	17·02	14·69	14·09	14·00	37·00	33·85	37·68	236	216	241
Averages for 4-monthly Periods, and Total Harvest-Years (20 Years, 1877–8 to 1896–7).														
Sept. 1 to Dec. 31	11·19	11·57	7·47	7·72	7·23	4·10	3·85	4·34	20·27	17·30	17·95	129	110	115
Jan. 1 to April 30	7·37	7·76	4·74	5·32	5·01	3·02	2·44	2·75	7·49	7·94	9·57	48	51	61
May 1 to Aug. 31	9·94	10·24	2·79	2·90	2·66	7·45	7·34	7·58	7·31	5·59	6·35	47	36	40
Total Harvest-year	28·50	29·57	15·00	15·94	14·90	14·57	13·63	14·67	35·07	30·83	33·87	224	197	216

(1) Calculated on the Rainfall shown by the $\frac{1}{1000}$th acre gauge.

(2) Commercial—reckoning 5 per cent. impurity.

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NUMERICAL SUMMARY OF RESULTS RELATING TO RAINFALL AND DRAINAGE AT ROTHAMSTED—*continued.*

Harvest-Years. September 1 to August 31.	Rainfall.		Drainage.			Difference (1), evaporated (or retained by soil).			Loss of Nitrogen per Acre in Drainage. Reckoned as Nitrogen.			Loss of Nitrogen per Acre in Drainage. Reckoned as Nitrate of Soda. (2)		
	5-inch Funnel Gauge.	$\frac{1}{1000}$th Acre Gauge.	Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.	Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.	Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.	Soil 20 ins. deep.	Soil 40 ins. deep.	Soil 60 ins. deep.
Averages for each Month. 20 Harvest-Years, 1877–8 to 1896–7.														
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
September	2·53	2·63	1·04	1·02	0·95	1·59	1·61	1·68	3·91	2·73	2·69	25·0	17·5	17·2
October	3·29	3·38	2·07	2·09	1·93	1·31	1·29	1·45	6·38	5·00	5·04	40·7	31·9	32·2
November	3·05	3·14	2·41	2·51	2·37	0·73	0·63	0·77	6·30	5·66	5·86	40·3	36·2	37·4
December	2·32	2·42	1·95	2·10	1·98	0·47	0·32	0·44	3·68	3·91	4·36	23·5	25·0	27·9
January	1·91	2·04	1·67	1·88	1·82	0·37	0·16	0·22	2·57	2·81	3·40	16·4	18·0	21·7
February	1·87	1·95	1·55	1·71	1·58	0·40	0·24	0·37	2·46	2·51	3·00	15·7	16·0	19·1
March	1·77	1·88	1·00	1·15	1·08	0·88	0·73	0·80	1·48	1·67	2·00	9·4	10·6	12·8
April	1·82	1·89	0·52	0·58	0·53	1·37	1·31	1·36	0·98	0·95	1·17	6·3	6·1	7·5
May	2·11	2·17	0·58	0·65	0·57	1·59	1·52	1·60	1·13	1·04	1·19	7·2	6·6	7·6
June	2·26	2·33	0·61	0·65	0·61	1·72	1·68	1·72	1·24	1·09	1·25	7·9	7·0	8·0
July	2·73	2·80	0·73	0·74	0·69	2·07	2·06	2·11	2·07	1·53	1·69	13·3	9·8	10·8
August	2·84	2·94	0·87	0·86	0·79	2·07	2·08	2·15	2·87	1·93	2·22	18·4	12·3	14·2
Total	28·50	29·57	15·00	15·94	14·90	14·57	13·63	14·67	35·07	30·83	33·87	224·1	197·0	216 4
Harvest-Year, 1898–9.														
September	0·52	0·60	..	..	..	0·60	0·60	0·60	..	..	..	..	..	..
October	2·75	2·89	1·22	1·16	1·06	1·67	1·73	1·83	5·23	3·65	3·45	33·4	23·3	22·0
November	2·32	2·44	1·87	1·81	1·72	0·57	0·63	0·72	8·67	5·73	5·70	55·4	36·6	36·4
December	2·82	3·01	2·37	2·44	2·47	0·64	0·57	0·54	9·31	6·14	6·44	59·5	39·2	41·2
January	2·79	2·96	2·46	2·71	2·75	0·50	0·25	0·21	5·13	6·20	6·65	32·8	39·6	42·5
February	2·33	2·44	2·08	2·13	2·12	0·36	0·31	0·32	2·26	3·41	4·17	14·5	21·8	26·7
March	0·80	0·87	(0·004)	0·04	0·04	0·87	0·83	0·83	0·01	0·06	0·07	(0·04)	0·4	0·4
April	2·61	2·73	0·67	0·76	0·82	2·06	1·97	1·91	0·85	1·22	1·53	5·4	7·8	9·8
May	2·64	2·81	1·12	1·18	1·22	1·69	1·63	1·59	1·39	1·79	2·32	8·9	11·4	14·8
June	1·48	1·58	0·04	0·04	0·07	1·54	1·54	1·51	0·09	0·07	0·13	0·6	0·4	0·8
July	1·18	1·27	0·16	0·21	0·21	1·11	1·06	1·06	0·29	0·38	0·45	1·9	2·4	2·9
August	1·01	1·09	..	..	(0·001)	1·09	1·09	1·09	..	..	(0·002)	..	..	(0·01)
Total	23·25	24·69	11·99	12·48	12·48	12·70	12·21	12·21	33·23	28·65	30·91	212·4	182·9	197·5
Last Harvest-Year, 1899–1900.														
September	2·36	2·46	0·26	0·19	0·16	2·20	2·27	2·30	1·40	0·79	0·63	8·9	5·1	4·0
October	3·60	3·75	2·67	2·68	2·56	1·08	1·07	1·19	10·22	7·16	8·46	65·3	45·8	54·1
November	3·69	3·76	3·46	3·45	3·44	0·30	0·31	0·32	10·58	8·82	9·49	67·6	56·3	60·7
December	1·36	1·41	0·89	0·86	0·83	0·52	0·55	0·58	2·32	1·92	2·04	14·8	12·3	13·0
January	3·54	3·67	3·29	3·54	3·46	0·38	0·13	0·21	5·20	6·48	7·20	33·3	41·4	46·0
February	4·82	4·91	4·22	4·39	4·71	0·69	0·52	0·20	3·24	5·06	6·61	20·7	32·3	42·2
March	0·95	0·96	0·13	0·27	0·28	0·83	0·69	0·68	0·15	0·34	0·44	1·0	2·1	2·8
April	1·33	1·33	0·31	0·40	0·41	1·02	0·93	0·92	0·47	0·50	0·43	3·0	3·2	2·8
May	1·06	1·08	(0·001)	0·01	0·02	1·08	1·07	1·06	..	0·01	0·04	..	0·1	0·2
June	2·56	2·63	0·04	0·05	0·08	2·59	2·58	2·55	0·07	0·08	0·14	0·4	0·5	0·9
July	1·07	1·13	..	0·01	0·03	1·13	1·12	1·10	..	0·04	0·04	..	0·2	0·3
August	3·70	3·93	1·06	1·08	1·04	2·87	2·85	2·89	3·35	2·65	2·16	21·4	16·9	13·8
Total	30·04	31·02	16·33	16·93	17·02	14·69	14·09	14·00	37·00	33·85	37·68	236·4	216·2	240·8
Current Harvest-Year, 1900–1901.														
September	0·73	0·84	(0·001)	0·01	0·01	0·84	0·83	0·83	..	0·01	0·02	..	0·1	0·1
October	2·45	2·60	0·74	0·57	0·53	1·86	2·03	2·07	3·40	1·56	2·18	21·7	9·9	13·9
November	2·45	2·61	2·16	2·40	2·41	0·45	0·21	0·20	10·04	6·89	7·09	64·1	44·0	45·3
December	3·52	3·65	2·99	3·21	3·19	0·66	0·44	0·46	9·88	7·85	7·72	63·1	50·2	49·3
January	1·02	1·18	0·67	0·88	0·85	0·51	0·30	0·33	1·56	2·04	2·00	10·0	13·0	12·8
February	1·19	1·26	0·60	0·90	0·77	0·66	0·36	0·49	1·18	1·87	1·70	7·5	11·9	10·9
March	2·39	2·57	1·50	1·84	1·75	1·07	0·73	0·82	2·54	3·24	3·44	16·2	20·7	22·0
April	2·42	2·51	1·31	1·49	1·47	1·20	1·02	1·04	2·01	2·37	2·72	12·9	15·1	17·4
May	1·77	1·81	0·40	0·49	0·47	1·41	1·32	1·34	0·63	0·76	0·87	4·0	4·9	5·5
June														
July														
August														
Total														

(1) Calculated on the Rainfall shown by the $\frac{1}{1000}$th acre gauge.

(2) Commercial—reckoning 5 per cent. impurity.

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