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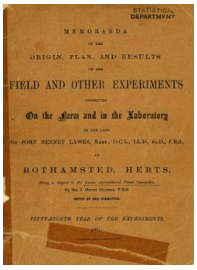
# Yields of the Field Experiments 1901

*Full Table of Content*




## Wheat; Broadbalk Field

### Rothamsted Research

Rothamsted Research (1902) *Wheat; Broadbalk Field ;* Yields Of The Field Experiments 1901, pp 28 - 31 **- DOI: https://doi.org/10.23637/ERADOC-1-229**

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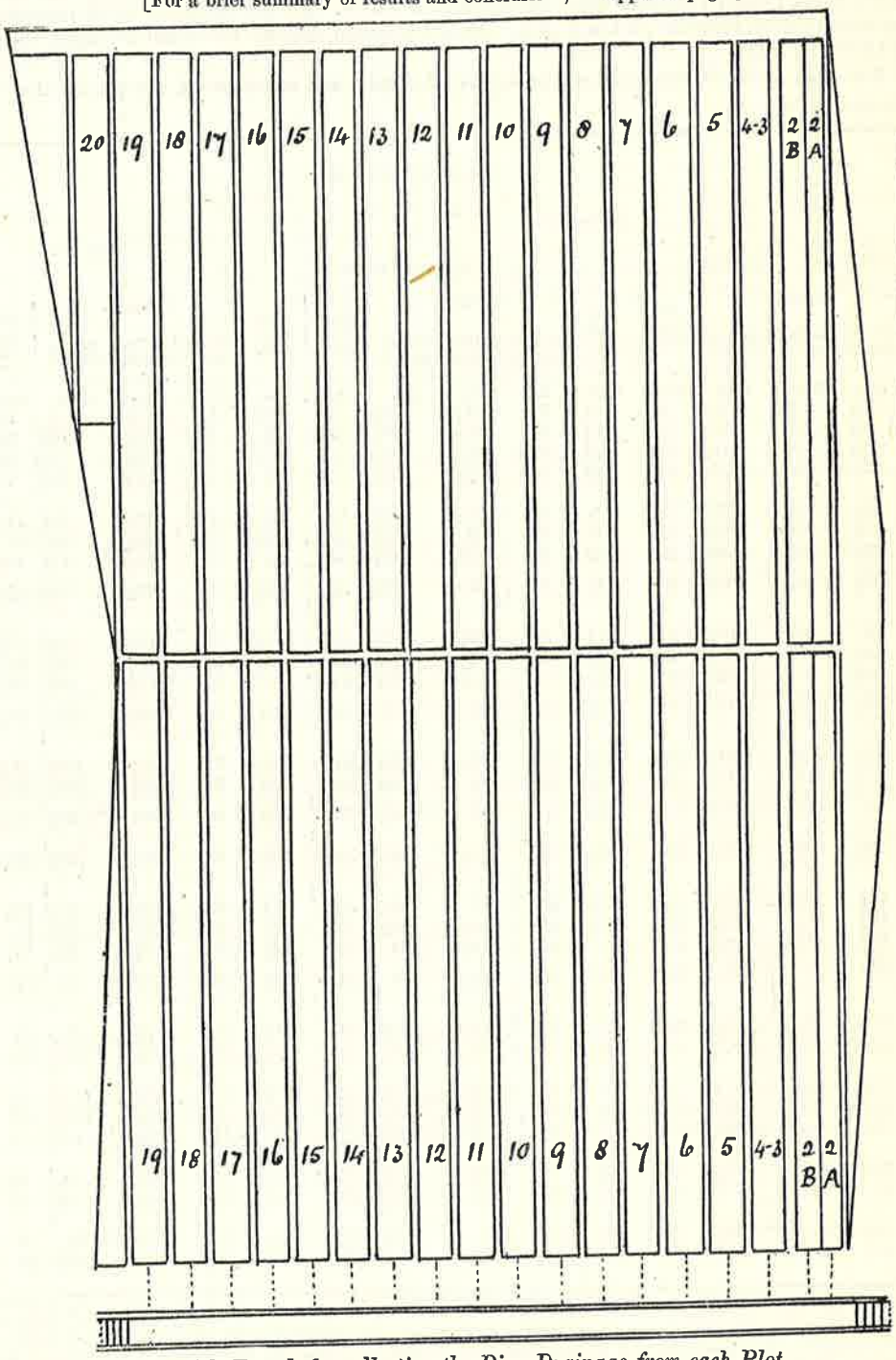
PLAN OF THE PLOTS IN BROADBALK FIELD,
ON WHICH WHEAT HAS BEEN GROWN
for 58 years in succession, 1843–4 to 1900–1901 inclusive.

[For a brief summary of results and conclusions, see opposite page.]




*Brick Trench for collecting the Pipe Drainage from each Plot.*

Total area of ploughed land about 11 acres.

Area of Plots 3–4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19, each $\frac{1}{2}$ acre.
Area of Lands A and B of Plot 2, each $\frac{9}{10}$ acre.
Area of Plot 20, about $\frac{1}{8}$ acre.

The double lines indicate division paths between plot and plot; also a path across the centre of each plot.

[For details of the manuring and produce, see pp. 30–31.]

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## RESULTS OF EXPERIMENTS IN BROADBALK FIELD ON THE GROWTH OF WHEAT,

for 58 years in succession on the same land—without manure, with Farmyard manure, and with various artificial manures. During the first 8 years, 1844–1851, various mineral and nitrogenous manures were applied, but not as a rule the same from year to year on the same plot. But, from 1851–2 to the present time, the same manures have, with few exceptions, been applied year after year on the same plots.

The results show that, unlike Leguminous crops such as Beans or Clover, Wheat may be successfully grown for many years in succession on ordinary arable land, provided suitable manures be applied, and the land be kept clean. Even without manure, the average produce over 47 years, 1852–1898, was nearly 13 bushels per acre; or more than the average of the whole of the United States of America, including their rich Prairie lands; in fact, about the average yield per acre of the Wheat lands of the whole world. Mineral manures alone give very little increase; nitrogenous manures alone considerably more than mineral manures alone; but the mixture of the two has given very much more than either separately. Indeed, in one case the average produce by mixed mineral and nitrogenous manure was more than that by the annual application of Farmyard manure; and in 7 out of the 10 cases in which such mixtures were used, the average yield per acre was from over 2 to over 8 bushels more than the average yield of the United Kingdom (which is rather more than 28 bushels at 60 lb. per bushel), under ordinary rotation.

It is estimated that the reduction in yield of the unmanured plot over the 40 years, 1852–91, after the growth of the crops without manure during the 8 preceding years, was, provided it had been uniform throughout, equivalent to a decline of one-sixth of a bushel from year to year due to exhaustion; that is irrespectively of fluctuations due to season.

For details of the manuring and produce of the different plots, see pages 30–31.

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## Experiments on the Growth of WHEAT year after year on the

Previous Cropping—1839, Turnips, with Farmyard Manure; 1840, Barley; 1841, Peas; 1842, Wheat; 1843, Oats; the last four Crops Unmanured.

First Experimental Wheat Crop in 1844. Wheat every year since; and, with some exceptions, nearly the same description of Manure on the same Plots each year—especially during the last 50 years (1852 and since). The Crop of the present year, 1901, is, therefore, the 58th Wheat Crop in succession. From the commencement of the experiments in 1843–4 up to 1876–7 inclusive, the mineral manures, the ammonium-salts, and rape-cake, &c., if any, were sown in the autumn, before the seed; excepting in 1845 and 1853, when, owing to the preceding wet autumn and winter, both seed and manures were spring sown; and for the crops of 1873, 4, 5, 6, and 7, the ammonium-salts applied to Plot 15 were top-dressed in the spring. Nitrate of soda has, however, always been sown in the spring. But, in consequence of the ascertained great loss of the nitrogen of the manures by drainage, especially in wet winters, it was decided to apply only the mineral manures (and Farmyard-manure) in the autumn, and the ammonium-salts, as well as the nitrate, in the spring; excepting on Plot 15, where, for comparison, the ammonium-salts were sown in the autumn. This plan was adopted for the crops of 1878, 1879, 1880, 1881, 1882, and 1883; but for the crop of 1884 and since, each ammonium-plot (except 15) has received 100 lbs. of ammonium-salts in the autumn with the mineral manures, and the balance of their ammonium-salts as a top-dressing in the spring: Plot 15, as already stated, receiving the whole of its ammonium-salts in the autumn.

The description of seed sown was:—for the first 5 years, 1843–4 to 1847–8, "Old Red Lammas"; for the next 4 years, 1848–9 to 1851–2, "Red Cluster"; for the next 29 years, 1852–3 to 1880–1, "Red Rostock"; and for the next 18 years, 1881–2 to 1898–9, "Club" or "Square Head" (Red). For 1899–1900, and since, "Square-Head's Master" (Red).

Notwithstanding very much labour annually bestowed on hand-hoeing, the land had, partly owing to the characters of the seasons, become very foul, *Alopecurus agrestis* (slender fox-tail) being the most prominent and troublesome weed. For the crop of 1889, therefore, down one half the length of the plots (the top), only alternate rows of wheat were sown, in order, as far as possible, to eradicate this and some other plants: the other half (the bottom) being sown in the usual way. For the crop of 1890, on the other hand, the full number of rows was sown on the top half, and only alternate rows on the bottom half of each plot, in order the better to clean that portion. For the crops

(Area under experiment.

| | |
|---|---|
| 1 acre .. .. .. = (about) 0·404 Hectare .. .. .. .. or 1·585 Prussian Morgen. | |
| 1 bushel .. .. = (about) 0·364 Hectolitre .. .. .. or 0·662 Prussian Scheffel. | |
| 1 lb. (pound avoir.) = (about) 0·453 Kilogramme .. .. .. or 0·907 Zollverein Pfund. | |
| 1 cwt. (hundredweight) = (about) 50·8 Kilogrammes .. .. .. or 1·016 Centner. | |
| 1 bushel per acre .. = (about) 0·9 Hectolitre per Hectare .. or 0·418 Pr. Scheffel per Pr. Morgen. | |
| 1 lb. per acre .. = (about) 1·12 Kilogramme per Hectare or 0·572 Zollv. Pfd. per Pr. Morgen. | |
| 1 cwt. per acre .. = (about) 125·6 Kilogrammes per Hectare or 0·641 Centner per Pr. Morgen. | |
| **Plots.** | Manures, per acre, per annum. [In 1898–9, and since, 400 lbs. Basic Slag used throughout instead of Superphosphate.] |
| 2 Land 1 | Farmyard Manure 14 tons (commencing '84–5) (10) .. .. .. .. .. .. .. .. .. .. .. .. .. |
| 2 Land 2 | Farmyard Manure 14 tons (1843–4 and every year since) .. .. .. .. .. .. .. .. .. .. .. |
| 3 | Unmanured continuously .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. |
| 4 | Unmanured for Crop of 1852, and since; previously Superphosphate (made with Muriatic Acid), and Sulph. Amm. |
| 5 (*a* and *b*) | 200 lbs. (1) Sulphate Potash, 100 lbs. (2) Sulph. Soda, 100 lbs. Sulphate Magnesia, 3½ cwts. Superphosphate (3) .. |
| 6 (*a* and *b*) | 200 lbs. (1) Sulph. Potash, 100 lbs. (2) Sulph. Soda, 100 lbs. Sulph. Mag., 3½ cwts. Superphos., 200 lbs. Amm.-salts (4) |
| 7 (*a* and *b*) | 200 lbs. (1) Sulphate Potash, 100 lbs. (2) Sulph. Soda, 100 lbs. Sulph. Mag., 3½ cwts. Superphos., 400 lbs. Amm.-salts |
| 8 (*a* and *b*) | 200 lbs. (1) Sulphate Potash, 100 lbs. (2) Sulph. Soda, 100 lbs. Sulph. Mag., 3½ cwts. Superphos., 600 lbs. Amm.-salts |
| 9 *a* | 200 lbs. (1) Sulph. Potash, 100 lbs. (2) Sulph. Soda, 100 lbs. Sulph. Mag., 3½ cwts. Superphos., 275 lbs. Nitrate Soda (5) |
| 9 *b* | 275 lbs. Nitrate of Soda (5). (For the Crops of 1894 and since, Plot 9*b* has received the same manures as Plot 9*a*.) |
| 10 *a* | 400 lbs. Ammonium-salts alone, for 1845, and each year since; Mineral Manure in 1844 .. .. .. .. .. |
| 10 *b* | 400 lbs. Ammonium-salts alone, for '45, and each year since (except '46 and '50); Mineral Manure '44, '48, '50 .. |
| 11 (*a* and *b*) | 400 lbs. Ammonium-salts, 3½ cwts. Superphosphate .. .. .. .. .. .. .. .. .. .. .. .. |
| 12 (*a* and *b*) | 400 lbs. Ammonium salts, 3½ cwts. Superphosphate, and 366⅔ lbs. (6) Sulphate of Soda .. .. .. .. .. |
| 13 (*a* and *b*) | 400 lbs. Ammonium-salts, 3½ cwts. Superphosphate, and 200 lbs. (6) Sulphate of Potash .. .. .. .. .. |
| 14 (*a* and *b*) | 400 lbs. Ammonium-salts, 3½ cwts. Superphosphate, and 280 lbs. (6) Sulphate of Magnesia .. .. .. .. |
| 15 *a* and *b*) | 200 lbs. (1) Sul. Pot., 100 lbs. (2) Sul. Sod., 100 lbs. Sul. Mag., 3½ cwts. Super. (7); 400 lbs. Amm. salts, in Autm. (8) |
| 16 (*a* and *b*) | 1852–64, 13 years, 200 lbs. Sulph. Potash, 100 lbs. Sulph. Soda, 100 lbs. Sulph. Mag., 3½ cwts. Superphos., and 800 lbs. Ammonium-salts; average produce 39½ bush. Grain, 46⅝ cwts. Straw .. .. .. .. .. |
| | 1865–1883, 19 years unmanured; average produce (19 years, 1865–83) 14⅝ bushels Grain, 12½ cwts. Straw .. |
| | 1884 and since, 200 lbs. Sul. Pot., 100 lbs. Sul. Soda, 100 lbs. Sul. Mag., 3½ cwts. Super., 550 lbs. Nitrate Soda (9) |
| (11) 17 (*a* and *b*) | 200 lbs. (1) Sulphate Potash, 100 lbs. (2) Sulphate Soda, 100 lbs. Sulphate Mag., and 3½ cwts. Superphosphate .. |
| (11) 18 (*a* and *b*) | 400 lbs. Ammonium-salts .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. |
| 19 | 1878-9 to '81–2, 1700 lbs., '83 and since 1889 lbs. Rape-cake, in Autumn. Previously, '52-78, 3½ cwts. Superph. Lime (12), 300 lbs. Sul. Am., and 500 lbs. Rape-cake; av. prod. (27 yrs., '52–78) 29¼ bush. Grain, 27⅛ cwts. straw |
| (13) 20 | Unmanured continuously .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. .. |
| 21 | Mixed Mineral Manures as Plot 5, and 100 lbs. Mur. Amm. 1852–'83—then discontinued .. .. .. .. |
| 22 | Mixed Mineral Manures as Plot 5, and 100 lbs. Sulp. Amm. 1852–'83—then discontinued .. .. .. .. |

(1) 300 lbs. per annum for Crop of 1858, and previously. (2) 200 lbs. per annum for Crop of 1858, and previously.

(3) "Superphosphate of Lime," up to 1887–8 inclusive, made from 200 lbs. Bone-ash, 150 lbs. Sulphuric acid sp. gr. 1·7 (and water); 1888–9 to 1897–8, made from high percentage mineral phosphates, and containing 37 per cent., or more, of soluble phosphate. In 1898–9, and since, 400 lbs. Basic Slag used throughout instead of Superphosphate.

(4) The "Ammonium-salts" (excepting for the crop of 1887), equal parts Sulphate and Muriate of Ammonia of Commerce. For the season 1886–7 the same quantity of Nitrogen was applied, but mostly as Sulphate Ammonia. In 1901, the second quarter from the top of Plots 6, 7, 8, 10, 11, 12, 13, 14, and 18, received instead of the portion of the "Ammonium-salts" usually applied in the spring, Bicarbonate of Ammonia containing an amount of Nitrogen equivalent to that in the "Ammonium-salts" it substituted.

(5) 9*a*, 475 lbs. Nitrate Soda in 1852, 275 lbs. in 1853 and 1854, 550 lbs. each year from 1855 to 1884. No Sulphate of Potash, Soda, or Magnesia, or Superphosphate, in 1852, 1853, or 1854. 9*b*, 475 lbs. Nitrate in 1852, 550 lbs. each year from 1853 to 1884. 550 lbs. Nitrate is reckoned to contain the same amount of Nitrogen as 400 lbs. "Ammonium-salts."

(6) For 1858, and previously—1½ time as much. (7) For 1872 and previously, made with Muriatic instead of Sulphuric Acid.

(8) 15*a*, for 1872 and previously, 400 lbs. Sulphate Ammonia, sown in the Autumn; for 1873–4–5–6 and 7, 400 lbs. "Ammonium-salts," sown in the Spring; for 1878 and since, 400 lbs. Ammonium-salts, sown in the Autumn. 15*b*, for 1872 and previously, 300 lbs. Sulphate Ammonia and 500 lbs. Rape-cake, sown in the Autumn. For 1873 and since, 15*a* and 15*b* both alike, as in the text.

(9) Owing to injury to the plant from the full dressing of Nitrate in years of drought, for the crops of 1899 and since, the Nitrate of Soda was top-dressed at twice, one-half being applied each time.

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FIELD.

SAME LAND; WITHOUT MANURE, AND WITH DIFFERENT DESCRIPTIONS OF MANURE.

of 1891 and since, however, the full number of rows have again been sown over the whole length of each plot. The amount of produce recorded in 1890 for 1889, was that obtained on the full sown, lower, or worst yielding half of the plots, and was doubtless somewhat too low. That recorded in 1891 for 1890, was that obtained on the full sown, upper, and better yielding half of the plots, which had also been thin sown, and hoed almost up to harvest, in fact, partially fallowed, the year before, and hence, although the season was undoubtedly a high yielding one, there can be no doubt that the produce as recorded was decidedly too high; and, on careful consideration of the results, the mean of the produce of the thick and thin sown portions of the plots has since been adopted for the crop of 1890. Lastly, the produce for 1891, being that of the whole of each of the plots, half of which had been thin sown, that is, partially fallowed in 1890, and the other half in 1889, was again doubtless somewhat too high. Thus, the produce adopted for 1889 was undoubtedly somewhat too low; that for 1890 probably very near the truth; and that for 1891 somewhat too high. The average produce for the three years together is, however, probably very near the truth; and the averages since taken for longer series of years, as given in the *Memoranda* for 1893, and since, are quite immaterially vitiated by the unavoidable irregularities above referred to.

After the crop of the 50th year (1893) was taken off, the two lands "*a*" and "*b*" were thrown together, and permanent division paths made between plot and plot. In a few cases in each of the years 1894 to 1898 inclusive, however, the crops on the two halves (*a* and *b*) were kept separate at harvest, and the amount of produce grown on each recorded. Below is given, besides the usual averages, the produce for both 1899 and 1900.

A plan of the plots as now arranged is given on p. 28, and a brief summary of the results on p. 29. It should be explained that for many years there were, besides the plots indicated on the plan, the manuring and produce of which are recorded in the Table below, two others, namely, Plots 0 and 1, which were under experiment up to 1883 inclusive, and the manuring and produce of which have been recorded in the *Memoranda* up to 1895, but have since been excluded from the plan and from the annual record. For the manuring and produce of these plots see previous issues of the *Memoranda*; also the Appendix Tables in No. 66 (Series 1) in the list of papers at p. 13.

about 11 acres.)

| Plots. | Produce per Acre. Dressed Grain. Quantity. Averages. 24 Yrs., 1852–75. | 24 Yrs., 1876–99. | 48 Yrs., 1852–99. | 56th Year, 1899. | 57th Year, 1900. | Weight per Bushel. Averages. 24 Yrs., 1852–75. | 24 Yrs., 1876–99. | 48 Yrs., 1852–99. | 56th Year, 1899. | 57th Year, 1900. | Total Straw. Averages. 24 Yrs., 1852–75. | 24 Yrs., 1876–99. | 48 Yrs., 1852–99. | 56th Year, 1899. | 57th Year, 1900. | Plots. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bush. | Bush. | Bush. | Bush. | Bush. | lbs. | lbs. | lbs. | lbs. | lbs. | Cwts. | Cwts. | Cwts. | Cwts. | Cwts. | |
| 2 {1 | .. | .. | .. | 34½ | 28½ | .. | .. | .. | 61⅛ | 60¾ | .. | .. | .. | 43⅝ | 31¼ | 2 {1 |
| 2 {2 | 35¼ | 35⅞ | 35½ | 42½ | 33¼ | 60 | 61⅛ | 60⅝ | 61¾ | 61¼ | 33⅝ | 34⅛ | 33⅞ | 52½ | 33⅝ | 2 {2 |
| 3 | 14 | 11¾ | (14){12⅞ / 13½} | 12 | 12¼ | 57¾ | 59⅝ | (14){58⅝ / 58¾} | 61¾ | 60¼ | 12⅜ | 8¾ | (14){10½ / 10⅞} | 9⅜ | 9 | 3 |
| 4 | 15 | 12 | | | | 58⅜ | 59¼ | | | | 13 | 8½ | | | | 4 |
| 5 | 16⅛ | 13¾ | 15 | 12⅞ | 12⅞ | 58⅞ | 59¾ | 59¼ | 62¼ | 60¾ | 14⅛ | 10½ | 12¼ | 12 | 10⅜ | 5 |
| 6 | 25¼ | 22¾ | 24 | 18¾ | 19¼ | 59⅜ | 60¾ | 60 | 61⅞ | 61 | 23½ | 19¾ | 21⅝ | 19⅛ | 16⅞ | 6 |
| 7 | 34¼ | 31¾ | 33 | 31¼ | 29¾ | 59¼ | 61 | 60⅛ | 61½ | 60¾ | 34⅝ | 31⅞ | 33¼ | 40⅜ | 26⅛ | 7 |
| 8 | 37½ | 35⅞ | 36¾ | 39⅛ | 44 | 59 | 60⅞ | 59⅞ | 61 | 60½ | 41¼ | 40½ | 40⅞ | 59⅞ | 39¾ | 8 |
| 9 {a | 37 | 32½ | (15){34¾ / 22⅝} | 25¾ | 23¾ | 58½ | 59¾ | (15){59⅛ / 56¾} | 62¼ | 60 | 42¼ | 34¾ | (15){38½ / 22⅝} | 31⅛ | 21⅝ | 9 {a |
| 9 {b | 25⅞ | 18¼ | | | | 56⅝ | 56¾ | | | | 28¼ | 17⅛ | | | | 9 {b |
| 10 {a | 21⅞ | 17¼ | (14){19⅜ / 21¾} | 22⅞ | 19¾ | 57 | 58¼ | (14){57⅝ / 57⅞} | 61½ | 58⅝ | 20⅞ | 14½ | (14){17¾ / 19⅞} | 22⅜ | 15¼ | 10 {a |
| 10 {b | 25 | 18⅜ | | | | 57⅝ | 58¼ | | | | 23¾ | 16 | | | | 10 {b |
| 11 | 27½ | 21 | 24¼ | 21¼ | 18¼ | 57¼ | 58⅝ | 57⅞ | 60¾ | 56¾ | 25⅞ | 20¼ | 23⅛ | 20⅝ | 14⅝ | 11 |
| 12 | 33⅛ | 27 | 30 | 28¾ | 24¾ | 59 | 59¾ | 59⅜ | 61¼ | 58¼ | 31¾ | 25⅝ | 28⅝ | 29¾ | 18¼ | 12 |
| 13 | 33⅛ | 29¾ | 31½ | 26¾ | 28⅛ | 59⅝ | 60⅞ | 60¼ | 60⅝ | 60⅝ | 33⅛ | 29⅞ | 31½ | 35¾ | 22⅞ | 13 |
| 14 | 33⅛ | 27⅝ | 30⅜ | 28¼ | 23¼ | 59¼ | 59¾ | 59½ | 61 | 57¾ | 32⅛ | 26½ | 29¼ | 30⅝ | 18 | 14 |
| 15 | 32⅞ | 28½ | 30¼ | 26¾ | 20¼ | 59¾ | 60½ | 60⅛ | 61⅜ | 60⅝ | 32½ | 27⅜ | 30 | 32⅛ | 17⅞ | 15 |
| 16 | 29 | 27⅛ | 28 | 37½ | 34⅞ | 59 | 59⅞ | 59⅜ | 61¼ | 60½ | 32 | 28 | 30 | 44¾ | 34⅝ | 16 |
| 17 | 16⅞ | 13⅝ | (16)15¼ | 13¾ | 29⅛(18) | 58⅞ | 59⅝ | (16)59¼ | 61⅝ | 60⅞(18) | 15⅜ | 10¾ | (16)13 | 12¾ | 23⅝(18) | 17 |
| 18 | 30¾ | 29⅞ | (17)30¼ | 26¾ | 11¾(19) | 59⅛ | 60¾ | (17)60⅛ | 61¼ | 60⅝(19) | 30⅜ | 28¾ | (17)29⅝ | 34¾ | 9⅞(19) | 18 |
| 19 | 30⅛ | 26½ | 28¼ | 28½ | 23¾ | 58½ | 59¾ | 59⅛ | 61¾ | 60⅝ | 28¼ | 24¼ | 26¼ | 33⅝ | 21⅜ | 19 |
| 20(13) | 13⅞ | 13 | (20)13½ | 12¼ | 9½ | 57¾ | 59⅜ | (20)58½ | 62 | 62 | 13¼ | 10 | (20)11⅝ | 11¼ | 7⅛ | 20 (13) |
| 21 | 21¼ | 16⅞ | (21)19 | .. | .. | 58⅜ | 58¾ | (21)58⅜ | .. | .. | 19¾ | 13⅞ | (21)16⅞ | .. | .. | 21 |
| 22 | 21 | 17¾ | (21)19⅜ | .. | .. | 58¼ | 58⅜ | (21)58⅜ | .. | .. | 19½ | 14⅝ | (21)17⅛ | .. | .. | 22 |

(10) From 1849 to 1883 one half of this land was unmanured, and the other half received Sulphates of Potash, Soda, and Magnesia; in 1884 the one half was wheat, and the other half fallow.

(11) The Manures of Plots 17 and 18 are, year by year, transposed. (12) Made with Muriatic instead of Sulphuric Acid.

(13) After the Crop of 1893 had been removed, this plot was joined to Plot 19, and a new Plot 20 was made from land adjoining, which had been unmanured for many years; growing wheat up to 1883 inclusive; and again in 1887 and 1891; Potatoes, 1889; and left fallow 1884, '5, '6, '8, '90, '92 and '93. (14) Averages of 24, 23, and 47 years, 1852–'98. (15) Averages of 21, 21, and 42 years, 1852–93.

(16) Averages of Mineral Manures, alternated with Ammonium-salts. (17) Averages of Ammonium-salts, alternated with Mineral Manures.

(18) Plot 17 had the Ammonium-salts for the Crop of 1900. (19) Plot 18 had the Mineral Manures for the Crop of 1900.

(20) Averages of 23, 24, and 47 years only; as, in 1868, owing to a mistake in carting, the produce could not be ascertained.

The Plots marked "(*a* and *b*)" were, up to 1893 inclusive, duplicate portions, "*a*" and "*b*," respectively, and were manured alike; excepting that, for the crops of 1864-5-6 and 7, the "*a*" portions of Plots 5, 6, 7, 8, 9, 16, and 17 (or 18), received a mixture of soluble Silicates in addition to the other Manures, but, hitherto, without any material effect; and for the crops of 1868 to 1879 inclusive, cut straw (that produced in the previous season) was applied (instead of Silicates) on the "*a*" portions of Plots 5, 6, 7, 8, 11, 12, 13, 14, and 17 (or 18); also for the crop of 1874, and each succeeding crop to 1879 inclusive, the straw of the previous season was cut up and applied to the "*a*" portion of Plot 15. For the crop of 1880 and since, the return of the straw has been discontinued. (21) Averages of 16, 16, and 32 years, 1852–83.

https://doi.org/10.23637/ERADOC-1-229 